



REPUBLIC OF KENYA
MINISTRY OF HEALTH

**EAST AFRICA'S CENTERS OF EXCELLENCE FOR SKILLS AND
TERTIARY EDUCATION IN BIOMEDICAL SCIENCES**

PROPOSED CONSTRUCTION OF EAST AFRICA'S KIDNEY
INSTITUTE COMPLEX AT KENYATTA NATIONAL HOSPITAL (KNH)
GROUNDS NAIROBI, KENYA

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2NO. 1300 kVA STANDBY POWER DIESEL GENERATOR
SYSTEMS INSTALLATION
(ALL RATES EXCLUSIVE OF TAXES)

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1 PART A; GENERAL SPECIFICATIONS

1.1 REGULATIONS AND STANDARDS

The equipment shall comply with all relevant statutory instruments and regulations current at the date of tender and in particular the following:

- ✚ I.E.E Wiring Regulations
- ✚ Regulation under the Electric Power Act
- ✚ Factories Act
- ✚ Any special regulations issued by the local Electricity or Water Undertakings
- ✚ Kenya Bureau of Standards (KEBS)

The equipment and all components shall comply with all relevant KEBS standards and codes of practice or other equal and approved standards specifications and codes. Where the equipment or part of it complies with other internationally recognized standards which are less stringent than British standards or Codes of practice, then the difference is to be stated in writing and must accompany the tender submission.

1.2 CONFORMITY WITH THE SPECIFICATION.

The equipment to be supplied shall conform in all respects to the specifications. Unless another standard is specifically mentioned in the specification, all materials and practices employed in the works must, where such standards exist be in accordance with the current KBS standards or code of practices or in accordance with such other authorized standard appropriate to the country of manufacture as - in the opinion of the Engineer - ensures equivalent or higher quality. .

Alternative which deviate in any respect from the specifications may only be submitted in addition to the main offer required by the Specification. Such alternative must be fully detailed and the price indicated may be considered for adoption after the comparison of quotation submitted in accordance with the Specifications.

1.3 OPERATING CONDITIONS

The equipment and all components shall be suitable for the operation in ambient conditions of 50C to 400C and up to 100% relative humidity

- i) in an unheated ventilated building
- ii) in the enclosed canopy as specified

Unless otherwise stated all ratings of equipment and components shall be interpreted as site rating and NOT sea level or other ratings.

1.4 FUNCTIONAL OBJECTIVES

The set shall be capable of operating continuously and satisfactorily in a medium dust laden atmosphere as defined in BS 1701 and in accordance with BS 649.

For a set which is required for standby duty, it will be connected to the switchboard through a circuit. It shall have an automatic mains failure control, appropriately interlocked with the other incoming supply. Provisions shall be made in the control circuit of the generator for automatic and remote push button control, including the terminals and cable glands for all external cables, which will be

supplied by others, where specified. It shall also be possible to start, operate and stop the set manually, independent of any automatic features.

Within the operating conditions specified in part 3 above the set shall be capable of starting and accepting full load within the shortest possible time, and in any case, in not more than 10 seconds.

1.5 GENERATING SET ARRANGEMENT

Unless otherwise indicated the set and its auxiliaries shall be mounted on sufficiently substantial under base. All items which must be held in correct relative alignment shall be located by means of dowels. The set shall be designed and supplied for operation bolted to the floor on robust anti-vibration and shock absorbing devices. They shall have adjusting screws for optimum setting and levelling and be so designed and installed that no appreciable engine vibration shall be transmitted to the floor or to any surrounding.

Bearings shall be suitable for operation over long periods without the need for replacement of the lubricant. Oil lubricated bearings shall be fitted with a visible oil level gauge.

1.6 DIESEL ENGINE

1.6.1 General

The engine shall comply in design and performance with BS.649 "Diesel Engines for General purposes" or its approved equivalent. The engine shall be designed for satisfactory operation on fuel oil and lubricating oils complying with BS. 2869.

The engine shall be totally enclosed, with forced lubrication from an integral pump having on the suction side a coarse strainer and on the delivery side a dual 'full flow' fine filter with a changeover cock incorporating pressure by-pass, so that the oil flow to the engine is maintained if the filter should choke. Alternatively a single filter of the self-cleaning type fitted with a by-pass relief valve and having the same filtration performance may be provided. Manual lubrication of any part of the engine will not be accepted. The capacity of the lubricating oil system shall be sufficient to enable the engine to run continuously for 12 hours at any load without replacement.

A filter with a by-pass relief valve shall be inserted in the fuel line immediately before the pump(s). The fuel filter element shall be incapable of passing particles larger than micrometers. The fuel system shall be so arranged that fuel resulting from filter, pump or pipe spillage shall be incapable of entering the engine sump. Air filters complying with KS 06-294: 1986, Grade 'A' and Grade 'B' suitable for use in a dusty atmosphere shall be fitted on the engine air intake(s)

No significant critical speed of the complete shaft system, including the generator, shall be within 15% of the rated speed. A manually reset over-speed trip shall be fitted to stop the engine if its speed exceeds the rated speed by 15%. A mechanical trip is preferred but an electrical over-speed trip may be offered. Both types shall be equipped with a pair of contacts which close on operation of the trip. If the device is belt driven, at least two belts shall be provided and the drive shall be capable of carrying full load with one belt removed.

The set shall be arranged such that on shut-down the cooling water temperature shall not rise with residual heat so that the high water temperature lock-out operates. The engine may be naturally aspirated as pressure charged, or as indicated.

The starting shall be by means of electricity supplied from a starter battery. The starter motor shall be of axial type, de-energizing by a device operated from the engine. A means of manual starting shall also be provided. Suitable means shall be provided for running by hand the engine main shaft and the associated generator to facilitate inspection and overhaul.

If weekly test runs are insufficient to prevent the drying out of the bearings, means shall be provided to ensure that the bearing surfaces are adequately and automatically wetted with lubricating oil either periodically or immediately prior to every start.

The engine shall be capable of being started from any crank position.

A thermostatically controlled 240-volt immersion heater may be fitted in the engine lubricating oil sump to facilitate starting. The heating surface loading of any lubricating oil heater(s) shall not exceed 0.015 watt per square millimeter to avoid carbonization of oil.

An efficient exhaust silencer with adequate draining facilities shall be supplied, and shall either be mounted on the set or installed in a generator room constructed as shown on the drawing indicated. The exhaust silencer system shall be so arranged that it may be readily relocated if required. Where any additional piping bends and fittings are specified, the manufacturer shall advise on any problems involved.

1.6.2 Fuel Oil System

An auxiliary fuel storage tank whose minimum capacity shall be sufficient to run the engine continuously on full load for 72 hours shall be installed in the position indicated in the contract drawing. It shall be supplied complete with supports. The tank shall be fitted with a fuel pump with a flexible suction hose to permit filling from a drum on the floor.

A three way cock shall be fitted in the line from tank to the engine to enable the fuel to be supplied from a source other than the storage tank. The position of the cock shall be clearly marked 'MANUAL, AUTOMATIC, OFF' as applicable.

A duplex oil filter shall be supplied between the storage tank and the diesel engine. The duplex filter shall be capable of being cleaned without dismantling, or in interruption of the fuel flow, and shall be easily maintainable.

The tank shall be equipped with a graduated dipstick, a clearly visible contents' gauge (not of the site glass type) and with drain, vent, overflow and inlet and outlet connection.

The set shall also have an integral belly/base fuel tank for daily services with an operational running capacity of 8 hours.

