

Standby Generator Specification

STANDBY GENERATORS

GENERAL TECHNICAL SPECIFICATION

9. General Technical Specification – Standby Generators

1 GENERAL:

This specification specifies the standard requirements for the generator installation. The specific requirements for the project are specified in Part 2 (Project Specification).

1.1 DEFINITIONS

The following words and/or expressions in this document have the following meaning:

- (1) **CLIENT**
means the department, council, firm, undertaking or party with which the contractor enters into a contract for the execution of the work described in this document.
- (2) **ENGINEER**
means the registered engineer appointed by the client to act as his representative and consulting engineer for the execution of the works specified in this document.
- (3) **CONTRACTOR**
means the person, firm or company appointed by the client to act as main contractor, nominated subcontractor or subcontractor to supply, erect and commission the installation described in this document.
- (4) **CONTRACT**
means the contract entered into by the client and the contractor regarding the execution of the work described in this document.
- (5) **INSTALLATION, WORKS or CONTRACT WORKS**
means the material and/or work to be supplied, installed and commissioned in terms of the contract entered into by the client and the contractor.
- (6) **SITE**
means the place, premises or site(s) where the installation described in this document, must be erected and commissioned.
- (7) **DOCUMENT, SPECIFICATION, INSTRUCTIONS, DRAWINGS or CONTRACT DOCUMENTS**
means this specification, accompanying drawings and any other documents or publications referred to herein.

1.2 MULTIPLE SETS

This specification describes one generator set with related equipment. Should more than one generator set be required all the requirements specified herein shall be applicable to every set required.

1.3 DEVIATIONS FROM THE SPECIFICATION

Tenderers must submit with each tender offer a clear and detailed description of any characteristics of the offered generator set not complying in all respects to the specification. The relevant paragraph in the specification must be referred to with a short description detailing the extent and type of deviations from the specification.

1.4 REQUIREMENTS AT VARIANCE

Tenderers must note that this standard specification is a general specification determining the general standard and requirements for the generator set required. The specific detail requirements, to which the generator set must comply, are detailed in the detail specification. In cases where the respective requirements are at variance, the requirements of the detail specification must be adhered to.

1.5 CODE SYMBOLS

To facilitate easy and coordinated administration of the project, code symbols in the text of the specification are used. Paragraphs and/or sub paragraphs requiring attention at different stadiums during execution of the contract are marked with different code symbols. Before the contractor requires the consultant engineer to carry out certain tests or inspections, the contractor must make sure that all the relevant items to which the installation must comply at that stage of completion, have been fully completed. Should the contractor fail in this requirement all fruitless expense incurred by the engineer as a result, regarding time and traveling costs, will be to the contractor's account.

The respective code symbols, and the stage at which compliance to items so marked is required, is as follows:

- AAA** Submission and adjudication of tenders.
- BBB** Inspection and testing of the generators at the premises of the manufacturer, before delivery thereof to site.
- CCC** Inspection and testing of the generators at site, after completion of the installation.
- DDD** Final inspection and testing of the generator set after expiry of the contractual maintenance period and before retention monies are paid out.

Items of general nature, although in no way less important, are not identified in this way.

1.6 VISIT TO SITE

AAA Tenderers must visit the site and satisfy themselves regarding site conditions, access to, size and position of site, availability of labour, labour conditions, transport, loading and unloading areas, storage areas and security of stored material, workshop areas, scaffolding, cranes, and all equipment required for the erection of the installation, since no additional claims regarding any such items will be entertained. Should an official site inspection be arranged during the tender period, all prospective tenderers must attend since this may be the only occasion where additional tender requirements are made known.

1.7 INFORMATION SCHEDULES

AAA The tenderer must note that, should the information schedules forming part of the tender document, not fully filled in, or if he fails to submit any other information required with his tender offer, his tender may be disqualified.

1.8 MAKING GOOD

CCC The contractor must keep the site neat and clean, and all rubble must be removed after completion of the installation.

1.9 SUPERFLUOUS MATERIAL

CCC All superfluous materials and equipment remains the property of the client, and must be handed over to the Client or his representative.

1.10 STATUTORY REQUIREMENTS

The installation must be completed in its entirety in full compliance with the following, where applicable:

- (a) The latest issue of "Code of Practice for the Wiring of Premises", SABS 10142.
- (b) The "Occupational Health and Safety Act" as amended.
- (c) The Minerals Act no 50 of 1991 including the Mines and Works Regulations.
- (d) The local Municipal bye-laws and regulations as well as the local supply authority's regulations.
- (e) The local fire regulations.
- (f) The Telkom regulations.

In additions the contractor must issue all notices and pay all the required fees in respect of the installation to the local authorities and shall exempt the client from all losses, costs or expenditures which may arise as a result of the contractor's negligence to comply with the requirements of the said regulations. It shall be assumed that the contractor is conversant with the abovementioned requirements. Should any requirement, bye-law or regulation, which contradicts the requirements of this document, apply or become applicable during erection of the installation, such requirement, bye-law or regulation overrules this document and the contractor must immediately inform the engineer of such a contradiction. Under no circumstances shall the contractor carry out any variations to the installation in terms of such contradiction without obtaining the written permission to do so from the engineer.

2 SCOPE OF THE WORK:

The tender price must include the following:

- (1) The supply, delivery, installation, testing and commissioning of the generator set and related equipment according to specification, within the tendered contract time.

- (2) The supply, delivery, installation, connecting, testing and commissioning of the control board, fuel tank(s), fuel piping, cables, air louvres and/or ducting, as specified.
- (3) The supply, connecting and use of all test equipment, switchgear and fuel necessary to carry out the tests procedures described herein, or as offered by the tenderer. All test equipment remains the property of the successful tenderer.
- (4) The supply and delivery of all spare parts, tools and manuals specified.
- (5) Comprehensive maintenance and guarantee of all equipment for a period of 12 months after the date of completion of the installation.
- (6) The supply and use of all materials and equipment not specifically detailed in this document, but required to complete the contract in terms of this document and all other authority's requirements and codes of practice applicable to this installation.

3 GENERAL TECHNICAL REQUIREMENTS:

3.1 OPERATIONAL REQUIREMENTS

BBB The generator set must be fully automatic, it must start as soon as the mains supply is interrupted and must disconnect the emergency load automatically from the mains supply and reconnect it to the emergency supply and continue supplying the load with emergency power for an adjustable time period after the mains supply is restored, and re-connect the emergency load to the mains supply, and carry on running for a further period for cooling down, at no load, before automatically stopping to be ready again to start automatically should the mains supply be interrupted once again.

3.2 CAPACITY

The set must have sufficient capacity to supply the electrical load continuously at the specified site conditions without overheating or incurring detrimental effects in terms of the equipment manufacturer's instructions. In addition, the generator set must be capable of delivering an output of 110 % of the specified electrical load under any site conditions, in accordance with requirements, for any one-hour period during a twelve hour operating period.

3.3 LOAD ACCEPTANCE

BBB The generator set must be capable of accepting 70 % of the specified full load immediately and in one step and thereafter the remaining 30 % of the load within 10 seconds after starting, without exceeding the prescribed voltage and frequency limits.

3.4 PROTECTION

The set must be automatically self-protecting against damage resulting from abnormal ambient and/or load conditions, failure of components or electrical fault conditions.

3.5 MACHINE ROOM

Unless otherwise specified, the generator set must be installed in a machine room supplied by others for this purpose. No other equipment shall be housed in the machine room.

3.6 VOLTAGE AND FREQUENCY LIMITS

The generator set must automatically take over the supply to the emergency load as soon as the voltage and/or frequency of the mains supply exceeds the following limits for longer than the period predescribed :

Voltage : + 10 % or - 10 % of the nominal no-load voltage for 10 seconds or longer.

Frequency : Less than 48 Hz and more than 52 Hz for 0,1 seconds or longer.

3.7 POWER FACTOR

AAA All information submitted regarding the ability of the generator set must be based on a lagging power factor of 0,8.

3.8 MECHANICAL SYSTEM

The contractor is responsible to ensure that the respective rotating components comprising the dynamic system are sufficiently matched that mechanical vibration stresses resulting from critical torque and resonance, do not reach detrimental proportions.

3.9 REGULATION

BBB Notwithstanding the fact that the regulation of the engine and alternator are determined by publications BS 5514, BS 4999 and BS 5000 respectively, the nett electrical output characteristic of the set must comply with the specified requirements when the complete set is tested in accordance with the specified test procedures.

3.10 MOVING COMPONENTS

CCC All dangerously moving components must be screened off with sturdy, easily removable screens of sheet steel or expanded metal in accordance with the applicable regulations.

3.11 TENDER INFORMATION

AAA Comprehensive detail, manufacturer's performance curves, tables and illustrations of the equipment offered must be submitted with every tender offer.

3.12 EARTHING

The housing of the alternator, the engine and all parts of the mounting frame must be electrically interconnected.

CCC The star point of the generator must be solidly earthed to the earth busbar in the control board with a copper earth conductor of sectional area at least 50 % of that of the current carrying conductors. The earth conductor need never be greater than 70 mm² in cross sectional area.

4 INSTALLATION REQUIREMENTS:

CCC (1) Appearance of the installation

The general appearance of the installation must be neat with all finishes and fixings indicating a high quality of workmanship.

CCC (2) Correcting bad work

Should the engineer find any part of the installation not acceptable, the contractor must correct the same at his cost or replace the rejected part to the engineer's requirements.

5 ENGINE:

5.1 TYPE AND CHARACTERISTICS

- (1) The engine must be a pressure ignition, fuel injection industrial four-cycle or two-cycle diesel engine.
- (2) The engine may be air or water cooled, turbo charged or naturally aspirated.

5.2 ENGINE OUTPUT

AAA (1) The nett engine output under the most adverse ambient conditions must be strictly determined in terms of SABS 5514 of 1979, as amended.

AAA (2) Should use be made of any other calculation method, such method must be motivated in detail and is subject to the approval of the engineer. Full details of such calculation methods must be submitted with the tender offer.

BBB (3) The derating of the engine output to compensate for ambient conditions must be guaranteed by the successful tenderer and proved during the tests.

(4) The engine output must be calculated when diesel fuel complying with the minimum requirements for commercial diesel fuel marketed in the RSA, is used.

5.3 STARTING

- (1) The engine must start easily without any use of special equipment to assist starting.
- (2) The starter motor must be controlled from the control board and must be powered by the starter battery.
- (3) The electrical starter of the engine must be designed so that the drive gear automatically disengages as soon as the starter motor is driven by the engine. This bendix mechanism must be of robust and proven type.

BBB (4) The start up time in either automatic or manual control mode must not exceed 10 seconds from the time the start signal is given until the generator set accepts the full specified electrical load, subject to the engine starting at the first attempt.

BBB (5) The starter motor must be activated for an adjustable period of 5 to 10 seconds immediately after the start signal is given. After an adjustable pause of 5 to 10 seconds, the starter must be engaged once again. After three such unsuccessful

start attempts, the start control must automatically switch off and the "set fail" alarm must be activated.

5.4 GOVERNOR

BBB Unless otherwise specified, the governor must regulate the engine speed in accordance with class A2 regulation per BS 5514 of 1979 as amended, with nominal speed of 1500 r.p.m.

5.5 AIR FILTER

BBB (1) The air intake filter must be of the heavy duty dry type. The capacity of the filter must sufficient to ensure 200 hours operation without attention in the ambient conditions expected at the site.

(2) The filter must be equipped with a differential pressure indicator, clearly indicating when the filter requires attention.

(3) The air filter must be of the easily serviceable, clip-open type.

5.6 FLY WHEEL

The engine must be provided with a fly wheel with sufficient inertia to ensure that the cyclic irregularity of the engine is kept within the limits specified in the BS 5514 of 1979, as amended.

5.7 WIRING

BBB The insulation material of all wiring must be suitable for continuous service at the ambient temperature encountered during normal operation of the generator set. The positions where the ambient temperature may exceed 70°C, all wiring must be silicon rubber insulated.