1.6.3 Lubricating Oil System

An engine driven integral gear type lubricating oil pump shall be provided. The lubricating oil system shall include an oil cooler and fine mesh filters, together with devices to indicate lubricating oil pressure and to initiate a 240 volt A.C. Lubricating oil Low pressure Alarm, Lubricating Oil High Temperature Alarm and Cooling Water High Temperature Alarm.

As separate 240 volt A.C. Motor driven automatic lubricating oil priming pump shall be provided for intermittent operation when the diesel is lying idle.

1.6.4 Starting of Engine

The diesel generator set shall have facilities for local and remote push button starting, with a Local/Remote/ Automatic selector switch at the local panel.

On mains failure the engine shall be capable of being automatically started from battery located near the generator set. The battery shall be complete with drip tray and trickle charger. All necessary relays, contacts, switches and miscellaneous items for the starting sequence shall be supplied and installed in the local control panel.

The system shall be designed to give maximum reliability in starting. The Contractor shall state in detail his proposals to ensure reliable starting and prevention of deterioration of the diesel engine, generator and exciter during idle periods.

All manually operated valves and controls on whose setting the correct operation of the automatic starting equipment depends shall be provided with locking devices.

1.6.5 Cooling System

The engine may be air or water cooled unless a preference is indicated.

1.6.6 Air Cooling of Engine

Cooling air for the engine and lubricating oil shall be provided by fan(s) mechanically driven from the engine. The cooling system shall be adequate for the total requirements of the engine when running on continuous full load and on 10% overload for one hour in accordance with BS 649 and under the conditions of Section 3.

The engine shall be so designed that the cooling air discharges into or is drawn through a reasonably airtight ducted assembly enclosing the lubricating oil cooler, the cylinder barrels and the cylinder heads of the engine. This assembly shall terminate in a flanged outlet to which trunking may be readily attached when necessary, to enable hot air from the cooling system to be discharged outside the building

Belt driven fans shall have at least two belts and the drive shall be capable of transmitting the full load with one belt removed. The cooling air temperature shall be controlled so as to maintain a safe working temperature of the cylinder head(s) and the engine shall shut down if the maximum is exceeded.

1.6.7 Water Cooling of Engine

A radiator of the air blast type shall be provided. It shall either have separate sections for water and for lubricating oil or be arranged for jacket water cooling only.

The radiator shall be mounted on the set and the fan(s) shall be mechanically driven from the engine. Where indicated the radiators shall be suitable for remote wall or floor mounting, in which case the fan shall be electric motor driven from a supply similar in voltage, phase and frequency to the alternator output and shall be started on line.

Where remotely mounted, the fan shall only operate when generating set is running and shall be controlled by a thermostat mounted in the radiator such that the fan motor will start on rising temperature 50°C and stop on falling temperature.

Belt driven fans shall be provided with at least two belts and the drive shall be capable of transmitting the full load with one belt removed. Circulation of the jacket water and lubricating oil through the respective radiator sections and /or heat exchanger shall be by means of pumps mechanically driven by the engine.

Belt driven pumps shall be provided with at least two belts and drive shall be capable of transmitting the full load with one belt removed.

Circulation by thermosyphon will be accepted provided the engine will operate under the conditions of section 6 and in accordance with BS 649. An easily visible flow indicator provided with contacts shall be fitted in the water outlet from the engine; the contacts shall close in the 'no flow' condition and shut down the set.

Alternatively in thermosyphon systems and sealed or pressurized radiator systems the flow indicator may be dispensed with providing the engine shuts down by the operation of the high temperature or low oil pressure safety devices in accordance with section 6.30.

A thermostatically controlled diverter valve shall be inserted in the engine water discharge pipe with a return to the circulating pipe section, to maintain the circulating water at the optimum temperature irrespective of the load. Alternatively a thermostatic bypass will be accepted.

A radiator make-up/expansion tank, fitted with float control inlet, shall be provided. If a sealed or pressurized unit is offered the tank may be dispensed with. Where indicated provision shall be made on the radiator framework to permit the attachment of ducting for the discharge air.

A thermometer shall be mounted near the cylinder head(s) to indicate water temperature. Where a lubricating oil cooler is fitted, thermometers shall be mounted at the oil inlet too and outlet from the engine. Alternatively, thermocouple may be provided at all thermometer positions and taken to an instrument panel.

Adequate drains shall be provided at low points in the water and lubricating oil systems of the radiator and, where applicable, of the heat exchanger.

1.6.8 Governing System

Governing shall conform to B.S. 640 Class A. The governor shall control the frequency within the limits stated in Section 6 Part. Manual speed adjustment shall be provided over a range of +/-15% of the rated speed at any load. The governor system shall be of the mechanical or hydraulic type. In addition the engine shall be fitted with an approved overspeed trip device which shall operate independently of the normal speed governor and shall act directly upon the fuel supply to the engine. The overspeed shall act at a speed of 12% to 15% in excess of normal operating speed.

1.6.9 Exhaust System

The diesel engine shall be provided with a suitable exhaust system for horizontal discharge outside the diesel generator room. The silencer shall be of spark arresting type and shall be equipped with cleaning and draining arrangements. If an exhaust driven turbo-charger is supplied it shall include air intake filters, mani-folds and outlet manifolds.

All necessary ducting, piping, supports and lagging required for the system shall be included.

Weatherproof wall boxes permitting expansion shall be fitted where the exhaust piping passes through the building wall or roof. Pipe work shall be connected at site by butt weld connections or use of flanged joints. The use of screwed connectors shall be avoided.

Flanges shall conform to the appropriate Table of B.S.10: 1962. Welding of flanges at site shall be carried out in accordance with B.S.806. The faces of flanges shall be machined and the backs shall be machined or spot faced to receive the bolt heads.

Valves and fittings shall be of approved design and manufacture and shall be subject to the same tests as the highest pressure piping or vessel to which they are connected.

1.6.10 Engine Instruments

Unless otherwise indicated the following instruments shall be provided:

- (a) A lubricating oil pressure gauge
- (b) A running hours meter
- (c) A tachometer
- (d) A water thermometer
- (e) An exhaust gas pyrometer or thermometer mounted near the mani-fold
- (f) Lubricating oil thermometers on the inlet to and outlet from the engine, when a lubricating oil cooler is fitted
- (g) Exhaust turbo-blower pressure gauge(s) as applicable

1.6.11 Pipe work, Valves and Fittings

All piping shall comply with requirements of KS-259:1989 for mild steel pipes.

Provision shall be made for ready handing of all parts of the plant during assembly or disassembly of the unit.

Adequate provision shall be made for attaching lifting devices, slings and eyebolts.

1.7 THE GENERATOR (ALTERNATOR AND EXCITER)

1.7.1 General

The generator shall comply with B.S.2613:197, for service in tropical conditions, and shall withstand being idle for considerable periods without any harmful drop in the insulation resistance.

The generator shall have a prime rated net output as specified in the schedules of the Bills of Quantities, at 0.8 lagging power factor, , 50 Hertz with brushless rotating rectifier excitation system and voltage regulator. It shall be directly coupled to the engine and be sized such that it will accept the maximum output of the engine including overload. The output voltage shall be maintained within plus or minus 2 ½ % from no load to full load conditions. The alternator shall be capable of operating within the range of plus or minus 15% of the nominal voltage according to the automatic voltage regulator.

Three phase machines shall be star connected, and a diagram showing the terminal marking and phase rotation shall be provided in the terminal box. Cables connecting the machine winding and machine terminals shall not have a higher de-rating factor for temperature than the windings.

The insulation shall comply with BS 2757 excluding Classes Y and A. The insulation shall have an oil, moisture and fungus proof finish, with a surface which will not retain dust or condensation. It shall be possible to put the set in service after long periods in unheated storage without necessarily drying out the insulation.

The alternator shall be capable of withstanding a short circuit for three seconds when under the control of the automatic voltage regulator.

1.7.2 Excitation

Excitation shall be by means of brushless direct coupled exciter armature. The alternators shall be designed for an excitation voltage at full load of not less than 50 Volts unless prior approval is given.

1.7.3 Electrical Control Panel

The Automatic Mains Failure control panel shall be provided and fitted with the following:-

- a) Two contactors and two incoming MCCB's each of suitable rating for controlling the supply from the mains transformer and standby generator.
- b) An automatic voltage regulator for the set.
- c) Control equipment as necessary including phase failure protection relay for both the mains supply and the generator supply (with both under and over voltage protection) and phase sequence protection relay for the mains supply all to fulfill the functional requirements and automatic changeover as detailed in Part 7.32
- d) One ammeter and a selector switch to measure each phase current and neutral current
- e) One voltmeter and a selector switch to read line to line and line to neutral voltage
- f) A frequency meter. The meters shall comply with BS 89, table 7.

1.7.4 General

The set is to be used for mains failure duty and an automatic starting panel shall be provided which shall contain all necessary equipment for controlling the automatic starting and stopping of the set, lubricating oil priming (if necessary), all auxiliaries, fault warnings and shut downs. All faults, warning and shut-downs shall be separately indicated. There shall be test facilities for indication lamps, etc, preferably by means of a single test button.

Means shall be provided for isolating all supplies to the starting panel either by an isolating switch or by withdrawable fuses.

When the set is stopped other than under lock-out conditions, it shall be self-resetting ready for the next start. The set shall be suitable for starting by manual means. e.g. by cranking or direct operation of the starter solenoid.

All switches and push buttons shall be clearly marked to indicate their function.

It shall be possible to operate the 'Start' and 'Stop' buttons and to see the 'Set Failure' indications without opening the panel doors.

1.7.5 Automatic Changeover Controls

The controls shall be installed and wired in the machine control panel. The control shall be provided such that on failure of the normal electricity supply, it will automatically initiate the starting of and effect the transfer of load to the standby generator. The schematic for the controls shall be approved by the Electrical Engineer before manufacture commences.

Where failure of the normal supply is referred to, it shall be defined as follows:

- a) Complete loss of voltage in one line or in all the three lines
- b) Falling of voltage below 85% of the normal voltage between two lines or line and neutral
- c) Voltage overshoot to 110% of the normal voltage between two lines or line and neutral
- d) Incorrect phase sequence

On failure of the normal supply, the unit shall operate in the following manner:

- (a) After a delay, adjustable from 0 to 15 seconds (to avoid operation by a transient dip in voltage) a signal shall be given to start the standby generating set.
- (b) On receipt of a signal from the standby generating set that it is ready to take load, and providing that the failure of the normal supply still persists, the normal supply contactor in the control panel shall open and the standby contactor shall close. If the normal supply has been restored before the changeover has taken place, the contactor shall not operate and the starting relay contacts shall open to initiate the shutting down of the standby generating set.

When the standby supply is in operation and the normal supply is restored and remains within 10% of rated voltage on all phases for a pre-set time (adjustable up to 120 second) the standby contactor shall open and the normal supply contactor shall close; the starting relay contacts shall then open to shut down the generating set.

Provision shall be made so that automatic return to normal supply can be prevented if required. Once a start signal has been sent to standby generating set, the engine starting sequence shall be allowed to continue until the set is ready to take the load before a stopping signal is sent.

A push button labelled 'Test' shall be provided to enable a failure of normal supply to be simulated. If the button is pressed and released the equipment shall complete the starting sequence, and when the set is ready to take load it shall be shut down. If the button is held depressed the equipment shall change over to the standby supply when the set is ready to take load.

Indicating lamps or illuminated panels shall be provided on the front of the panel. They shall be appropriately labelled, easily visible and shall give the following information:

- a) 'Main Supply Available'
- b) 'Generator Supply Available'
- c) 'Mains Supply on load'
- d) 'Generator Supply on load'

1.7.6 Lock out

The set shall stop and lock out to prevent further starting when:

- a) It fails to start when the electric starter motor has been in operation for 20 seconds under automatic start condition.
- b) The lubricating oil pressure falls to a value at which it would be unsafe to continue running the engine.
- c) The cooling water does not flow, when the engine is fitted with a visible flow indicator on the cooling water system.
- d)
 - (i) In water cooled engines the cooling water temperature exceeds a predetermined limit.
 - (ii) In air cooled engines the cylinder head temperature exceeds a safe maximum.
- e) The overspeed trip has operated.

Failure of the circuits concerned in sub-section 7.40(b) to 7.40(e) shall cause a set to shut down. Reset of lock out shall be by hand.

1.7.7 Fault indication

Each lock-out detailed in section 7.04 shall be indicated by a lamp on the panel together with an indication of the fault causing the shut-down. The fault warning lights shall be set to operate before the lock-out.

1.7.8 Starting Battery and Charger

The battery shall be 24 volts and capable of with-standing the loads imposed upon it by its specified duties. It may be of lead-acid or alkaline type and shall be of sufficient capacity for four starts in succession once in an eight-hour period. Auxiliary circuits connected to the battery shall be protected by fuses.

The battery shall be used to supply an automatic starting and control equipment, and relay operation shall not be impaired when the battery is supplying current to the starter motor.

A single phase supply for battery charging shall be available from the main M.V SWITCHBOARD.

A charger shall be provided which will recharge the battery after engine starting and maintain it in a charged condition when the set is standing or is in service. It may also supply the load of any automatic starting and control equipment, and an additional load up to 24 watts when the set is running and in service.

An alternative quick charge rate shall be provided. The charger shall be fitted with an ammeter to measure the charge and discharge current excluding the starter motor current.

1.7.9 Wiring and Earthing

Power cables and small wiring cables interconnecting major components shall be of the heat and oil resistant type and shall be metal sheathed or run in metal ducts or metal conduit, which shall be coded and terminated with lugs or eyes or to be soldered, the terminations shall be clearly marked with the numbers and letters of the terminals to which they are connected. Terminals shall be numbered or lettered, easily accessible and fitted with individual insulating barriers or adequately spaced. Barriers shall be fitted to separate control terminals from power wiring terminals.

All metal work housing electrical equipment shall be bonded to a brass earthing terminal and connected to station Earth and as detailed in the schedule.

1.7.10 Contactors

Contactors shall have magnetic circuits designed for a.c or d.c operation and shall be rated in accordance with ks 04-182:1982. Four pole- contactors shall be fitted for three phase-equipment and two-pole contactors for single phase equipments. Main and auxiliary contacts shall be silver faced or better.

1.7.11 Relays

Relays shall preferably be of sealed type mounted in approved plug-in bias with spring loaded retainers but if this is not practicable they shall be mounted on individual sub-bases and wired so that easy access is obtained to soldered connections. Unsealed relays shall be enclosed in individual or common dust protecting cases.

Time delays, if of the pneumatic type, shall operate on filtered air. The thermal type of time delay relay will not be accepted.

1.7.12 Fuses

Fuses shall comply with KS-183:1978. A spare fuse cartridge for each pole shall be mounted inside each equipment.

1.7.13 Rectifiers, Capacitors and solid State components

Rectifiers, capacitors and solid state components shall be suitable for any transient voltage and high currents likely to be encountered during the operation of the equipment and for the internal operating temperature of the enclosures at the specified maximum external ambient temperature.

1.7.14 Enclosures for Equipment

Enclosures for electrical and control equipment shall be drip proof and dust protecting, with adequate front and rear access as necessary for maintenance and repair. Special attention shall be given to the method of construction and to the mounting of the components to minimize the effect of vibration. Diagrams of connections in durable form shall be mounted inside the enclosures.