6 GENERATOR :

6.1 TYPE

BBB The generator must be a self-excited brushless, four pole, 400/231V, 50Hz, 3-phase alternator, complying with the applicable requirements of BS 4999 and BS 5000 specifications.

The generator must be of the two bearing type equipped with ball or roller bearings. The bearings must be pre-lubricated to ensure long service periods without attention. Single bearing machines may be offered.

The generator must be equipped with semi-conductor rectified self-excitation and a semi-conductor automatic adjustable voltage regulator. The output voltage must at least be adjustable between - 10% to + 10% of the specified nominal value.

Output

AAA
BBB (1) The generator must, in accordance with the manufacturer's requirements, capable of delivering the prescribed full load continuously, as well as 10% overload for any one hour period in a twelve hour operation period during which the temperature rise must not exceed the maximum specified in BS 5000, taking in account the possible ambient conditions specified for rotating machines with class

B insulation (130 C). The insulation class of the offered machine must at least comply with the requirements of class F insulation (155 C).

The classification of insulation must be in accordance with the BS 2757 as amended. The rating of the alternator must be strictly determined in accordance with BS 4999 and BS 5000 taking into account the most adverse ambient conditions.

- (2) The generator must be equipped with damper windings, enabling the unit to accommodate an unbalanced load of at least 25% of full load at any load and at the normal operating conditions without incurring any damage.

6.2 EXCITATION AND REGULATION

BBB (1) The generator regulation must comply with the regulation class VR 2.31 as defined in BS 4999, Part 40, 1972.

- (2) The voltage regulation must be better than $\pm 2\frac{1}{2}\%$ of the nominal voltage at all load conditions and with any power factor between 1 and 0,8 lagging and with engine speed variations of up to 5%.
- (3) During 25% of full load unbalance conditions, the regulation need not comply with the above, but it must not exceed $\pm 5\%$ of the nominal voltage at a power factor between 1 and 0,8 lagging and engine speed variations of 5% between 0% and 100% of full load.
- (4) The voltage regulating system must be able to restore the output voltage to within 3% of the nominal value within 1,5 seconds after full load is suddenly applied. The transient voltage drop may not exceed 15% of the nominal value.
- (5) The excitation voltage must be obtained from a rotor mounted 3-phase alternator and a rotating full wave diode rectifier bridge. A semi-conductor automatic voltage regulator must control the exciter field current. The inherent damping of the exciter must limit overshoot and resonance.
- (6) The alternator design must ensure sufficient inherent loss of excitation to protect the machine against damage under short circuit conditions.

6.3 CONNECTIONS

BBB (1) The generator windings must terminate on stud bolts mounted in a suitable terminal housing with a removable cover plate. The terminal housing must be large enough to facilitate the comfortable termination of the cable size specified.

CCC (2) The cables must enter the terminal box neatly and next to each other from the side where the cable duct or cable tray is provided.

CCC (3) Should the standard terminal box of the alternator not comply with these requirements an additional terminal box must be supplied to comply.

6.4 WAVEFORM

BBB The alternator output waveform must comply with the requirements of BS 4999 : Part 40, par. 40.6.1.1.

Although these requirements are said to be applicable to units larger than 300kVA, they will, for the purposes of this specification be read as being also applicable to smaller units.

7 COUPLING :

The engine generator must be directly coupled through a shock absorbing coupling.

8 MOUNTING :

BBB 100kVA sets and larger

- (1) The mounting base must be of the duplex type, consisting of two separate steel frames sized so that the one fits within the other.
- (2) The inner frame must be fixed to the outer frame with vibration mountings installed at an angle of 45° to the horizontal. The mountings must be large enough to bear the weight of the fully mounted set.
- (3) The engine and the generator must be mounted solidly on the inner frame.

Sets smaller than 100 kVA

- (4) The mounting base may be of the uniflex type consisting of a single steel frame with the engine and alternator directly mounted thereon on vibration mountings. In this case the engine and generator must be solidly bolted together to form a unit.

General

- (5) The outer frame must not be bolted on the floor.
- (6) The outer frame must be manufactured in the form of a sledge with lifting holes to facilitate transport and/or moving of the set.
- (7) The mounting base as a whole must be designed to :
 - (a) withstand any bending loads applied to the engine block, coupling and generator frame,
 - (b) withstand torsion and bending moments caused by engine torque; and
 - (c) prevent resonating vibration at the normal operating speed.
- (8) All cross members must clear the floor by at least 50mm to facilitate the easy installation and removal of a drip panel.
- (9) The cross members of the frame must preferably not be of concave sections. Should this be the case, each cross member must be drilled in at least three positions to ensure that fluid will drip into the drip pan.

9 SERVICE CONNECTIONS:

- CCC** (1) All service connections between static and vibrating sections must be flexible.

- (2) All service connections to and from the set must be of a heat resistant type where applicable or must be protected sufficiently against damage resulting from heat or mechanical abrasion.
- (3) Electrical connections to and from the engine must consist of silicon rubber insulated copper conductors.
- (4) The crank case breather pipe must terminate directly above the oil drip pan.
- (5) Rigid fuel pipes must all be of copper and must be neatly installed and firmly fixed.
- (6) All electrical connections must be neatly made in accordance with standard practice. Conductors must terminate in suitable cable lugs and/or glands. Groups of conductors must be contained in a suitable duct.
- (7) Unless specified to the contrary, the supply, installation and connection of all electrical cables and other services between the respective components of this installation forms part of this contract. The termination and connection to the distribution board of all incoming and outgoing cables supplied and installed by others also forms part of this contract.

10 CONTROL AND DISTRIBUTION BOARD:

10.1 GENERAL

An integrated control and distribution board, separate from the generator set and fully equipped with all equipment necessary for the control and protection of the generator set, automatic mains transferring, battery charger, alarms and switchgear for outgoing supplies, must be supplied and installed in the generator room.

10.2 DRAWINGS FOR APPROVAL

BBB The contractor must submit three paper prints of each working drawing to the engineer for his written approval before commencing with the manufacture of the board. These drawings must clearly show:

- (1) a complete circuit diagram of all equipment on the board,
- (2) a complete layout with dimensions, showing the relative sizes, spacing and position of equipment and the general construction of the board, and
- (3) positions and the fixing method of busbars.

10.3 CONSTRUCTION

BBB (1) The board must consist of separate sections, separated by sheet metal bulkheads, to accommodate power distribution, control and bypass switchgear respectively, as applicable.

BBB (2) The board must be a totally enclosed free-standing unit without doors. The boards must not stand higher than 2,3m above floor level and must be sized to fit in the space provided for it.

CCC (3) The board must be vermin-proof, dust-proof and drip-proof to at least comply with class IP41 of IEC 144 protection.

CCC (4) Welded joints must be ground smooth.

AAA (5) The contractor must fully acquaint himself with the limitations on access to the generator room. To facilitate easy transport and installation of the board in the generator room, the board may be manufactured in separate sections. Each section must fit through the access doors and passages and must be strong enough to avoid damage during transport. The respective sections must be securely bolted together after installation.

(6) Cable gland plates of sufficient size and strength to accommodate the specified cables to the board must be provided at the top and/or bottom of the board as required. The lower cable gland plate must be situated at least 400mm above the base or floor level.

(7) The side panels must be made of 2mm thick and stiffened sheet metal.

(8) Machine punched holes for the installation of additional circuit breakers must be provided. These holes must be temporarily covered with steel cover plates, painted to match the board.

(9) The front panels must be hinged to the frame and must be designed to suite the required grouping of equipment as required and in accordance with the positions of busbars.

(10) The edges of the front panels must be bent over by 20mm to fit over a projecting lip on the board frame work. Alternatively the panels must have bent-over edges to fit flush into the front face of the frame work.

(11) Each hinged panel must be provided with a chrome plated handle.

10.4 WIRING

BBB (1) Wiring must consist of PVC insulated conductors, neatly grouped in horizontal and vertical bundles and contained in suitable plastic channels. The size and number of wiring channels provided must be sufficient to avoid adverse interheating in large groups of conductors.

(2) All wiring must be kept away from uninsulated terminals or live parts.

(3) The board must be completely wired in the factory. All external control and interlocking connections to the board must terminate on a suitable terminal strip.

(4) The current rating of conductors used in internal wiring must be sufficient for the current and each relevant circuit. The ratings must comply with the requirements of the standard regulations with the prescribed grouping factors taken into account.

(5) The colours of insulated conductors for alternating current must co-incide with the phase colours of the supply. All control and other circuits must be suitably colour coded throughout.

(6) All control wiring must be grey, and the end of each conductor must be numbered. The number must be stamped on a plastic ring fitting over the end of conductor. The terminals to which the conductors are connected must be numbered

independently of the conductor number with the same number as that of the conductor connected thereto.

- CCC** (7) The colour codes and conductor numbers must be clearly shown on the wiring diagrams.

10.5 BUSBARS

- BBB** (1) Busbars of solid copper with a minimum sectional area of 6mm x 18mm must be installed for each phase and neutral conductor and must be mounted on suitable insulators.
- (2) The current density in busbars must never exceed 1.8Amp per mm².
- (3) An earth busbar of 70mm² minimum sectional area must be provided over the entire width of the board.
- (4) Each busbar must be covered over its entire length with a double layer of PVC insulated tape or plastic shrink on material, of colour in accordance with the relative phase colour.
- (5) All cables connected to busbars must be provided with suitable lugs securely bolted to the busbar with cadmium plated steel bolts and washers. Three spare bolts, complete with washers and nuts, must be provided on each busbar in a suitable position to facilitate future connections.
- (6) The spacing between adjacent busbars must be at least twice the length of the greatest sectional dimension, but never less than 50mm. Busbars must be installed at least 150mm away from the nearest equipment.
- (7) The mounting, insulation and rating of busbars must be suitable for the system voltage and short circuit capacity.

10.6 EQUIPMENT BBB

10.6.1 Access

Direct access to all equipment and wiring must be facilitated by only the removal of the front panels of the board. Access to any piece of equipment must not be obstructed by any other equipment, bracket or wiring.

10.6.2 Spacing

The following requirements regarding the spacing of equipment must be strictly adhered to :

- (1) A minimum of 100mm between any equipment and the frame or internal bulk head must be maintained.
- (2) A minimum of 100mm between horizontal rows of equipment. The maximum dimensions of the equipment must be taken into account and not only that of the sections protruding through the front panels.
- (3) Single and double pole circuit breakers up to 60A and triple pole circuit breakers up to 30A may be installed directly adjacent to each other.

- (4) Free space of at least 40mm on either side of circuit breakers and isolators rated at not more than 100A must be maintained. A minimum of 75mm must be maintained on either side of larger circuit breakers and isolators and any other equipment.
- (5) All other equipment must be sufficiently spaced to allow for the minimum bending radius of the conductors to be connected thereto.
- (6) Sufficient space must be allowed for the installation of future equipment as prescribed.
- (7) The spacing allowed must be sufficient to facilitate the easy and neat connection of cable ends and wiring of current rating equal to that of the equipment it is to be connected to.

10.6.3 Grouping of Equipment

Equipment in the board must be arranged in logical groups. The working drawings to be submitted for approval before manufacture must detail the grouping clearly and, should the engineer so instruct, be are-grouped to his requirements.

10.6.4 Mounting of Circuit Breakers

All molded case circuit breakers must be mounted flush in the board so that only the operating handles project through the front panel. Circuit breakers and isolators must be installed so that the operating handle points upwards for the "ON" position and downwards for the "OFF" position, throughout.

10.6.5 Mounting of Contactors

Contactors must be directly mounted on the board frame and behind the front panel. No plastic or other type of dust shields are required.

10.6.6 Mounting of Instruments

All ammeters, volt meters and frequency meters and other instruments must be flush mounted in a hinged front panel. The rear of these instruments must be covered with a removable lid of suitable non-conductive material screwed to the panel so that the terminals of the meters cannot be inadvertently touched while the door is open. Fuses for the protection of the instruments must be mounted in a suitable place behind the front panels and must be clearly labelled to denote their function.