1.8 SURFACE FINISH

All ferrous metal work shall be either painted or processed to give a rust proof coating. Ferrous metal work to be painted shall first be either shot blasted or thoroughly wire brushed to remove all scale and oxide and immediately given one brushed coat or two sprayed coats of primer.

After not less than four hours, one brushed or two sprayed undercoats followed by one brushed or two sprayed finishing coats of heat and oil resisting quality paint shall be applied.

Successive coats of paint shall be slightly differing shades. Interior surfaces of electrical equipment enclosures shall be finished white and all external surfaces shall be finished grey (Bs 2660, colour 9-097)

Engine crank cases shall not be painted internally unless the paint is resistant to the lubricating oil.

1.9 RECORD DRAWINGS

The Contractor shall provide to the engineer four sets of the following drawings:

- a) Where indicated a building drawing showing details of cable entries, pipe entries and ducts required, and the exhaust system.
- b) A general arrangement drawing showing the principal dimensions and weight of the set.
- c) A general arrangement of the diesel engine.
- d) A general arrangement of the alternator and exciter showing terminal markings, polarity and phase rotation
- e) A general arrangement of the electrical control panel(s).
- f) A schematic and wiring diagram of the electrical control panel (s)

1.10 MAINTENANCE MANUAL

Upon practical completion of the Contract works the Contractor shall furnish to the Engineer four copies of Manuals. The manuals shall be printed on good quality paper ISO A4 size and shall have stiff covers of durable materials.

The Manual shall contain full operating and maintenance instructions for each item of equipment, plant and apparatus set out in a form dealing systematically with each system. It shall include, as may be applicable to the contract works, the following and any other items listed in the text of the specification hereinafter:

- a) System Description
- b) Plant
- c) Valve Operation
- d) Switch Operation
- e) Procedure of Fault Finding
- f) Emergency Procedures
- g) Lubrication Requirement
- h) Maintenance and Servicing periods and Procedures
- i) Colour coding legend for all services
- j) Schematic and wiring Diagrams of plant, Apparatus and Switchgear
- k) Record Drawings, true too scale, reduced to international A4 size
- l) Lists of primary and secondary spares

The Manual is to be specially prepared for the contract works and Manufacture's standard descriptive literature and plant operating instruction cards will not be accepted for inclusion unless exceptionally approved by the engineer. The contractor shall, however, affix such cards, if suitable, adjacent to plant and apparatus. One spare set of all such cards shall be furnished to the electrical Engineer.

The maker's name, the rating of the set, the contract number, the location of the site and the year of installation shall appear on the front covers.

1.11 FACTORY TESTS

The set shall be tested as a unit at the manufacturer's workshop (or elsewhere by agreement) for output and performance generally in accordance with the requirements of BS 649 and as 2613.

The Engineer shall be given adequate notice in writing of the date and time of the work tests and he, or his representative shall if he so desires, be present at such tests and given all reasonable facilities for his own inspections during the course of the tests.

Whether or not the Engineer or his representative attends the tests, he shall be furnished, by the Contractor, with copies of all relevant tests certificates.

1.12 INSTALLATION

Installation of all plant and equipment shall be carried out by the contractor under adequate supervision from skilled staff provided by the plant and equipment's manufacturer or his appointed agent.

Plant or equipment which are shipped before the relevant test certificate has been approved by the Engineer shall be shipped at the contractor's own risk and should the test certificate not be approved, new tests may be ordered by the Engineer at the contractor's expense.

1.13 SPARE PARTS

The contractor shall submit with his tender a separate priced list of recommended spare parts including any optional extras which he recommends should be purchased for the set and its control equipment and are not supplied as standard with the unit. The initial spares required at handover shall be deemed to have been included in the tender pricing.

1.14 TOOLS

A complete set of tools and general and special testing equipment shall be provided, including grease and oil guns, necessary for the normal maintenance of the set and its controls.

The tools shall be of the best quality, the spanners being of chrome vanadium steel, and shall be contained in a suitable robust steel tool box with lid fitted with a lock and two keys. All tools and testing equipment may be used by the Contractor in the execution of the contract works but will not be accepted as part of the Contract works by the Engineer unless they are handed over in clean and undamaged condition, in perfect working order and effectively in new condition.

1.15 MAINTENANCE PERIOD

The Contractor shall maintain the complete set and associated control equipment forming the unit for a period of twelve calendar months from the date that the unit is put into commission and regular use.

During this maintenance period, the contractor shall at his own expense.

- a) Make good any defects in the unit and replace any parts that fail or show signs of weakness or undue wear in consequences of faulty design, workmanship or materials.
- b) Visit the site with all diligence and attend to any such defect that arises within 48 hours of receiving notification of the defect.
- c) Carry out regular examination and services of the unit at the intervals laid down by the manufacturer, or every three months, whichever is the sooner, the service examination to include all necessary adjustments, greasing, oiling, cleaning, changing of lubricating oils (where necessary) to keep the unit in sound and efficient working order.
- d) Instruct the maintenance personnel in the proper operation, care and maintenance of the set and its equipment.

If during the maintenance period the unit is or is likely to be out of use for a period greater than 48 hours, due to the unit or part thereof developing a defect attributable to faulty design, workmanship or materials, or due to neglect of maintenance by the Contractor, the Contractor shall at his own expense immediately provide and install on free loan a suitable temporary unit for use until the required repair or replacement has been satisfactorily undertaken and the original set (or its replacement) put to proper working order.

At the end of the twelve months period of maintenance the Contractor shall (in addition to normal servicing work) carry out a comprehensive examination and test of the set and its auxiliaries, to ensure that the unit is in proper working order and in satisfactory condition for handing over to the Engineer whose representative shall be present at such examination and test.

1.16 MAINTENANCE CONTRACT

The Contractor may be called upon to enter into maintenance contract with the Employer for the servicing the Generating sets after the expiry of the initial maintenance period. The Contractor shall indicate his willingness to carry out this service at the time of tendering and shall ensure that component personnel are available locally to be called at short notice to attend to Generator faults.

1.17 TRANSPORT AND STORAGE

All plant equipment shall, during transportation, be suitably packed, crated and protected to minimize the possibility of damage, and prevent corrosion or other deterioration.

On arrival at site all plant and equipment shall be examined and any damage to parts and protective priming coats made good before storage or installation.

2 PART B: PARTICULAR SPECIFICATIONS

2.1 Location of Site

The site of the proposed works is located at Kenyatta National Hospital Grounds along Ngong Road, Nairobi.

2.2 Description of Project

The project objective is to establish the East Africa Kidney Institute Project, which shall be a centre of excellence for kidney related diseases in the East Africa Region. The project shall entail development of a complex to accommodate wards, theatres, dialysis units, administration offices, data centre and plant rooms. The complex will entail a Basement, Ground, First, Second, Third and Fourth Floors.

2.3 Scope of Sub-Contract Works

The scope of work comprises the supply, erection, assembly, wiring connection, testing, commissioning and setting to work of standby generators, synchronisation, ancillary equipment together with a control panel in accordance with the Specification and Contract Drawings to provide a complete and operable installation.

2.4 Commencement of Works

The Sub-Contractor in submitting his tender shall be deemed to have included for commencing any necessary work on site at such a time as will comply with the laid out programme by the Main Contractor.

2.5 Duration of Contract

The tenderer shall be required to indicate the anticipated contract period in the schedules appended to this document. He shall be required to phase his work in accordance with the Main Contractor's requirements.

2.6 Contract Drawings

The Sub-Contractor shall be deemed to have studied all the relevant Contract Drawings and to have allowed for any necessary provision of his Sub-Contract Works required thereby.