10.6.7 Mounting of Fuses

Fuse holders containing fuses that form part of the power distribution must be mounted semi-flush in the front panel with the fuse holder handle protruding sufficiently to facilitate easy removal thereof without opening or removing the panel. Control fuses may be located inside control panels.

10.7 PAINT FINISH

BBB Care must be taken that all corners, edges and inaccessible areas are sufficiently covered. The paint finish must comply with the standards and thickness prescribed elsewhere herein.

10.8 COLOUR

BBB The colour of the board must be Electrical Orange. The inside of the board may however be white.

11 EQUIPMENT IN CONTROL AND DISTRIBUTION BOARD :

Supply and install the following equipment in the respective sections of the board. The equipment lists given below are not necessarily complete and serve only as a guide regarding the required grouping of equipment. Any other equipment necessary for compliance with the required functions of the set, must be supplied and installed.

The required sectionalization of the board must be strictly adhered to. Grouping together of eg. light and heavy current equipment will not be acceptable.

11.1 LIGHT CURRENT CONTROL SECTION

BBB The following equipment must be installed in the light current control section of the board :

- (1) Control circuit, switches, control relays and semi-conductor components.
- (2) Four position selector switch to select the control function.
- (3) Sensor units for mains voltage, alternator voltage and alternator frequency.
- (4) Two push buttons, red and green respectively, for the manual start and stop functions.
- (5) Battery charger with related equipment and instruments.
- (6) Alarm indication and alarm reset push button.
- (7) Lamp test push button.
- (8) Labeled screw terminals for all outgoing control wiring.

11.2 ALTERNATOR SWITCHGEAR SECTION

BBB The following equipment must supplied and installed in the alternator switchgear section of the board :

- (1) Alternator supply main circuit breaker.
- (2) Six pole change-over switch.
- (3) Current transformers for alternator supply instruments.
- (4) Busbars.
- (5) Cable gland plate for the termination of alternator supply cable(s).
- (6) Labeled screw terminals for outgoing control wiring.

11.3 DISTRIBUTION SECTION

BBB The following equipment must be supplied and installed in the distribution switchgear section of the board:

- (1) Main circuit breaker for mains supply.
- (2) Six pole by-pass switch.
- (3) Current breakers for all circuits as prescribed.
- (4) Current transformers for mains supply instruments.
- (5) Busbars.
- (6) Cable gland plate for the termination of the mains supply and outgoing circuit cables.

11.4 LIGHT CURRENT EQUIPMENT

- BBB** (1) Tenderers may offer their standard equipment on condition that it complies in all respects with the operational requirements detailed in this document. Should such equipment deviate from the requirements, such deviations must be clearly pointed out in the tender offer. Should no such variations be documented, full compliance to the required operational functions shall be accepted and such compliance shall be contractually binding.
- (2) The semi-conductor control unit must at least comply with the following requirements:
- (a) The unit must consist of a sturdy base frame suitable for containing withdrawable plug in type printed circuit cards.
 - (b) The light current control relays must be mounted on the printed circuit modules.
 - (c) All control switches must be mounted on the base frame unit and not on the printed circuit cards.
 - (d) Printed circuit card contact strips and plugs must be of high quality with gold plated spring loaded contacts.
 - (e) The mounting of components on the printed circuit cards must be of professional quality.
 - (f) The modules must be interlocked to avoid faulty installation.
 - (g) All circuits must be designed fail-safe.
 - (h) All components must be rated conservatively and the unit as a whole must be adequately protected against lightning and switching surges.

11.5 CIRCUIT BREAKERS

BBB The following circuit breakers must be provided, installed and suitably labelled in the heavy current section of the distribution board:

- (1) A three pole circuit breaker as main switch for the mains supply to the distribution board.
- (2) A three pole circuit breaker as main switch for the alternator supply to the distribution board.
- (3) All circuit breakers for the protection of the circuits related to the generator set, eg. re-heaters, battery charger. These circuit breakers must be grouped together and labelled to denote their function.
- (4) Single and triple pole circuit breakers required in the detail specification as supply switches to the various outgoing supplies.

In single phase systems the main circuit breakers must be double pole units.

11.6 CHANGE-OVER SWITCH

- BBB** (1) An automatic change-over switch must be provided in the alternator switchgear section of the control board. The unit may consist of two contactors or two motorized air circuit breakers, mechanically and electrically interlocked so that both units can simultaneously be opened but not closed.
- (2) Time relays must be provided in the interlock circuitry so that a time delay of at least 3 seconds is insured in the switch over function. After the first contactor opens, three seconds must elapse before the other is engaged. This time delay must be provided in both switching directions.
- (3) The change-over switch must interrupt all three phase conductors in three phase systems and the phase conductor and neutral conductor in single phase systems.

11.7 BYPASS SWITCH

- BBB** (1) Supply and install a manually operated bypass switch to connect the incoming mains supply to either the change over switch or, alternatively, directly to the outgoing supply circuit as shown on the enclosed sketch.
- (2) The bypass switch must have only two positions, labelled as follows:
- BYPASS STANDBY
- Should the bypass switch be required with an off-position, this must be the centre position and must be labeled:
- OFF
- (3) The bypass switch must be mounted within the distribution section or in a separate section separated from the control section with sheet metal bulkheads so that no exposed live terminals are accessible within the control section without removing the panel to the bypass or distribution sections. The operating handle must protrude through the front panel of the board.
- (4) The bypass switch must switch only the phase conductors and not the neutral conductor.

11.8 VOLTAGE SENSORS

BBB Two identical, but separate, voltage sensor units must be supplied to monitor the mains and alternator supplies respectively. Each unit must comply with the following requirements :

- (1) It must be a semi-conductor type with two trip units respectively adjustable from 90% to 100% and 100% to 110% of nominal mains voltage.
- (2) The unit must trip after the voltage of any of the three phases exceeds the set high and/or low limits for longer than 5 seconds.

11.9 FREQUENCY SENSORS

BBB Supply and install a frequency sensor unit to monitor the frequency of the alternator supply. The unit must be a separate semi-conductor type with two adjustable trip units, adjustable from 45 to 50 Hz and 50 to 55 Hz respectively.

The initial set points must be 48 Hz and 52 Hz respectively. The unit must trip within 0,25 seconds after the frequency exceeds any of these preset limits.

11.10 INSTRUMENTS

The list of instruments below represents the minimum requirements for control board instrumentation. Any additional instrumentation necessary for the operation of the installation, must also be supplied. The types and quality of instruments is specified elsewhere.

The instruments must be sensibly arranged, labelled and grouped in the respective sections for generator set and mains supply instrumentation. Wherever applicable, instruments must be fuse protected.

BBB (1) Panel Lights

Six panel lights, coloured according to the phase colours, three each for the alternator and mains supplies respectively. The lights must be directly connected to the supply side of each main switch.

Labels : MAINS ALTERNATOR

BBB (2) Frequency meter to monitor the alternator output frequency.

Label : ALT.Hz

BBB (3) Ammeters

Six ammeters, to indicate the maximum demand and momentary phase current values of both the alternator and main supplies respectively.

Labels : R W B R W B
MAINS ALTERNATOR

BBB (4) Volt meter

Two 0 - 600 Volt meters, each with a seven position selector switch.

Switch labels : ALTERNATOR MAINS

Position labels : R/G, G/B, R/B, R/N, G/N, B/N, AF

BBB (5) Hour meter

An electrical cyclometer type running hour meter.

Labels : HOURS

CCC (6) Fuel content meter

A fuel content meter need only be supplied if a bulk fuel tank is required and such a meter is specifically required in the detail specification. The supply and installation of the sensor unit in the tank, as well as the connection thereof to the meter forms part of the instruction to supply and install such a meter. The meter must indicate the fuel content of the tank to $\pm 5\%$ accuracy. The indication may be analogue or in steps but within the accuracy limit set above.

11.11 EQUIPMENT RATING

BBB The current rating and short circuit rating of all equipment must be sufficient to comply with the system requirements. In cases where the equipment cannot comply, suitably designed back up protection must be provided.

12 SET MOUNTED CONTROL EQUIPMENT :

BBB The following equipment must be mounted on a suitable panel on the generator set. The panel must be mounted on the non-vibrating frame of the set and/or on suitable neoprene vibration mountings. The equipment must be labeled as indicated.

12.1 KEY SWITCH

BBB (1) Supply and install an industrial type two position key switch. The key must only be removable in the OFF position. The two switch positions must be clearly labeled OFF and ON and the switch itself, MASTER CONTROL.

(2) With the key switch in the OFF position, it must be impossible for the set to be started from the control board regardless of the position of the control selector switch. Switching off the key switch while the set is in operation must stop the set immediately.

(3) With the key switch in the ON position, all the required control functions must be in operation.

Label : ON/OFF
MASTER CONTROL

12.2 INSTRUMENTS

BBB (1) An oil pressure meter with metric calibration indicating the pressure in the main oil duct to the oil filters.

Label : OIL PRESSURE

- (2) A temperature meter calibrated in °C, indicating the temperature of the cooling water in water cooled engines and the temperature of a centrally situated cylinder head in air cooled engines.

Label : TEMP

- (3) A DC-ammeter indicating the charge or discharge current of the engine driven battery charger.

Label : AMMETER

All the instruments must be clearly marked to indicate the normal operating range and the maximum and/or minimum available readings. The danger zone must be red in all cases.

13 CONTROL OF THE SET : CCC

Except for the activation of heavy current equipment, all control functions must be battery powered.

The respective control systems must be designed fail-safe without exception.

The required operational control function of the set must be selectable with a four position selector switch mounted on the front panel of the control board. The four respective positions of the switch must be clearly labeled as follows:

OFF AUTO MANUAL TEST

The required functioning of the control system in each of these control modes, with the bypass switch in the "bypass" position is as follows:

13.1 OFF-POSITION CCC

- (1) Both sections of the change-over switch must be opened.
- (2) All alarm and control circuits must be de-energized and out of operation. The supply to the battery charger must however be maintained.
- (3) It must only be possible to connect the electrical load to the mains supply by switching the by-pass switch to the bypass position.

13.2 AUTO POSITION CCC

- (1) Normal Condition

With the mains voltage on, the change-over switch must be switched so that the mains supply is connected to the load. All control and alarm circuits must be operational.

- (2) Power Failure

As soon as the mains supply is interrupted or exceeds the preset limits of the sensor modules, an adjustable timer (0 to 60 seconds) must be activated.

Should the mains supply be restored before the time expires, the change-over contactor must immediately switch back to the mains supply.

Should the mains supply not be restored within the timer period, the time relay must initiate the start up cycle of the generator set. Restoration of the mains supply after this time must have no influence on the set until it has taken over the load or failed to start.

(3) Starting **CCC**

As soon as the start cycle of the set has been activated, all alarm circuits must be temporarily inhibited. Thereafter the prescribed three start attempts must be activated in succession. Should the set fail to start, the start cycle must be automatically terminated and a start failure indication given on the board.

Should the mains supply then be restored the change-over switch must reconnect the load to the mains supply after the prescribed 0 to 60 seconds delay.

Should the set start, the alarm circuits must be activated as soon as sufficient time has elapsed to allow the set to stabilize. The change-over switch must there-after be activated to connect the electrical load to the alternator.

(4) Stopping

As soon as the mains supply is restored, a 0 - 60 seconds adjustable timer must be activated. Should the mains supply remain restored for the timed period, the change-over switch must disconnect the load from the alternator supply and re-connected to the mains supply. Hereafter a 0 to 5 minute timer must be activated. For this period the set must remain running at no load to cool down. After this time period has expired the set must stop automatically to be read once again in the standby mode.

(5) Trip

Should a fault condition arise while the set is in operation, it must trip automatically and the change-over switch disconnect the alternator from the load immediately so that the set does not run down while connected to the load.

13.3 MANUAL POSITION **CCC**

With the selector switch in the manual position it must be possible to stop and start the set by activating the stop and start push buttons on the control board.

Should the set be started manually, the change-over switch must automatically connect the load to the alternator as soon as the change-over time delay has expired.

All alarm and protection circuits must be in operation.

13.4 TEST POSITION **CCC**

With the selector switch in the test position, it must be possible to :

- (1) stop and start the set by means of manual control but without the change-over contactor operating,
- (2) run the set without taking over the load, and

- (3) all alarm and protection circuits remaining in operation.

14 ALARMS AND PROTECTION:

14.1 GENERAL

CCC (1) The generator set must be automatically protected against damage resulting from fault conditions which could normally occur in the installation during normal operation by means of automatic alarm circuits activated by suitable sensors.

- (2) The alarm system must indicate a fault condition clearly to facilitate quick diagnosis and repair.

AAA (3) Should the nature and extent of the prescribed protection facilities described herein, be advisably extendable in the opinion of the tenderer, the tenderer must submit such recommendations in writing with his tender offer. This extension of protection facilities must be offered as an alternative tender offer.

14.2 ALARM AND PROTECTION CIRCUITS AND SENSORS

Provision must be made for the following protection and alarm circuits. The wording of related labels for identification purposes is given in capital letters in each case.

- (1) Low Engine Oil Pressure

CCC The sensor must monitor the oil pressure directly in the oil way to the engine bearings so that a blocked oil filter will also cause alarm indication. The sensor must be of a proven type recommended by the engine manufacturer.

OIL PRESS

- (2) High Engine Temperature

CCC Air cooled engine:

Supply and install at least two semi-conductive type sensors to monitor the temperature of at least two separate cylinder heads. The sensors must be in accordance with the recommendations of the engine manufacturer and must activate the alarm circuit separately and/or jointly within 30 seconds after the temperature exceeds the set limit. The trip point must be easily adjustable with the normal working point approximately in the middle of the adjustment range. The adjustment must be calibrated.

Water cooled engine:

Supply and install a temperature sensor in a strategic position to monitor the temperature of the cooled water within the engine block. The sensor must comply with the recommendations of the engine manufacturer.

The sensor must operate jointly with or separately from the low water level sensor described below within 30 seconds after the temperature exceeds the set limits. The trip point must be easily adjustable with the normal work point situated approximately in the middle of the adjustment range. The sensor must be easily accessible and removable for maintenance and test purposes.

TEMP. HIGH

(3) Low Water Level in Radiator

CCC This alarm circuit only applies to water cooled engines. The sensor must be of the static type and must monitor the water level in the upper radiator tank. The sensor must operate jointly with or separately from the water temperature sensor to trip within 30 seconds after the water level drops below the sensor.

Even though the temperature control unit may be activated by more than one sensor, there must be only single temperature high indication on the control board.

TEMP. HIGH

(4) Engine Speed

CCC The sensor unit must monitor the alternator output frequency. It must be a separate semi-conductor unit with two trip circuits, adjustable from 45 to 50 Hz and from 50 to 55 Hz respectively. The unit must trip within 0,25 seconds after the frequency exceeds the set limits.

(5) Alternator Voltage

CCC Supply a composite semi-conductor type sensor unit with a low voltage trip adjustable from 90% to 100% and a high voltage trip adjustable from 100% to 110% of nominal voltage. The unit must trip should the voltage of any of the phases exceed the set limits for longer than 5 seconds.

VOLTAGE

(6) Overcurrent

CCC This alarm must only be activated by an auxiliary contact to the alternator circuit breaker in case it trips on over load or a fault condition.

OVERLOAD

(7) Start Failure

CCC This alarm must trip immediately should the generator set for whatever reason, refuse to start within the prescribed three start attempts.

START FAIL

(8) Day Tank Contents

CCC This alarm circuit must be activated as soon as the fuel level in the day tank falls below the prescribed minimum level. The sensor must be an easily removable static type.

DAY TANK

(9) Bulk tank contents (Only if required in detail specification)

CCC This alarm circuit must be activated as soon as the fuel level in the bulk tank falls to below the prescribed minimum level. The sensor must be an easily removable static type.

BULK TANK

The related control modules or printed circuits must be clearly labelled as specified to denote their respective functions.

(10) Battery Charger

CCC Provide an alarm circuit to trip as soon as the D.C. output voltage drops to 90% of the set value. The alarm circuit must be inhibited during a failure in the power supply.

BAT. CHARGER

15 OPERATIONAL REQUIREMENTS

The abovementioned alarm and protection circuits must comply with the following operational requirements:

15.1 Critical Alarms

CCC The activation of any of the alarm conditions listed under (1) to (6) inclusive above, must immediately stop the engine and activate full alarm indication as specified. The set must then not be able to start again before the alarm condition has been attended to and the alarm circuit reset.

15.2 Non-critical Alarms

CCC The activation of any of the alarms listed under (7) to (10) inclusive above, must not stop the set when in operation but must give full alarm indication as specified.

15.3 Alarms during starting

CCC All alarm circuits must be inhibited during the starting cycle of the engine until the engine has reached operational speed or has failed to start.

15.4 Reset push button

CCC A reset push button must be provided on the control panel to reset any alarm indication to normal after the alarm condition has been attended to.

15.5 Fleeting Alarm

CCC Should a fleeting alarm occur, the alarm circuitry must indicate it as a permanent alarm and the alarm system must operate as specified.

16 INDICATION OF ALARM CONDITION

The alarm system must at least comply with the following requirements:

16.1 Remote Alarm Indication

CCC A master alarm relay must be activated as soon as any of the abovementioned alarm conditions occur. This relay must also be reset to normal as soon as the alarm condition has been reset. One set of 5A change over contacts of this relay must be wired out to an easily accessible terminal block. The terminal block must be situated in a prominent position in the control board and must be labelled as follows:

REMOTE ALARM

16.2 Control board indication

CCC Each alarm circuit must give a separate visual indication on the control panel by means of a LED indication light. The indication must be a battery powered panel light. The respective units must be labeled clearly as specified above.

16.3 Hooter and red light

CCC In addition to the above alarm indication facilities, provision must be made for the installation of an electronic hooter equal or similar to the "KLAXON" type SY2/725 with continuous output of 110dB at a distance of two metres mounted together on the same bracket with a 40W flashing red warning light. This indication unit must be battery powered and suitable for external use and be mounted directly below the roof eave on the outside surface of the machine room wall. The light and hooter must be switched on and off simultaneously depending upon the occurrence or cancellation of an alarm condition. The supply and installation of the cable to the unit from the control board forms part of this contract.

The supply to the unit must be protected by a 5 Ampere circuit breaker labeled as follows:

HOOTER

17 SENSORS

CCC All alarm sensors must be easily accessible and removable for maintenance and/or test purposes. The required characteristics, operation and type of each sensor is specified in conjunction with the relevant alarm circuit described herein.

18 POWER SUPPLY TO ALARM SYSTEM

CCC The entire alarm system must be battery powered and must remain operational during interruptions in the mains or alternator supplies.

19 RADIO INTERFERENCE SUPPRESSION:

CCC All radio interferences must be suppressed in terms of BS800 as amended. This requirement applies to the entire installation, inclusive of the alternator and related control systems, and also the equipment in the control board and emergency lights.

20 EXHAUST SYSTEM: CCC

- (1) The entire exhaust system, inclusive of silencers, hangers, clamps, connections, bends and flashings form part of the installation.
- (2) The diameter of the exhaust pipe must be sufficient to ensure that the back pressure remains within limits. The radius of bends in the exhaust pipe must be at least 2,5 times the pipe diameter. The exhaust system must not depend on an extraction fan to reduce the back pressure.
- (3) The silencer must be a residential type. It must be mounted within the machine room, independently of the engine or exhaust pipe. The sound attenuation of the system must be at least 25dBA.
- (4) The exhaust pipe must be insulated with aluminium clad mineral wool lagging inside the generator room.
- (5) A section of flexible piping must be installed between the silencer and the engine. The connection must allow relative movement between the engine and the exhaust system, and thermal expansion of the exhaust system without causing stress at the exhaust manifold or silencer.
- (6) The exhaust pipe must be installed horizontally through an outside wall of the machine room and terminate outside with a 30 degree bend downwards to prevent rain water entering the system. The point of the exhaust pipe must project approximately 400mm past the roof eave.

The section of the exhaust pipe and related flashing outside the building, must be manufactured of stainless steel. The horizontal section of the exhaust pipe must be installed with a slight inclination so that condensate will drain outwards. The contractor must thoroughly seal and finish the point of exit of the exhaust pipe through the wall.

- (7) Should the exhaust system be exceptionally long and fixed at several positions, expansion connections must be provided between fixing points.

21 VENTILATION, COOLING AND HEATING:

21.1 STRUCTURAL REQUIREMENTS

AAA While compiling their tenders, tenderers must take into account the required provision for cooling the generator set and/or ventilation of the machine room. Special structural requirements to install, accommodate and ventilate the set and related accessories, must be submitted with the tender offer in the form of fully detailed and dimensioned drawings.

21.2 VENTILATION

AAA This contract includes the supply of all air louvres required to be installed in the walls and/or doors of the machine rooms. Where applicable the louvres must be delivered in time in accordance with the building program to the builder on site for building in thereof. It is the contractor's responsibility to see to it that the air louvres are installed in accordance with his requirements.

All air louvres in outside walls must be vermin proofed on the inside with 10mm galvanized mesh, securely fixed to the louvres.

21.3 COOLING

The offered engine may be of the air cooled or water cooled type. Should the engine be a water cooled type, a pressure type reinforced fan cooled radiator must be provided.

Regardless whether a water or air cooled engine is offered, the supply and delivery of all air ducting within the machine room forms part of this contract.

The hot air from the engine must be lead to an outside louvre by means of a close-fitting hot air duct in such a manner that no serious hot air leakage can occur within the machine room.

The cold ventilation air must be drawn into the machine room through other air louvres. Care must be taken in the positioning of the respective louvres and exhaust outlet to ensure that hot air and/or exhaust gas cannot be drawn back into the machine room via the cold air inlet louvres.

The machine room design is based on the installation of either an air cooled or an water cooled engine. Should the layout not suit the engine being offered, the tenderer must allow in his tender price for all structural and/other adjustments.

21.4 HEATING

BBB A thermostatically controlled heater must be provided in the cooling system of water cooled engine and in the oil sump of air cooled engines. The heater must be of sufficient rating to maintain the engine at such a temperature that it will start immediately and take load as specified even during the extreme lowest ambient temperature conditions that may be experienced at site. The heater element must be suitable for use at mains voltage and must be protected with a circuit breaker in the control panel labeled as follows:

Circuit Breaker Label: ENGINE HEAT

22 FUEL SYSTEM:

22.1 GENERAL

The engine and entire fuel system must be suitable for use with all grades of diesel fuel commercially available in South Africa.

CCC No galvanized materials or materials containing zinc may form part of the fuel system. Unless specified otherwise the supply and installation of the entire fuel system inclusive of day tank, bulk tank, manholes and service connections form part of this contract. Should a bulk fuel tank be available at little or no charge from an oil company, the co-ordination of services with this oil company as well as negotiations regarding the installation of the tank forms part of this contract and tenderers must allow for this in their tender price.

22.2 CONNECTION

CCC All electrical and fuel connections must be free of leaks and installed neatly as specified. All piping must be neatly secured by clamps or bolts. All fuel pipes or bolts except the flexible connections specified must be of copper. All connections between static and vibrating parts must be of reinforced flexible piping.