2.7 Statement of Compliance

The tenderer shall provide as an integral part of his bid, a statement of compliance in which he shall clearly declare any items of the specification to which his offer does not comply and an alternative which is included in the offer.

2.8 Site Visit

The tenderer shall be required to visit site and be deemed to have satisfied himself with regard to conditions under which the Sub-Contract works shall have to be carried out.

2.9 DIESEL ENGINE

2.9.1 Cylinder Block

The cylinder block shall be made of one-piece cast iron. It shall have full length water jacket with circulation around each cylinder. The cylinder block shall have wet liners with rubber seal at the bottom end.

2.9.2 Cylinder Head

The cylinder head for each bank of cylinders shall be of one piece and manufactured from cast iron. It shall be secured by studs of high tensile steel and be easily detachable. Valve seats shall be replaceable.

2.9.3 Pistons

The pistons shall be made of die cast aluminium alloy and tapered with a ground skirt. The pistons shall have at least three compression and two oil control rings. The combustion chamber and the valve recess shall be smooth contoured. The pistons shall have fully floating pins.

2.9.4 Valves

The valves shall have separate guides pressed into the cylinder head. Operation shall be of the normal pushrod/rocket type with tappet adjustment at the rocker arm.

2.9.5 Fly-Wheel

The Fly-Wheel shall be of heavy cast iron with close coupling type cast iron flywheel housing and shall have a gear ring bolted onto it. The gear ring shall have heat treated teeth.

2.9.6 Crankshaft

The crankshaft shall be forged steel with induction hardened main and journals. It shall be statistically and dynamically balanced and shall have replaceable, line steel shell bearings.

2.9.7 Connecting Rods

The connecting rods shall be of I Section forged steel.

2.9.8 Fuel and Air System

The engine shall have a non-block injection pump which is gear driven through flexible coupling. The fuel pump shall be integral and shall incorporate a hand primer. The engine shall have a multi-core injector nozzle. A fuel filter shall be provided complete with a replaceable element and the engine shall have a heavy duty oil bath air cleaner.

2.9.9 Governor

The Governor shall be of the centrifugal type operating direct on the fuel line and shall be capable of maintaining the speed constant within 33/34 of nominal output in accordance with B.S.849:1958 Class A2.

2.9.10 Protection

The engine shall be provided with the following protective devices capable of providing audible and visible alarm signals at one or more remote locations.

- (a) Low lubricating oil pressure.
- (b) High lubricating oil temperature.
- (c) High cooling water temperature.
- (d) High engine speed.

2.9.11 Instrumentation

The engine shall be provided with the following instruments to indicate various speeds and temperatures:-

- i) Tachometer indicating the engine speed.
- ii) Instrumentation to indicate the temperature of the exhaust gases.
- iii) Instrumentation to indicate the temperature of the lubrication oil.
- iv) Instrumentation to indicate the pressure of the lubrication oil.
- v) Instrumentation to indicate the pressure of the cooling water.

2.9.12 Ancillary Equipment

The Sub-Contractor shall be responsible for providing the following ancillary equipment required for the installation:

- (a) Exhaust piping and heavy duty silencer including flexible piping off the engine exhaust manifold. The exhaust piping provided shall be sufficiently long to cover the route shown on the Contract Drawings. The Sub-Contractor shall liaise with the Main Contractor for the final positioning of the exhaust pipe.
- b) Fuel day service tank for 24 hour operation capacity with contents gauge, drain pipe with cock, vent fill connection and engine supply pipe with isolating valve. The fuel tank shall be set-mounted within the base frame.
- (c) Basic set of tools and special tools or gauges required for maintenance, all contained in a steel, lockable box. The tools may include but not limited to the following:-
 - set of open-ended spanners
 - Set of ring spanners
 - circlip pliers (internal and external)
 - normal pliers
 - insulated crocodile pliers
 - set of insulated screwdrivers
 - hammer
 - valve spring compression tool
 - piston band assembling set

- set of feeler gauges
 - valve grinding tool
 - cleaning outfit for injector nozzle
- (d) Semi-rotary hand pump to be mounted adjacent to the header tank with necessary piping from pump to header tank.

2.9.13 Cooling System

Unless otherwise specified elsewhere, a suitable radiator shall be provided for the cooling water and lubricating oil requirements of the engine when operating under the site conditions stated. This shall be complete with engine driven fan and drive, guard for fan and drive, belt tensioner and all integral oil and water piping connections.

A suitable duct from the radiator face flange, extending to the engine roomwall, total distance 1.5 metres, shall be supplied incorporating a flexible section if required.

Circulation of both lubricating oil and primary water shall be catered for by means of geared or belt driven pumps, integral with the engine.

A thermostatic by-pass shall be fitted in the water outlet from the engine to give a quick warm up and even temperature control over the load range.

2.9.14 Lubrication

The engine components shall be lubricated via a pressure oil system from an integral oil pump driven by the engine. The system shall incorporate oil filters, the secondary oil filter being of the changeable type. A suitable relief valve shall be provided to maintain the pump discharge pressure within safe limits.

2.9.15 Starting

The engine shall start up by means of a D.C motor which shall be supplied from a set of rechargeable batteries of an appropriate voltage and of such a capacity as to enable up to ten start-ups in one hour when fully charged.

2.9.16 Compliance

The equipment and installation shall comply with B.S. 5514.

The Sub-Contractor shall in his statement of compliance confirm that the engine would be capable of running fuel to BS 2869: 1988 Class A2.

2.9.17 Noise Level

The Sub-Contractor shall state in his statement of compliance the level of noise in decibels expected in the engine room. In any case this shall not exceed 70 dBA at 7m. **The set shall incorporate an integral acoustic canopy to significantly reduce the noise level.**

2.9.18 Ancillary Power Requirements

In selecting the size of the diesel engine, the Sub-Contractor shall make suitable allowances for power requirements for the cooling system, the lubricating system and any other requirements that may be necessary for that set.

2.9.19 Ventilation

The Sub-Contractor must ensure that adequate ventilation in the generator room is provided. If any alterations need be carried out to facilitate this, the Sub-Contractor shall communicate this information before installing the generator set.

2.9.20 The proposed set by tenderer

The Tenderer to attach the details specification of the set to be supplier.....
.....

2.10 GENERATOR SET

2.10.1 Alternator

The alternator shall be of 12 wire reconnectable brushless type rated at 0.8.p.f lagging in accordance with B.S.2612:1975 and having a revolving field, a single self aligning roller bearing and solid half coupling to connect to the engine.

The alternator shall be screen protected, drip-proof and shall be wound with high temperature, tropicalised class B insulation of the stator and class F insulation on the rotor. The stator frame shall be barrel design with conventional two layer winding in semi-enclosed skewed slot, pitched to give a good wave-form with low harmonic content.

The rotor core shall be specially constructed with strip winding to obtain maximum cooling to the rotor and stator.

2.10.2 A.C. Exciter

An A.C. exciter of direct-coupled flange mounted type shall be supplied. The exciter frame shall be of modular iron and shall serve additionally as the bearing housing. The exciter armature shall be mounted on a tub on the alternator shaft. Connections shall be taken to the rotating rectifiers, which shall be carried on aluminium castings, from the main room.

2.10.3 Automatic Voltage Regulator

A Thyristor type static automatic voltage regulator shall be built into the machine. This regulator shall incorporate a zener diode bridge reference voltage circuit, thyristor drive reactor with series silicon diode and a further commutating diode. Under steady conditions, the automatic voltage regulator shall maintain the voltage within plus or minus 2 1/2% for all balanced loads between no load and full load at power factors between unity and zero lagging. The automatic voltage regulator shall be complete with hand-operated manual control potentiometer which shall be fitted in control panel.

The voltage level controls shall enable the terminal voltage to be adjustable within the range - 5% to +10%

The Voltage drop controls shall be adjustable for proper division in reactive kVA when operating in parallel with other alternators.

The voltage gain controls shall be adjustable to compensate for engine speed variations when operating with a speed-droop governor. After any change of load, the voltage shall not vary by more than plus or minus 15% the rated voltage, and shall return to within plus or minus 3% within 3 seconds, and to within plus or minus 2.5 % of rated voltage within 15 seconds. On starting, the voltage overshoot shall not exceed 15% and shall return to within plus or minus 3% within 3 seconds.

2.10.4 Terminal Box

Any suitably dimensioned terminal box suitable for conduit or cable entry shall be supplied with undrilled gland plate.

2.10.5 Rating

The machine shall be continuously maximum rated in accordance with B.S. 2613 and shall be so derated owing to site conditions - at the specified electrical output is obtained from the alternator. The Sub-Contractor shall provide additional labelling on the generator to distinguish clearly between the nameplate ratings and the actual ratings on site.

The tenderer's manufacturer's catalogue should indicate the percentage reductions from the nameplate rating resulting from altitude and inlet temperature for any of the following engine variations:-

- (a) Naturally aspirated
- (b) Turbo-charged without a charge air cooler.
- (c) Turbo-charged with a charge air cooler.

2.10.6 Radio Interference Suppression

The generator sets shall be suppressed for radio interference in accordance with B.S.800 and VDE Class G/N.

2.10.7 Duty Performance

The generator will be used as a standby duty generator continuous rated.

2.10.8 Generator Set Specification

The proposed generator shall have an integral acoustic canopy (locally manufactured canopies not acceptable) and shall be rated for the following parameters after suitable derating for the site service conditions and allowing for power requirements for integral cooling system, lubricating system and any other integral parts of the set.

Generators output	1No.1300kVA Unit
Power factor	0.8 lagging
No load voltage	415 volts
Phases	3
Frequency	50Hz
Speed	1500 r.p.m.
Ambient Temperature	up to 37 ⁰ C.

2.10.9 Testing and Commissioning

The Sub-Contractor shall include for fully commissioning the set and its control equipment, and for the purpose of the required tests, shall provide all necessary instruments, tools, fuel and lubricating oil.

The tests and checks shall be carried out by the Sub-Contractor in the presence of the Engineer or his representative, as applicable.

- i. Check that the main frame is level in all directions, engine and generator shafts are in proper alignment and the vibration absorbing devices are properly installed and located.

- ii. Check water and sump oil levels and that the water jacket is in working order.
 - iii. Check the battery electrolyte levels and the specified gravity.
 - iv. Ensure that sufficient oil is in the fuel tank for a two hour test run.
 - v. Examine the containers in which the fuel and lubricating oils were delivered and check that the type of oils are recommended for the unit.
 - vi. Check that the engine block water drain points are free from sludge and other blockages.
 - vii. Check engine bolts, main drive coupling, valve clearance, fuel pumps section, governor settings, pipe line connections, water hose, exhaust couplings, flexible pipe-work etc. and the ball valve and overflow work.
 - viii. Check all out-going connections on the generator and at the control panel. All lugs for principal connections shall have clean and bright contact surfaces. A suitable abrasive material shall be used where necessary.
 - ix. Check access panels and doors for proper opening and closing and for the functioning of any interlocks fitted.
 - x. With the set isolated from the main supply and the selector switch in the 'Manual' position, start the engine by means of the 'start' push button and allow it to run up to normal speed. Check that during the time the engine starter
 - xi. Check that during the time the engine starter motor is in operation, the mains battery charger is automatically switched off to avoid its being overloaded by the reduction in voltage across the battery.
 - xii. Check instruments and gauges for normal operation and response and that the generator voltage is being maintained within the prescribed limits, making due allowance for no-load conditions. Compare the reading of the frequency meter with that of the engine tachometer.
 - xiii. Stop engine by turning selector switch to "off" position and verify that generator contactor opens as between 95% and 85% normal voltage. Re-check water and oil levels.
 - xiv. Turn selector switch to 'Auto' position. Disconnect the sensing circuit supply and check that the set starts, the mains contactor opens, and the generator contactor closes in correct order. Reconnect the sensing circuit to verify that the engine stops on restoration of the mains supply and the contactors operate correctly. Check voltage sensing time delays on each phase in turn and also that the push buttons for mains failure simulation and engine stopping operate correctly.
- NB** Running of the engine for any length of time under-no-load conditions is undesirable and tests calling for such operation should be carried out in as short a time as is consistent with thoroughness.
- xv. Operate the necessary isolators and switches to put the set on stand-by for essential services network with the selector switch in the 'Auto' position, and

using the mains failure simulation push, verify that the set operates correctly with the appropriate time delay for taking up load and that the carrying of the load and its distribution over the three phases are satisfactory.

- xvi. Run the set at various loads for periods totalling at least 30 minutes. Check the voltage and current in each phase in turn and that the voltage and frequency are being maintained within the required limits with large alterations of load.
- xvii. Check the operation of the turbo-charger units and the colour of the exhaust gas at various loads.
- xviii. Check that the various engine safeguards operate satisfactorily.
- xix. Check the vibration absorbing devices for proper operation and that the performance of all flexible connections, both mechanical and electrical, is satisfactory.
- xx. Re-check the lubricating oil and water level, replenish the fuel oil tank and leave the set in normal operating order.
- xxi. An initial supply of all lubricating oils and greases shall be provided by the Sub-Contractor.

2.11 CONTROL PANEL

2.11.1 General

The generator set control shall be a microprocessor-based generator set monitoring, metering and control system which gives the operator a high level of information and control for monitoring and operating the generator set including comprehensive metering. By lagging trends it shall be possible for the generator to avert possible faults in future.

The control panels shall be totally enclosed IP 32 type plant mounted on an anti-vibration mountings on the alternators, fitted with removable covers giving access to the control gear, terminal and connection blocks and undrilled gland plates for cables entry and shall be finished in tropicalized weather proof paint to suit the set. The control panels shall be rated for 2No. 1300kVA Unit output of the generators.

2.11.2 Function

The control cubicle shall house the start/stop buttons and protection systems and shall be complete with all the necessary relays and circuitry for the following requirements.

It shall integrate automatic voltage regulation and engine speed governing.

It shall provide true alternator overcurrent protection, incorporate additional protective functions and offer some degree of load protection.

It shall regulate short circuit current, limiting damage to the distribution system, particularly during single-phase faults.

2.11.3 Control and Logic Section

Facilities shall be available with suitable circuit breakers protection for the following functions:-

- (a) Manual start
- (b) Manual stop

- (c) Stall lockout, i.e. a lockout to prevent re-cranking of an engine upon fuel failure, or stall conditions.

2.11.4 Protection Circuits

Suitably fused protection circuits, for oil, water, speed and one spare, shall be allowed for. The first stage protection shall be by means of fail-safe circuits while the second stage shall be energised on halt circuits. All circuits except overspeed shall be commissioned after a delay following engine start-up.

The circuits for:-

- (a) Lubricating oil pressure
- (b) Water temperature
- (c) Spare.

Shall be either alarm, or alarm and shut-down. The latter shall be achieved by means of a link within the control panel.

The circuit for engine overspeed shall give simultaneous alarm and shut down. When the engine has a faulty condition, the protection circuits shall still accept further faults. Once a shut-down signal has been given, the protection circuits shall be locked on so as: -

- i. Not to give further fault indication as engine stops.
- ii. To give indication of fault condition even when the engine has stopped.