22.3 FUEL FILTERS

- 22.3.1 Two filters, a micro filter and heavy duty sludge filter must **CCC** be installed between the day tank and the engine. The filters must have replaceable elements suitable for the required fuel flow to the engine and for 200 hours continuous operation without maintenance. The housing of the sludge filter must be of a clear material to allow visual inspection and large enough to serve as a water trap.
- 22.3.2 Should a bulk fuel tank be required, an additional heavy duty sludge filter similar to that described above must be installed next to the day tank in the fuel supply line from the bulk tank.
- 22.3.3 All filters must be of high quality and easily maintainable. The filters must be mounted in easily accessible positions.
- 22.3.4 Should no bulk tank be required, a suitable valve and sludge filter similar to that described above must be provided in the fuel supply pipe from the manually operated fuel pump. The filter must also have a see through housing so that the water content is visible.

22.4 ENGINE FUEL SYSTEM

CCC Should the relative fuel levels in the specific installation make it necessary, an engine mounted fuel supply pump must be provided.

- (1) A manually operated fuel pump must be provided in the injector pump housing to facilitate bleeding of the fuel system.
- (2) A separate fuel solenoid valve must be provided in the fuel supply line to the engine. When the generator set is switched off, this valve must be closed. The solenoid must be designed for continuous service and must remain energized when the engine is in operation. The engine must be stopped, in normal operation or upon occurrence of an alarm condition, by de-energizing this solenoid.

22.5 DAY TANK CCC

- (1) The capacity of the fuel tank must comply with the lesser of the following requirements:
 - (a) Sufficient fuel to provide the generator set at full load for eight hours in cases where a bulk tank is installed and 24 hours in cases where no bulk tank is installed.
 - (b) The maximum amount of fuel that may be stored above ground in terms of the Authorities' regulations.
 - (c) Never more than 1 000 litres.
- (2) The contractor must fill the day tank after completion of all acceptance tests.
- (3) The tank must be designed so that water and sludge will accumulate at the lowest point thereof where it can be drained of.
- (4) The tank must be manufactured of welded sheet steel to sufficient size to contain the specified amount of fuel.

- (5) The tank must be provided with an inspection opening, with a lid to facilitate cleaning and inspection. The lid must be bolted to the tank with at least 4 bolts and a suitable gasket must be provided. A smaller screw-on lid for manual filling of the tank must be provided.
- (6) The tank must be supplied complete with a welded angle iron stand suitably designed for bolting to the floor. The day tank must be equipped with a level indicator, suitably protected against damage.
- (7) The fuel line to the engine must be connected to the tank, clear of the bottom, to ensure that sludge and sediment will not enter the fuel pipe.
- (8) The fuel return pipe from the engine must be directly connected to the tank.
- (9) A shut-off valve must be installed adjacent to the tank in the fuel line to the engine.
- (10) If a bulk fuel tank is required, an electrically driven fuel pump for automatic filling of the day tank from the bulk fuel tank, must be supplied and installed. The pump must be mounted on a shelf under the day tank forming part of the tank stand.

The pump must have sufficient capacity to overcome the level difference between the supply and delivery points, regardless of the respective fuel levels in the two tanks, as well as providing a fuel flow considerably in excess of the engine consumption. The fuel pump must run continuously while the engine runs, the excess fuel gravitating back to the bulk tank via an overflow return pipe. An alarm sensor, installed in the wall of the tank, must activate a fail-safe alarm circuit as soon as the fuel level falls below 80%.

- (11) Should no bulk tank be required in the contract, a heavy duty, manually operated, electrically driven fuel pump with pumping capacity sufficient to fill the empty day tank completely in 30 minutes, must be supplied and installed. Should the day tank be smaller than 200 litres, this electrical fuel pump may be replaced with a 32mm hand-operated wing pump. In both cases the pump must be mounted on the day tank stand. A suction hose of sufficient diameter and length to facilitate filling the day tank from fuel containers on a vehicle outside the machine room, must be provided. To facilitate storage of the suction hose, a suitably steel frame or hose reel must be provided adjacent to the day tank.

22.6 BULK FUEL TANK CCC

- (1) Supply and install a bulk fuel tank with the specified capacity as indicated. The tender price must include the cost of the excavation, the supply and installation of a concrete base and anchors in the excavated hole, the installing and anchoring of the tank, the backfilling of the excavation, the building of an inspection manhole with lid, all fuel and electrical connections, content meter if required, and low alarm connection.
- (2) The tank must be manufactured of welded sheet steel of sufficient thickness.
- (3) The manhole must be brick-built at a height of at least 400mm above ground level and must be fitted with a standard cast iron lid and frame. The manhole must provide access to the electrical and fuel connections to the tank as well as the inspection manhole.

- (4) The outside surface of the tank must be treated with cognisance of local ground conditions with cold bitumen or other similar protection against corrosion and water as recommended by the tank manufacturer.
- (5) The tank must be provided with a standard tanker connection situated in the manhole. The tank must also have a breather pipe installed underground from the manhole to the machine room wall, vertically up the wall to terminate under the roof eave.
- (6) The tank must be installed on, and anchored to, a suitably designed concrete base to prevent underground water pressure raising the tank when empty. The contractor must submit his design drawing of the base to the engineer for approval before installation of the tank.
- (7) If specifically specified in the detailed specification, a fuel content meter indicating the fuel content of the tank on the generator control panel, must be supplied and installed. A submerged pressure transducer, resistance wire or any other proven method complying with the relevant SABS requirements for such equipment, may be used.

The indication on the control panel must be calibrated in litre and must also be equipped with a N/O alarm contact to activate a remote alarm should the fuel content in the tank fall below 20% of the capacity. The metering equipment is fully described in the paragraph regarding control board instruments.

- (8) The fuel pipe to the generator must withdraw fuel clear of the bottom of the tank so that sufficient space is left for sediment and water.
- (9) A wooden dipstick calibrated in litres for the direct measurement of the fuel content of the bulk tank, must be provided. The accuracy of calibration must not exceed $\pm 5\%$.

23 LUBRICATION :

- (1) Lubrication System

The engine must be provided with a high pressure lubrication system with sufficient capacity to ensure that all main bearings, gears and related moving parts subjected too high wear, are sufficiently lubricated.

BBB (2) Oil Filters

Coarse and fine oil filters with replaceable elements suitable for 200 hours service without maintenance, must be provided in an easily accessible position.

- (3) Filter elements and oil

The contractor must supply the generator set complete with filter elements as well as the first filling of lubricants. The cost of these items must be included in the tender price.

BBB (4) Pre-lubricating pump

All engines rated 500 kW and larger must be provided with an electrically driven pre-lubricating pump to raise the oil pressure in the engine to the minimum

working level immediately before the engine starts, if recommended by the engine supplier.

CCC (5) Drain pump

A hand-operated oil sump drain pump must be provided for all sets rated 230 kW or larger, in cases where draining the engine oil is difficult. The drain pipe and hand valve must be mounted in an accessible position on the outside of the engine base to facilitate easy draining of the engine oil.

24 BATTERY : CCC

- (1) The set must be equipped with a fully charged lead acid battery of sufficient capacity and voltage to suit the electrical system and requirements of the generator set.
- (2) The battery capacity must be sufficient to ensure that it can, at minimum ambient temperature, maintain the full starting current of the generator set continuously for 90 seconds without the cell voltage dropping to below 1,5 volts pr cell while the starter is running. Should the control and protection circuits also be powered by the starter battery, the battery capacity must be sufficient to maintain the control and protection circuits after operation of three starting cycles of three attempts each.
- (3) The battery must be mounted on a frame of wood or PVC covered angle iron near the starter motor. The frame must be mounted independently of the vibrating parts of the set.
- (4) Battery cables installed from the battery across the floor to the set, must be protected with a sheet metal housing.
- (5) When the engine is in operation, the battery must be recharged by an engine mounted alternator/rectifier with automatic current control. When the engine is not in operation, the battery must be recharged by a constant voltage battery charger mounted in the control panel in accordance with the battery manufacturer's specification.
- (6) All connections to the battery must be sealed airtight with a non-grease type sealant which does not dry out, such as TECTYL or similar, to prevent corrosion of the connection.

25 BATTERY CHARGER :

- CCC** (1) When the set is not in operation, the batteries must be kept charged by means of a battery charger mounted in the control panel. The supply to the charger must be directly connected so that the charger supply is maintained regardless of the positions of the selector or bypass switches. The 230 Volt terminals and components must therefore be covered to prevent touching.
- (2) The battery charger must be suitable for use at the normal mains supply voltage with a maximum voltage variation of $\pm 10\%$ and a maximum frequency variation of ± 3 Hz.
 - (3) The battery charger output must be automatically short circuit protected.
 - (4) The battery charger output voltage must be controlled, so that the charge current is maintained within the limits set by the battery manufacturer for all charge conditions.

- (5) The maximum possible charge current must not exceed the limit set by the battery manufacturer.
- (6) No manually operated boost charge facility must be provided.
- (7) The battery charger must consist of a single phase, double winding, vacuum impregnated dry type transformer and full wave silicon diode rectifier. The battery charger must also be equipped with the following :
 - (a) a main switch switching both the AC input and DC output;
 - (b) HRC fuses to protect the input and output circuits;
 - (c) internally mounted potentiometers for the adjustment of the maximum charge current and charge voltage;
 - (d) a flush mounted voltmeter to indicate the DC voltage; and
 - (e) a flush mounted ammeter to indicate the DC charge current.

The protection fuses must be of the high rupturing capacity cartridge types, mounted in molded case fuse holders. All incoming and outgoing circuits must terminate on numbered terminals.

Radio interferences must be suppressed in terms of BS800.

26 LABELLING OF EQUIPMENT:

- CCC** (1) Diligent attention must be paid to the complete and clear labeling of all equipment.
- (2) Labels must consist of neatly engraved multi-layer hard plastic sheeting, so that the labels have white letters on a black background. Labels must be fixed with brass bolts and nuts or rivets. Self-tapping screws, glue, etc, shall not be acceptable.
 - (3) Each item of equipment, whether externally or internally mounted, must be labeled. This includes circuit breakers, isolators, contactors, meters and instruments, panel lights, switches and terminals.
 - (4) Labels for flush mounted equipment must be situated on the faceplates of the control panel directly below the indicated equipment. Where certain items of equipment are mounted closely adjacent to each other with insufficient space below for labeling, such as single pole circuit breakers, such equipment must be numbered with engraved labels. An engraved legend card must be provided elsewhere on the front panel of the control board, denoting the function opposite each relevant item number.
 - (5) The conductors must be numbered at each end in accordance with the conductor number on the drawings. The terminals, to which such conductors are connected, must be independently and similarly numbered.

27 LOOSE EQUIPMENT :

27.1 DRIP PANS

CCC A sturdy, removable drip pan must be provided under the generator set. The pan must be manufactured of galvanized sheeting with the edges at least 30mm high. The edges of the steel must be bent over to stiffen same. The pan must cover the entire inner area of the base frame so that any water, oil or fuel leakages will be contained.

Provide a similar drip pan for the day tank. The pan need not be removable, but must be larger than the horizontal area of the day tank.

27.2 BATTERY EQUIPMENT

CCC Supply in each machine room a five liter plastic electrolyte can filled with distilled water, a suitable funnel and hydrometer.

27.3 FIRE EXTINGUISHERS

CCC Two 4,5 kg CO₂ fire extinguishers, suitable for use on electric fires, must be supplied and installed against the inner walls of the machine room in the indicated positions.

27.4 GLOVES

CCC Supply one pair of electrical insulating gloves. The gloves must be of the large size and suitable for use at 1 000 Volt.

27.5 EMERGENCY LIGHTS

CCC Supply, install and connect 40 Watt fluorescent tube emergency lights, one above each generator set and one above each control board. The light fittings must be switched on and off by a suitable light switch situated at the generator room door and must be powered by the starting battery of the set. The circuit must be protected by a suitably sized fuse mounted in the control board.

The emergency lights must be supplied from one central or individual inverter units powered by the set starter battery only when the DC light switch is on. No additional batteries or chargers must be provided. The light output of the fittings must be 100% of the normal light output of a 40 Watt fluorescent tube lamp.