The fault circuit shall be re-set by pushing the "Re-Set" button.

One audible alarm mute shall be provided for each fault channel. This shall mute the alarm for the fault causing the alarm, but shall leave the others prepared for further faults.

2.11.5 Switching Section

A suitably fused switching section for engine functions as per list below shall be provided:

- (a) Fuel rack solenoid (start or stop)
- (b) Starter motor solenoid via a repeater.

2.11.6 Indication

Indicator lamps (LEDs) as per list below shall be provided:

- (a) Engine running and protection circuits commissioned - green.
- (b) Fault parameters - all red.

The indication circuits shall have a lamp test pushbutton by means of which the LED's can be tested.

2.11.7 Control Switching

A rotary switch with off/on positions, to switch the control circuit supplies. In the 'ON' position the engine shall be started by depressing a push button and stopped by depressing a 'Stop' push button.

The indicators, switches and push buttons shall be mounted on the front face of the chassis unit.

2.11.8 Alarm

The Contractor shall supply and install an alarm bell which is loud enough to be heard even when the engine is running. The supply for the bell shall be obtained from the control cubicle through suitably rated fuses or circuit breaker.

2.11.9 Mains Detection

A mains detection unit which can register a mains voltage failure under the following conditions shall be provided: -

- (a) Failure of any one or more phases
- (b) Incorrect phase sequence {Contractor shall check phase sequence prior to connection if the detection unit is not available}.
- (c) Over/under volts on any individual or all phases -
i.e. -15% and +5% nominal voltage.
- (d) Excessive frequency change i.e. minus or plus 3 Hz.

The failure condition shall be used to produce a start signal for the standby engine after a delay. The delay shall be adjustable and shall ensure the failure is not a transient condition.

Mains detection units shall receive their sensing supplied from the busbars feeding the load.

2.11.10 Switchgear, Instrumentation and Controls

The following equipment shall be provided by the Generator supplier:-

- (a) Moulded case circuit breaker, triple pole and neutral, with magnetic release to provide alternator short circuit protection, trip free handle and shunt trip.
- (b) One bolted neutral link.
- (c) Alternator voltage trimmer regulator.
- (d) 3 No. one per phase, flush mounting voltmeter.
- (e) 1 No. one flush mounting ammeters.
- (f) 1 No. one voltmeter rotary selector switch
- (g) One set of control circuit instruments and the accompanying fuses.
- (h) All internal wiring, terminals, cable lugs, legends and one main earthing bar.
- (i) One No. frequency meter.
- (j) Cable boxes and glands to suit.
- (k) Generator hours run meter.
- (l) Kilowatt hour meter.
- (m) Ammeter selector switch.

2.11.11 Terminations

All internal wiring terminations shall be numbered and marked with appropriate and approved tags whose writing shall not wear out with time.

2.11.12 Trickle Charger

The trickle charger shall have rating and service parameters such as to keep the engine start batteries fully charged and ready for service whenever required. When the engine is running the batteries shall be charged from an integral charger alternator.

2.11.13 Battery Monitoring System

There will also be a battery monitoring system to warn if battery is "weak" or charge drops too low for a prolonged period of time.

2.11.14 Hours Counter

The Contractor shall allow for the installation of an hours counter on the control panel of the generator.

2.12 AUTOMATIC PARALLELING PANEL

2.12.1 Control Panel

A Motorized unit shall be provided which, on failure of the normal electricity supply, will automatically initiate the starting of and effect the transfer of load to the stand-by generator. The unit shall contain power contactors and ancillary apparatus as specified. The unit shall be provided by Electrical Contractor however supplier shall coordinated and allow all the necessary accessories to make system functional.

2.12.2 Mains Supply Failure

Failure of the normal supply shall mean complete loss of voltage or the falling below 85% of the nominal voltage between any two phases or phase and neutral.

2.12.3 Normal & Standby Contactors

The power circuit shall consist of two motorized breakers feeding a common busbar to which the load will be directly connected. One breaker shall control the normal supply, the other standby supply they shall be electrically and mechanically interlocked so that they cannot both be closed at the same time. These breakers shall be 4 pole rated as shown on the contract drawings.

2.12.4 Mains Failure Changeover Operation

On failure of the normal supply, the unit shall operate in the following manner:-

After a delay, adjustable from 0 to 5 seconds (to avoid operation by a transient dip in voltage) a signal shall be given to start the stand-by generating set.

On receipt of a signal from the stand-by generating set that it is ready to take the load and providing that the failure of the normal supply still persists, the generator supply contactors shall close. If the normal supply has been restored before the change-over has taken place, the contactors shall not operate and the starting delay contacts shall open to initiate the shutting down of the stand-by generating set.

2.12.5 Normal Supply Restoration Changeover Operation

When the stand-by supply is in operation and the normal supply is restored and remains within 10% of rated voltage on all phases for a pre-set time (adjustable) the stand-by contactor shall open and the normal supply contactors shall close; the starting relay contacts shall then open to shut down the stand-by generating set.

Provision should be so made that automatic return to normal supply can be prevented if required.

2.12.6 Stop Signal

Once a start signal has been sent to the stand-by generating set, the engine starting sequence shall be allowed to continue until the set is ready to take the load before a stopping signal is sent.

2.12.7 External Connections Facilities

By addition of external connections the following facilities shall be available if specified in the Bills of Quantities.

Remote starting of the stand-by generating set and transfer of the load to it.

Restoration of the normal supply on failure of the stand-by generating set.

2.12.8 Switches

Each switch shall be labelled with its duty and each position shall be marked. The following switches shall be fitted:-

Contactors control switch, with make before break contacts and 'Hand' and 'Auto' positions. In the 'Hand' position the unit shall be controlled by the "Contactor Hand Control Switch". In the 'auto' position the unit shall operate automatically irrespective of the position of the "Contactor Hand Control Switch".

A Contactor Hand Control Switch; with 'Stand-by' and 'Normal' position.

An Auto Return Switch, having 'on' and 'off' positions. In the 'on' position the return to normal supply shall be automatic when the normal supply is restored.

2.12.9 Indicators

Indicating lamps/LED shall be provided. They shall be appropriately labelled easily visible and shall give the following information.

- (i) Normal supply available.
- (ii) Stand-by supply available.
- (iii) Normal supply in use.
- (iv) Stand-by supply in use.

A test push button shall be provided on the panel to test the lamps/LED.

2.12.10 Test Button

A push button labelled 'Test' shall be provided to enable a failure of normal supply to be simulated. If the button is pressed and released the equipment shall complete the starting sequence and when the set is ready to take the load it shall be shut down. If the button is held depressed the equipment shall change-over to the stand-by supply when the set is ready to take load.

2.12.11 Control Circuit Power Supply

The control circuit supply shall be either 12 volts or 24 volts d.c depending upon the starting battery and charger. No current shall be drawn from the control supply when the unit is accepting the normal power supply.

2.13 BY-PASS SWITCHES

2.13.1 General

The by-pass switch should be suitably labelled to show the normal and by-pass position. It shall be in a suitable enclosure.

Contactor By-Pass switches; shall be provided to enable the essential load circuits to be served direct from the normal supply to enable the generator and/or the control equipment to be serviced. The by-pass switches shall be provided with a suitable and conspicuous label warning against leaving the generator in the disconnected position.

PART C

BILLS OF QUANTITIES

3 PART C: BILLS OF QUANTITIES

3.1 GENERAL NOTES TO TENDERERS

1. The Bills of Quantities form part of the contract documents and are to be read in conjunction with the contract drawings and general specifications of materials and works.
2. The prices quoted shall be deemed to include for all obligations under the sub-contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding 16% VAT**).
3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.
4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the sub-contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality will be accepted.
5. Should the sub-contractor install any material not specified here in before receiving **written approval** from the Project Manager, the sub-contractor shall remove the material in question and, **at his own cost**, install the proper material.
6. The grand total of prices in the Summary of Volume 1 must be carried forward to the **Form of Tender for the tender to be deemed valid**.
7. The Bills of Quantities are divided generally into three sections:-

a. Contractual Requirements – Bill 1

Sub-contractors contractual requirements as called for the bill of quantities shall be priced and included in the tender. However the Tenderer is free to include and price any other items he deems necessary taking into consideration conditions he is likely to encounter on site.

b. Installation Items – Other Bills

The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the contract Drawings, conditions of contract and specifications. The unit of measurements and observations are as per Volume 1 or as indicated in the Bills of Quantities.

c. Summary

The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, summary volume included. The sub-contractor shall insert his totals and enter his grand total tender sum in the summary of prices of Volume 1.

3.2 BILLS OF QUANTITIES

SECTION D.W. 1.0 TITLE: PRELIMINARIES & CONTRACTUAL REQUIREMENTS

Item	Description	Unit	Qty	Rate	KShs.
1	<u>CONTRACTUAL REQUIREMENTS</u>				
A.	Preparation of working drawings, printing and distribution.	Sum			
B.	Preparation of ‘As Installed Drawings’, printing and distribution as specified. Drawings to include: (a) Blue Prints - 4 sets of each. (b) AutoCAD on CD – 2 No. (c) Operational Instructions, manuals and test certificates	Sum Sum Sum			
C.	Allow Kshs. 4,200,000.00 Provisional sum for overseas factory inspection to cater for 6 No. persons (Client Rep- 1 No., SDPW Electrical Engineer – 1, No. SDPW Technical – 1 No., User Departments Reps – 2 No., Consulting Electrical Engineer – 1 No.) for generator	Sum			4,200,000.00
D.	Any other item necessary to complete the installations in this section (please state)	Sum			

Total Carried to Main Summary Page

SCHEDULE NO. 7A**STANDBY BACK UP POWER GENERATION SYSTEM (1000kVA)**

Item	Description	Unit	Qty	Rate	KShs.
	Supply & Installation of the following complete as specified:				
A.	Sound attenuated 1300kVA 415V 50Hz prime rated diesel engine generators set complete with control panel suitable for AMF operation and for parallel operation of the set as specified. As well as initial fill of diesel. (with BMS compatible control panel)	No.	1		
B.	3200A 3 phase Generator synchronizing panel as specified on drawing with BMS interfacing points complete with all signals cables and associated accessories (Allow Future Second Generator Interconnection and Control System as shown on the drawing).	No.	1		
C.	Supply, Install, Test and Commission 50,000 litres Normal Capacity Double Walled Carbon Steel Fusion daily fuel tank. The tank shall UL Fire Rated supplied complete with a man-way, 570mm square man lid 8mm thick BMS interfaces as specified	No.	1		
D.	Fuel Pipe Work				
	Supply, deliver and install seamless Sch. 32 Dia. steel pipes to API 5L for flanged welded connections, complete with all inline couplings, unions, connectors, reducers, joints, etc as required for complete installation.	LM	10		
	Ditto 32mm Dia	LM	20		
	Ditto 25mm Dia	LM	30		
	Ditto 80mm Dia	LM	1		
	Extra over Tubing	Sum			
	80mm Dia. Tank Loading CS Check Valve	No.	1		
Total Carried forward to collection Page					

Item	Description	Unit	Qty	Rate	KShs.
E.	Fuel Management System Supply, deliver and install Fully Wired Fuel Control Panel Level Switching complete with continuous fuel level indication, 25 Dial Digital float switches for genset level indicators, Float controlled solenoid valve to monitor/trigger feed to the gensets base tank, the LAN Connection Provision and any other control required to monitor the fuel system as shown on the drawing. Automatic Fuel Pump Transfer system both duty and standby Set complete with BMS comptible control panel 15mm Dia. Spirax Sarco Float Controlled Normally Closed Solenoid Valve 32mm Dia. CS Isolation Valve Ditto 25mm Dia. CS Isolation Valve 32mm Dia. CS Non-Return Valve Ditto 25mm Dia. CS Non-Return Valve Float level probes /sensors(2)-22150 By-pass line with isolation valves	Set	1		
		No.	3		
		No.	1		
		No.	2		
		No.	1		
		No.	2		
		No.	2		
		No.	1		
F.	Allow for Electrical wiring and cabling complete with 25mm Dia. HG Galvanized Steel Conduits.	Sum			
G.	Exhaust Extention	m	45		
H.	Radiator extract system and engine exhaust system ducting, piping, insulation, jackets complete with support structure and fixings.	No.	1		
I	Residential type environmentally friendly silencer with support structure and fixings.	No.	1		
J	Batteries and charger both internal; and external.	No.	1		
K.	BMS Contacts points for generators and fuel tank	Sum			
L	Copper earthing mat 1000mmx1000mm constructed of 25mm x 3mm copper tape at 150mm intervals laid 600mm deep in ground	No.	1		
Total Carried forward to collection Page					

Item	Description	Unit	Qty	Rate	KShs.
M	40mmx3mmx300mm long station earth bar mounted on insulators and installed in the location within gen-room as agreed on the site including connections of 120mm ² ECC	No.	1		
N	Allow for fixing of gen set to floor slab as recommended by the Manufacturer	Item	1		
O	Factory Test and commission the sets as per the requirements of the specification and provide a log of tests under different loading conditions in an agreed format.	Item	1		
P	Documentation, operating manuals, working drawings and record Drawings	Item	1		
Q	Warranty for 12 months from date of commissioning including regular servicing for 12 months as per the recommendations of the Manufacturer.	Item	1		
R	Any other item necessary to complete the installation in this section.	Sum			

Total Carried forward to collection Page

MAIN SUMMARY OF PRICES

Item	Description	Unit	Qty	Rate	KShs.
1	Sub-Contract Preliminaries & Contractual Requirements (Page A/24)	Sum			
2	Page – D/15	Sum			
3	Page – D/16	Sum			
4	Page – D/23 - 1No. 1300kVA Power Generator Installation	Sum			
	SUB TOTAL				

Total Carried Forward to Main Summary of Volume I

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4 PART D: TECHNICAL SCHEDULE

4.1 Documentation Requirements

Document	With Bid	Before Manufacture	During FAT	Upon Delivery
Preliminary general arrangement drawing (with dimensions)	YES			
QA / QC Plan in accordance with ISO 9001:2008		YES		
General arrangement drawing (with dimensions)		YES		
Schematics/Line diagrams for construction	N/A	YES	N/A	N/A
Recommended Spares List	N/A	N/A	N/A	YES
Routine Test Reports / Certificates			YES	
Type Test Reports / Certificates	N/A	N/A	YES	N/A
Commissioning Procedure	N/A	N/A	N/A	YES
As-built General arrangement drawing			YES	
As-built Schematics			YES	
Site Test Reports / Certificates				YES
Special Test Reports / Certificates	N/A	N/A	YES	NO

4.2 TECHNICAL SCHEDULE

The tenderer must submit comprehensive manufacturer's technical brochures and performance details for all items listed in this schedule.

ITEM No.	Description	Particulars
A	Engine	
B	Alternator	
C	Cable	
D	Underground Fuel Tank, pumping system	
E	Spares and Lubricants	

5 PART E: DRAWING SCHEDULE

5.1 DRAWING SCHEDULE:

As shall be provided during project implementation.