The supply and installation of all conduit, wiring and associated accessories forms part of this contract. Surface-mounted conduit must be painted in accordance with the colour of the surface upon which it is mounted.

27.6 CABINET

CCC Supply and install a floor standing steel cabinet with shelves, lockable doors and two keys to house the specified loose equipment, spares, manuals and tools in the indicated position in the machine room. Only one cabinet per machine room is required, regardless of the number of sets.

27.7 MANUALS

CCC Two complete sets of manuals must be provided and placed in the steel cabinet in the machine room. Each set must contain at least the following:

- (1) All manufacturers' requirements.
- (2) Complete operational instructions.

- (3) A fully illustrated technical description containing full instructions for maintenance and repair work to the engine, alternator and control board. Each copy must be in the form of a full workshop manual compiled by the equipment manufacturer.
- (4) A comprehensive spares list.
- (5) A set of A3 size drawings showing the electrical installation and wiring, fully annotated. All conductor numbers and switchgear components must be shown.

Each manual must be prepared professionally and bound in book form. Drawings must be drawn professionally with stenciled annotations.

The contract shall not be regarded as being complete before the contractor has fully complied with these requirements.

27.8 GENERAL

CCC The respective requirements regarding the provision of spares, tools drawings and notices are described in separate paragraphs under the relevant headings. Please refer thereto.

28 SPARES AND TOOLS :

CCC Tenderers must allow in their tender price for the supply and delivery at site of the following spares and equipment:

Tools (per installation, regardless of number of sets)

- 1 - set chrome vanadium spanners 6mm - 22mm, one end open and one end ring
- 1 - set Allen keys 2mm - 10mm
- 2 - screwdrivers, one larger and one small
- 1 - hydrometer
- 1 - 150mm pliers with insulated handles and wire cutting section

Engine spares (per each engine and additional to installed items)

- 2 - sets of all fuel filter elements
- 4 - sets of all lubricating oil filter elements
- 1 - set of air filter elements
- 1 - set V-belts

Control board spares

- 2 - lamps of each type used
- 2 - fuses of each type used

Alternator spares

- 1 - set diodes

29 PAINT FINISH :

29.1 METAL PARTS

BBB All exposed metal parts forming part of the installation, must, wherever relevant,

CCC be prepared and painted in accordance with SABS 064/1988. After treatment of the surface, the total thickness of the covering layer applied must at least comply with the following :

Baked enamel	:	(SABS 783 type 1)	-	90 micron
Baked powder epoxy paint			-	60 micron
Epoxy type spray paint				
Minimum cover thickness			-	100 micron

29.2 MACHINE ROOM FLOOR

CCC The concrete machine room floor must be treated as follows:

- (1) The moisture content of the concrete must be less than 17%.
- (2) Removal all loose material.
- (3) Apply epoxy paint in accordance with the specifications of a reputable paint manufacturer to give a final minimum cover thickness of 150 micron.

30. NOTICES:

CCC (1) Supply and install a clear and easily readable warning notice in a prominent position in the machine room. The notice must be made of corrosion-resistant material, preferably plastic, with big and clearly engraved letters, reading as follows:

DANGER

This engine will start without notice. Turn selector switch on control board to "OFF" before working on the plant.

- (2) Supply and install a pressed metal notice, 250 x 150mm in size, on the outside of each door to the machine room. A skull and crossbones with the words "GEVAAR/DANGER/INGOZI" must be engraved thereon.
- (3) Supply and install all other notices required by the "Occupational Health and Safety Act", as amended.

31 DRAWINGS:

31.1 PRIOR APPROVAL

BBB The successful tenderer must, immediately after being awarded the tender, submit two copies of each of the following drawings to the engineer for his approval:

- (1) Complete general layout drawings.
- (2) Working drawings detailing the fuelling and exhaust systems.

- (3) Complete dimensioned drawings showing the generator set with accessories.
- (4) Complete wiring diagrams including block diagrams of all control and other circuitry.
- (5) A complete to scale drawing of the front elevation of the control board showing the position of all equipment.

31.2 AS-INSTALLED DRAWINGS

DDD After completion of the installation a comprehensive drawing must be prepared, at least A1 in size, professionally drawn in black ink on polyester paper. A free-hand drawing and/or annotations shall not be acceptable. The drawing must mainly consist of three sections as follows:

- (1) A schematic layout of the heavy current switchgear, connections, busbars and instruments.
- (2) A complete wiring diagram of the light current control equipment and conductors with all components, conductors and conductor numbers clearly shown and described.
- (3) A similar complete wiring diagram of the engine mounted control panel.

All conductors, conductor numbers, components and contacts must be clearly shown exactly as installed and connected. A legend defining all abbreviations and drawing symbols, the name of the installation, the name of the contractor, his project reference number and telephone number for maintenance calls, must clearly be shown on the drawing.

This drawing must be submitted to the engineer after preparation thereof for his written approval. One paper copy of the approved drawing must be mounted behind a perspex cover at eye level against the machine room wall with four screws and rawl plugs.

32 TESTING:

32.1 GENERAL

The complete testing of the set as well as the provision of the necessary test facilities, instruments, dummy load, switchgear, fuel and lubricating oil to conduct the tests, forms part of this contract.

BBB The generator set must be tested strictly in accordance
CCC with the specification at the supplier's premises and
DDD after installation thereof in the machine room at site. The supplier must advise the engineer at least 2 weeks in advance of each test date so that he or his representative can arrange to attend.

In all cases the instruments provided by the supplier for test purposes only, shall remain the property of the supplier. These instruments must be of high quality to ensure that the readings obtained are accurate enough to determine compliance of the set to the requirements.

32.2 PREPARATION FOR FACTORY TEST

BBB The contractor must prepare the set as follows at least 8 hours before the initial test at the factory. After the set has been prepared it must not be run for a period of at least 8 hours preceding the test.

- (1) All services must be connected.
- (2) An adjustable resistance dummy load of sufficient capacity for 110% of full load of the set must be connected. The dummy load must be initially set to the load specified to be accepted by the generator set in one step, eg. 70% of full load or 100% of full load whichever the case may be.

The dummy load must be a balanced three phase load with the phase currents not more than 5% out of balance.
- (3) The engine exhaust pipe must be taken out of the test area so that no excessive gas build-up can occur in the test area.
- (4) The set must be positioned so that the hot air can ventilate out of the test area with minimum of recirculation.
- (5) The control board must be connected to the main supply and the selector switch set in the "off" position. To avoid connecting the dummy load to the main supply, the dummy load must be connected through an isolator to the control board emergency supply busbars. The isolator must initially be switched off.
- (6) The following instruments must be connected to the alternator supply terminals or other suitable position.
 - (a) A digital frequency meter connected to any phase.
 - (b) A digital voltmeter connected to any phase if the alternator voltage control monitors all phase voltages. If only one phase is monitored for control purposes, the voltmeter must be connected to that phase.
 - (c) Three moving iron ammeters to read the phase current connected through current transformers if necessary.
 - (d) An electronic power factor meter connected as described in (b) above.
- (7) The fuel supply to the engine must be arranged in such a way that the supply to the engine can easily be changed from the main fuel tank to a calibrated 5 litre fuel measure and back.
- (8) Supply a stop watch for timing purposes.

NOTE :

Should the contractor request the engineer to test the set and the engineer, upon arrival at site, find that he cannot test the set according to the specification because the contractor has not prepared the set as specified, or has supplied insufficient or inferior instrumentation, the engineer will postpone the test and all fruitless travelling, accommodation, time and other costs incurred by him shall be to the account of the contractor.

32.3 FACTORY TEST

BBB The following tests must be carried out at the premises of the manufacturer :

- (1) Place a competent person at each of the frequency meter, voltmeter, and ammeter to take down readings.
- (2) Switch the control mode selector switch to the "Auto" position. Switch off the mains supply to the control board to simulate a power failure and to initiate the start cycle. Immediately switch the dummy load isolator on to connect the dummy load to the emergency supply busbars.
- (3) As soon as the set starts and the change-over switch connects the dummy load to the alternator, immediately read and note the:

 minimum frequency,
 minimum voltage,
 maximum current, and
 minimum power factor.
- (4) If possible also note how long after the connection to the load the voltage and frequency take to stabilize. Note the stabilized values.
- (5) Check if the load and phase balance of the dummy load was adjusted correctly for the load the set was specified to accept in one step.
- (6) Should the specification require the set to accept less than 100% load in one step, the dummy load must be adjusted to 100% load within 15 seconds after start up of the set. Immediately after which the abovementioned voltage, frequency, and time readings must be repeated.
- (7) After the set has run at full load for several minutes to stabilize, increase the load to 110% of full load for 1 hour. After this the load can be reduced to 100% and the set run for another hour. During this two hour period the following readings must be taken at least every 30 minutes:

 Engine temperatures
 Engine oil pressure
 Supply voltage
 Supply current (3 x)
 Frequency
- (8) After the above test has been completed, the voltage, power factory, frequency and phase currents must be noted before and immediately after a load change of 25% of full load.
- (9) Switch the dummy load isolator off and the supply voltage to the control boards on. Note the time taken for the:
 - (a) Change over switch to operate and,
 - (b) The engine to stop.
- (10) Check the set thoroughly for any leakages.
- (11) Check the construction, paint finish, mounting, labels, instrumentation and

equipment for compliance with the specification. Check if all the items marked "B" in the specification has been complied with.

32.4 TESTS AFTER INSTALLATION OF THE SET ON SITE

CCC After completion of the installation the following test and inspections must be conducted:

- (1) Test the control, alarm and protection functions of the set by simulating a fault condition in each circuit in turn.
- (2) Check the entire installation regarding all items marked "B" and "C" in the specification.
- (3) Check the quality of the installation regarding the ventilation louvres, exhaust system, fuel tanks and connections, electrical cable work, emergency lighting, paint finishes, connections to starting battery and mounting thereof, compliance to requirements regarding manuals and drawings and general making good of damage to the building wherever applicable.

NOTE:

The installation shall not be accepted should any of the above items be incomplete or requirements not complied with.

33 TRAINING OF THE OPERATOR:

DDD After the set has been completed and commissioned, the contractor must train a competent person appointed by the client to fully understand the operation of the installation.

34 GUARANTEE AND MAINTENANCE:

34.1 GUARANTEE

- (1) The contractor must guarantee the installation for a period of twelve (12) months from the date of acceptance of the completed installation by the client.
- (2) After being notified of a fault, the contractor must immediately, at his cost, do the necessary maintenance work to ensure that the installation is in good working order.

34.2 MAINTENANCE

- DDD** (1) The contractor must maintain the installation in accordance with the requirements of the equipment manufacturers and normal practice, for a period of twelve months after acceptance of the completed installation by the client. The requirements in par. 5(a) to (k) below must also be complied with.
- (2) After expiry of the twelve months maintenance period, the client may require the contractor to enter into a service contract for a further period of one year. This service contract may, on mutual agreement, be renewed on a yearly basis.
- CCC** (3) All tenderers must submit with their tender, a complete provisional service and maintenance contract. This contract must be a formal document signed by an authorized representative of the supplier and must detail the monthly service cost for the first year of maintenance after the expiry of the twelve month maintenance

period. Tenderers must also specify the terms of escalation of the quoted service cost.

- (4) The signing of the service contract shall in no way influence the validity of the abovementioned guarantee.
- (5) In terms of this service contract, the successful tenderer must undertake to have a suitably trained member of his staff visit the installation at least once per month to carry out the following activities:
 - (a) He must report to the responsible person on site and document his respective service activities, the date of his visit, tests, adjustments done and all further relevant details in a logbook which must remain in the machine room.
 - (b) Clean the generator set and related equipment thoroughly.
 - (c) Lubricate all moving parts according to instructions.
 - (d) Check the air filter and clean or replace same according to instructions.
 - (e) Check the lubricating oil, add oil or replace according to instructions.
 - (f) Note the reading on the hour meter.
 - (g) Replace the lubricating oil filter according to instructions.
 - (h) Do all adjustments to the engine valves and fuel injection equipment according to instructions.
 - (i) Clean the starting battery and top up electrolyte if required.
 - (j) Run the set for 30 minutes on load and check for satisfactory operation.
 - (k) Report to the client in writing regarding all major service requirements, components that are worn or damaged or must be replaced according to manufacturer's instructions. The contractor must submit a detailed quotation for each of these items.

35 QUALITY SPECIFICATION: BBB CCC

35.1 GENERAL

This quality specification determines the minimum requirements applicable to all equipment forming part of this installation.

Describing the quality requirements of any piece of equipment herein does not necessarily mean that such equipment is required in this installation and is only applicable as far as it is relevant.

Where equipment is specified by name in the specification, alternative makes may be offered subject to the engineer's prior approval and full compliance to the specified requirements, SABS and/or BS specifications applicable. The onus for obtaining the engineer's prior approval for such alternator supply equipment deviating from the specified requirements without obtaining the engineer's prior approval, the engineer may instruct him to remove such equipment immediately and replace same with equipment complying

with the specified requirements. The cost of such replacements shall be for the account of the contractor.

All equipment of the same type must be of the same manufacture.

35.2 RUPTURING CAPACITY

The fault current rupturing capacity of all equipment guaranteed by the manufacturers thereof, must at least be greater than the unsymmetrical fault level of the system of which it forms a part. Should this not be the case, sufficient back-up protection must be provided by installing correctly sized HRC fuses.

If the fault level exceeds 20 kA the switchgear must be type tested to SANS 61439 and 61642.

35.3 LOCALLY MANUFACTURED, SABS-MARK

Equipment manufactured in the RSA must preferably be used. Such equipment must preferably also bear the SABS mark. Should equipment with the SABS mark not be available, equipment bearing SABS approval must preferably be used. As a last alternative equipment bearing the relevant BS, VDE or NEMA-marks of approval may be used.

35.4 FUSES AND HOLDERS

High rupturing capacity fuses must comply with the requirements of SABS 172 or BS 88 and have a rupturing capacity of at least 80kA. Fuses not mounted in fuse switches, must be mounted in retractable holders and suitable bases.

The fuse unit must be securely mounted on the holder and not on the base. Each fuse and holder must have an inspection hole or point to enable identification of a blown fuse. The live supply conductor must be connected to the upper terminal of the base.

35.5 HIGH RUPTURING CAPACITY FUSE SWITCH COMPLETE WITH CARTRIDGE FUSES

The fuse switch must be of the 3-pole type with sufficient current rating for the service application and must comply with BS 2510 of 1954 or BS 3185 of 1959 whichever is applicable. The "ON" and "OFF" positions must be clearly indicated. With the switch in the "OFF" position the fuses must be fully isolated. The cover must be interlocked to prevent the switch from being opened while it is in the "ON" position and to prevent the switch being operated when the cover is opened.

35.6 MOLDED CASE AIR CIRCUIT BREAKER: 1A - 800A

This circuit breakers must comply with the requirements of SABS 156 of 1977 as amended, and must be suitable for use at mains voltages up to 440/250V, 50Hz, alternating current.

The fault current rupturing capacity of each unit must at least be greater than the fault level of the systems at the point of installation. Failing this, each unit must be back-up protected with suitably chosen HRC fuses.

35.7 CONTACTORS

Contactors may be of the open or totally enclosed types. The contactors must be 3-pole, electro mechanically air break units, suitable for use in a 440/250V system and must comply with SABS 1092 of 1977, as amended.

The current rating of the contacts and the mechanical strength of the unit must be sufficient to ensure that the unit shall withstand the maximum unsymmetrical fault current of the system for the period required for the protective circuit breaker and/or fuse to interrupt the fault without the contactor being damaged in any way.

Non-current carrying metal parts must be interconnected and suitably earthed to the earth terminal of the distribution board.

The voltage rating of the control coils of the contactors must comply with the system voltage. Contactor parts used for mains transfer switches must be mechanically and electrically interlocked.

Should the auxiliary contacts form an integral part of the contactor, units with sufficient contacts to ensure that one N/O and one N/C contacts are left as available spares in addition to contacts used for interlocking purposes. All auxiliary contacts must have a current rating of at least 6 Amps up to 230 Volt AC and unity power factor.

35.8 RELAYS

All relays must be of the "OAK", "TELEMECANIQUE" or "SIEMENS" or equal types. The voltage rating of the coils must be matched to the system voltage and the current rating of the contacts must be greater than required for the connected load.

Relays with a current rating of 6 Amp or lower must be of the plug-in type with a matching bakelite or similar type base plate. The base plate must be mounted in the board so that the relay can be viewed and/or removed easily. Connections to the base plate must be soldered or fixed with screw terminals. The relay must be housed in a dust proof clear plastic housing.

35.9 VOLTMETER SELECTOR SWITCH

All voltmeter selector switches must be suitable for a 4 wire, 3 phase 50Hz system at the specified system voltage and must be of the double contact air break type with an "off" position and 6 switch positions so that the phase-to-phase and phase-to-neutral voltages can be read with one voltmeter. The contacts must be of the break before make type. The switch positions must be clearly labelled and the unit must be suitable for flush mounting in the board so that only the control knob and indicator plate are mounted on the front of the faceplate of the distribution board.

The selector switch must be mounted directly below or next to the relevant voltmeter.

35.10 SELECTOR SWITCHES

Selector switches for the control and switching of control circuits must in general be of the same type of construction and specified for voltmeter selector switches. The movement of the lever must be limited to only allow sufficient rotation to cover the number of switch functions required and no more. The number of poles required to obtain the specified switch functions must be mounted on a common shaft. The contacts must be of a silver alloy or equal quality.

The current rating and service duty of their contacts must be suitable for the specified application.

35.11 PANEL LIGHTS

All panel lights must be of the TELEMECANIQUE or KLOCKNER MOELLER or equal type supplied with 22mm dia. chrome mounting ring. The lenses must be red, green or yellow, depending upon the phase colour, or indication required. All panel lights must be provided with LED's.

35.12 PUSH BUTTONS

All push buttons used in the installation must be of the TELEMECANIQUE or KLOCKNER MOELLER type or units of similar quality unless specified otherwise.

The push buttons must be mounted flush in the board and fixed with chrome plated screw type mounting ring. In general a push button with a green knob must be used for a switch on function and a push button with a red knob for a switch off function.

35.13 VOLTMETERS, AMMETERS, FREQUENCY METERS AND HOURMETERS

These types of meters must be of the "P.C.I." (Process Control Instruments) or really equal quality units of another manufacture. The dial plate of each meter must be 96 x 96mm square. All frequency meters, hourmeters and voltmeters must be protected with HRC fuses installed on the supply side of each circuit. The fuses must be housed in the conventional, withdrawable holders. The fuse holders must be mounted near the relevant meter and must be clearly mounted.

35.14 AMMETERS: INDICATION AND MAXIMUM DEMAND COMBINED

The instrument must be suitable for flush mounting with a 96 x 96mm square dial plate and must consist of a moving iron ammeter suitable for indication of the momentary current value, combined with maximum demand ammeter with a bimetal element indicating the average current value on a 15 minute basis. The maximum demand ammeter must be equipped with a resettable, residual indicator, indicating the highest current reading obtained. The bimetal system must be compensated for ambient temperature. All three indicators must be mounted on concentric scales.

The instrument must comply with BSS 89 as amended.

The ammeter must be equal to the PCI type FBia for use with a suitable metering type current transformer with a 5A secondary winding.

35.15 TERMINALS

Terminals for control and interlock circuits must be of the "KLIPPON" type or other type of equal quality. The terminal units must mount on a common metal rail suitable for mounting in the distribution board. The current rating of the terminals must suit the application and in no instance be smaller than 5A.

35.16 EARTH LEAKAGE RELAY (30mA) : SINGLE AND THREE-PHASE UNIT

(a) With circuit breaker

The unit must operate on the current balance principle. The sensitivity and reaction time of the relay must be sufficient to ensure immediate tripping should an earth leakage current of 30mA or more occur. The unit must be compensated for

ambient temperature variations and the sensitivity must remain within limit for normal frequency variations.

The unit must be equipped with an integral test push button by means of which the operation of the unit can be tested. The unit must be able to withstand fault currents as defined in SABS 156 of 5kA between phase and earth, phase and phase and phase and neutral conductor without any damage.

The single phase unit must be complete with a single or double pole circuit breaker and the three phase unit complete with a three pole circuit breaker. The circuit breakers must be equipped with overcurrent of at least 5kA when tested in accordance with SABS 156.

The three phase earth leakage units and relevant circuit breaker must be suitable for use in a 400/231V 50Hz system and the single phase unit and relevant circuit breaker must be suitable for use in a 230/220V 50Hz system. The earth leakage units must in all respects comply with SABS 767 of 1964 as amended and must bear the SABS mark.

(b) With isolator switch

The relay must comply with all the requirements detailed in (a) above except that the circuit breaker specified is replaced with on-load isolating switch with shunt trip coil and a fault current rating of 5kA.

35.17 THREE POLE ON-LOAD ISOLATOR SWITCH WITHOUT SHUNT TRIP

The isolator switches must be of the manually operated, air break type, suitable for flush mounting in a panel. The contacts must be silver alloy and the switch mechanism must be of the snap action type. The switches must be able to make and break circuits under full rated load and must be equipped with arc chutes. The switches must be able to withstand switching in a short circuit and shall be rated according to the fault current rating of the board at the position of installation.

To identify an isolator from a circuit breaker, the handle of the isolator unit must be in a different colour and the unit must be permanently marked "isolator".

35.18 BUSBAR INSULATORS

All busbar insulators must be glassfibre or epoxy, suitable for use at voltages up to 600V. The insulators must be able to withstand the mechanical stresses resulting from system short circuits.

35.19 ELECTRONIC COMPONENTS AND PRINTED CIRCUITS

- (1) The general arrangements, composition and configuration of circuitry and components must be logical and designed for easy maintenance and inspection of components.
- (2) Components must be of the best industrial quality available.
- (3) If possible all electronic circuits must be grouped in logical units for modules on printed circuits mounted in suitable frames.

- (4) Printed circuit cards must be mounted vertically to allow sufficient air movement for cooling. Care must be taken that the heat build-up in the panel does not exceed the ambient requirements of the components.
- (5) Printed circuits must be designed and manufactured in compliance with the requirements of publication 321 of the International Electrotechnical Commissioning affiliated to ISO.
- (6) All contacts and terminals on printed circuits must be gold plated.
- (7) The completed printed circuit must have a neat appearance with edges neatly finished.
- (8) Each printed circuit must be marked with a clear identification code number corresponding with the code number on the frame so that the position is clearly identified.
- (9) The code number on the frame must be visible when the control panel board doors are opened for inspection of the printed circuits. The corresponding code numbers must also be shown on the schematic diagram.

35.20 THYRISTORS AND POWER DIODES

- (1) Thyristors and power diodes forming part of the charging and power supply circuitry must be of the best commercial quality available. All components must be of the silicon type.

35.21 TIME RELAYS

All switch contacts in time relays must have a current rating at least greater than the circuit being switched and be suitable for the type of load being switched and the duty cycle. The relay must be equipped with a clear plastic, dust proof housing enclosing the relay coil, contacts and mechanism. The delay time must be adjustable with an external screw or button. The adjustment must be clearly calibrated in seconds and/or minutes.

35.22 CABLES

All heavy current cables must be PVC insulated steel wire armoured cables with copper conductors of sufficient cross-sectional areas for the application in terms of the most recent editions of SABS 1507 and SABS 0142.

Detailed Technical Specification – Standby Generators

1 INTRODUCTION

Standby generators are required for the new India Apron at King Shaka International Airport. Four (4) generators will be provided for the Apron.

2 GENERAL

This Item shall be read with the General Technical Specification (GTS) and provides specific requirements with reference to the GTS.

3 SCOPE OF THIS CONTRACT

The scope of this contract is as follows:

3.1 India Apron:

3.1.1 Four (4) off new 500kVA continues prime rated canopy generator sets each consisting of diesel engine with 500kVA alternator, day tank and sound attenuation intake and exhaust louvers.

3.1.2 Four (4) new LV automatic change-over Kiosks as specified which will include the auto change over gear as well as all control and monitoring functions of the new diesel generators.

4 SPECIFICATIONS

4.1 The general standard requirements for the generator installation components are specified in the “General Technical Specification”.

4.2 In addition, the specific requirements with changes and additions to the standards in the “General Technical Specification”, is specified in the “Detailed Technical Specification”, to suit the specific characteristics of the project. Should discrepancies between the “General Technical Specification” & the “Detailed Technical Specification” exist, the “Detailed Technical Specification” shall govern.

5 SITE INFORMATION

The site is situated at the King Shaka International Airport next to the N2 Coastal highway, La Mercy, Kwa-Zulu Natal, South Africa.

6 POWER SUPPLY

The power supply to the changeover and distribution boards will be 420/242 Volt, 50Hz, 4 wire supply with solidly earthed neutral, fed from dedicated 11 kV supply.

7 AMBIENT CONDITIONS

The installation shall meet the specified requirements under the following ambient conditions:

Item	Description	Details
7.1	Altitude	Approx. 20m AMSL
7.2	Temperature range	-5°C to 45°C
7.3	Pollution	Minimum smog present
7.4	Humidity	65% to 95% RH [Average throughout the year with 10% probability]

8 TESTING AND COMMISSIONING OF THE INSTALLATION

Tests shall be carried out as outlined in the “General Technical Specification”, Item 28.

9 MAINTENANCE AND GUARANTEE PERIOD

- 9.1 The maintenance and guarantee period shall be 12 months.
- 9.2 During this period the generator subcontractor shall carry out routine maintenance as outlined in the “General Technical Specification”, Item 30. Tests however, shall be carried out once a week.
- 9.3 As required in the “General Technical Specification”, Item 30 tenderers must submit detail of a service and maintenance contract for consideration by the Client to enter into such a contract, after expiry of the above 12 months maintenance period. The cost of this selfmate contract must not be included in the tender price. Allowance shall be made for tests to be carried out once a week.

10 TRAINING OF PERSONNEL

Refer to the “General Technical Specification”.

11 SUBCONTRACTING

- 11.1 The contractor shall submit statements from the suppliers of all equipment to the effect that the suppliers are the authorized agents of the manufacturers of the equipment and consequently are fully empowered to support the manufacturer's warranty.
- 11.2 Subcontracting of any part of the work will be subject to approval and the tenderer shall submit full detail of any subcontractors to be employed, at tender stage.

12 MAKING GOOD

The contractor will be responsible for making good in all trades, any damage or disturbance to the building, installation, tarred surfaces, concrete surfaces, paved surfaces, drains and other surfaces his employees or subcontractors may have caused during the construction of the installation.

13 PERSONNEL ON SITE

The contractor shall have a technically competent representative on site at all times when work is taking place. The person shall be required to attend to all technical matters, receive instructions on behalf of the contractor and co-ordinate installation work with other contractors on site.

14 PROGRAM AND CO-ORDINATION

The installation work shall be coordinated with other contractors and services on site as part of this contract.

15 BUILDERS WORK

All builders work will be carried out by others except where work is specifically specified to form part of this subcontract. Where openings for cable trays, pipes and cables through concrete slabs and concrete walls are required and not shown on the drawings, it must timeously be pointed out to the engineer. Where openings are required through brick walls, it shall be the responsibility of the generator contractor. Sufficient allowance shall be made in the tender price for such openings. Should extra openings through concrete not be asked for timeously, it shall become the responsibility of the generator contractor at no extra cost.

16 SITE FACILITIES

16.1 The tenderer shall make allowance for all lifting equipment, scaffolding and transport required on the site.

16.2 Electrical power and water for construction purposes will be available free of charge to the extent that it will be available to other contractors.

17 GENERATOR OUTPUT AND VOLTAGE

The rating of the generators under the specified site conditions shall be as follows:

- ☐ Voltage : 420/242 V, 4 wire with earthed neutral
- ☐ Power factor : 0.8 lagging
- ☐ Frequency : 50 Hz
- ☐ Rating : X kVA engine with X kVA alternator

18 AVAILABILITIES TO SITE

The contractor shall have free access to the position where the generator units shall be installed on site. Entrance to the site by means of a heavy duty delivery vehicle will be possible.

19 ACCOMMODATION

The units will be accommodated on plinths which form part of this contract.

20 ENGINE (GTS)

20.1 A water cooled diesel engine with frame mounted radiator is preferred.

20.2 An electronic governor shall be provided.

21 MOUNTING (GTS)

The generator set shall have duplex steel frame base.

22 CONTROL AND CHANGE OVER KIOSKS

The kiosks shall generally comply with GTS, to suit the requirements specified below.

The change-over kiosks, incorporating control and power for change over shall be installed at the India Apron next to the Miniature substation and shall include the following:

22.1 The change-over kiosks shall consist of the following:

- ✦ Normal network supply main ACB circuit breaker (800 Amp) (mechanically & electrically interlocked).
- ✦ The local standby generator ACB circuit breaker (800 Amp) (mechanically & electrically interlocked).
- ✦ PLC with software development.
- ✦ Busbars
- ✦ Cable gland plates.
- ✦ Labelled screw terminals for outgoing control wiring.
- ✦ All switchgear shall have auxiliary contacts and all contacts shall be wired to a common strip.
- ✦ 5 x Schneider NSX 160B – TMD – 160A LV 430300
- ✦ 2 x Schneider NSX 100B – TMD – 100A LV 429540
- ✦ 3 x Schneider NSX 100B – TMD – 32A LV 429545
- ✦ Surge Arrestors
- ✦ 5 x Elster A1700 meters for 400 Hertz ground power consumption monitoring

23 SET MOUNTED CONTROL EQUIPMENT

Refer to GTS.

24 CONTROL OF THE SETS

24.1 Control functions

Refer to GTS.

24.2 Monitoring functions

All monitoring and protection equipment as specified in the general specification shall be provided for each standby generator set.

In addition RS 485 ports on the PLC's shall be provided inside the kiosks from where a communication link for remote monitoring of all alarm functions can be done.

Voltage free contacts NO/NC wired to terminal strips shall be provided in the control board to indicate the following:

- ✦ General alarm

★ Power failure exists

★ Alternator on load

25 ALARMS AND PROTECTION

Refer to GTS.

26 RADIO INTERFERENCE AND SUPPRESSION

Refer to GTS.

27 EXHAUST SYSTEM

Refer to GTS.

28 VENTILATION COOLING AND HEATING

28.1 Refer to GTS.

28.2 Noise generated by the equipment, if measured, 7 m from the generator, shall not exceed 65dB.

28.3 As stated previously a water cooled diesel engine with frame mounted pressure type reinforced fan cooled radiator is preferred. Galvanized ducting shall be provided as specified.

28.4 Heating shall be provided in the water cooling circuit of the engine as specified in GTS.

29 FUEL SYSTEMS

29.1 Refer to GTS. Approved tests shall be conducted on all fuel systems and tanks to ensure no leaks will occur, and certificates issued to that effect.

29.2 Reliable fuel filters shall be provided to each engine.

30 SPARES AND TOOLS

30.1 Refer to GTS.

30.2 Tools : As specified in GTS.

30.3 Engine, control board and alternator spares shall be provided as specified.

31 PAINT FINISH

Refer to GTS.

32 NOTICES

32.1 Refer to GTS.

32.2 All notices shall be installed. External notices shall be of the metal type.

33 DRAWINGS FOR APPROVAL

Drawings in accordance with GTS, are required.

34 TESTING

Testing of the installation shall be in accordance with GTS.

35 FABRICATION OF CONTROL AND CHANGE OVER KIOSKS IN GENERAL

The LV panels shall in all aspects conform to SABS 1180, Parts 1, 2 and 3 as applicable.

35.1 GENERAL

The kiosks shall be of adequate size to accommodate the number of outgoing circuits specified.

The kiosks shall have three sections, namely:

- one section containing the auto change over gear with all incoming and outgoing switchgear and cables, and
- one section containing the outgoing cables and circuit breakers,
- and
- one section containing spare space for communication equipment required.

35.2 FRAMEWORK

A metal framework for the kiosk shall be manufactured from angle iron, channel iron on 2mm minimum folded metal. A solid U-channel base frame, sufficiently braced to support all equipment and span floor trenches and access holes shall be provided. Kiosks shall be of cubicle design with 2mm side panels forming divisions between cubicles. The maximum allowable cubicle width is 1,8m. Joints shall be non-continuously butt welded. Welds shall be ground smooth and the joint wiped with plumbers' metal in order to provide a smooth finish.

35.3 REAR AND SIDE PANELS

The rear panels shall be removable and shall be manufactured from 2mm minimum sheet steel. The panels shall have returned edges which are recessed in the frame or which fit over lips on the switchboard frame. The panels shall be secured to the frame by means of studs and chromiumpated hexagonal domed brass nuts or hank nuts or captive fasteners equal or similar to "DZUS" or "CAMLOC". Where switchboards are intended for installation in vertical building ducts or against walls, the rear and side panels may consist of a single folded sheet which is either bolted or welded to the frame or which forms part of the folded metal frame

35.4 FRONT PANELS

The front panels inside the kiosks shall preferably be hinged except where flush mounted equipment prevents this. Alternatively, panels shall be secured by means of two pins at the bottom and a latch or lock at the top of the panel. The panels shall be arranged in multi-tiered fashion to allow for the logical grouping of equipment.

The hinged front panels shall have a dished appearance with 20mm upturns which fit over a lip on the kiosk frame. Corners shall be welded and smoothed.

The panels shall be of 2mm minimum sheet steel with machine punched slots to allow for the flush mounting of instrumentation, switchgear toggles and operating handles. A minimum clearance of 50mm shall be maintained between the rear of equipment mounted on the panels (taking into account terminals or other projections) and the frame and chassis of the kiosk. Seltamate panels shall preferably be provided for the mounting of instrumentation and for covering flush mounted switchgear. Enclosed switchgear with front panels eg combination fuse-switch units, may be flush mounted in the board in lieu of seltamate hinged panels.

Hinged panels shall be suitably braced and stiffened to carry the weight of flush mounted equipment and to prevent warping.

Hinged panels with flush mounted equipment and panels higher than 600mm shall be supported by hinges of adequate strength to ensure smooth and reliable operation. 16mm Pedestal or similar heavy duty hinges with single fixing bolts may be used on panels smaller than 600mm. On the larger panels long pedestal type hinges with two fixing bolts per hinge are preferred. Piano hinges are not acceptable for this application.

A tubular chromium-plated handle shall be fitted on each panel. The handle may be omitted if "DZUS" or "CAMLOC" fasteners are used.

Banking plates shall be fitted over slots intended for future equipment. These plates shall be fixed in a manner which does not require the drilling of holes through the front panel. Dummy circuit breakers may be fitted where applicable.

Front panels containing live equipment such as instrumentation of controls switches, shall be bonded to the kiosk frame with a braided copper earth strap with an equivalent cross-sectional area of at least 4mm².

35.5 SECURING OF FRONT PANELS

Hinged panels shall be secured in position by means of square key operated non-ferrous fasteners designed to draw the panels closed or by "BARKER & NELSON" or similar quick-release fasteners. Selftapping screws are not acceptable. Where non-hinged removable panels are specified, they shall be secured in position by means of 6mm studs and hexagonal chromed brass dome nuts and washers or hank nuts or "DZUS" or "CAMLOC" or similar captive fasteners. Non-hinged removable panels may alternatively be secured in position by means of two pins at the bottom and a latch or lock at the top.

35.6 DOORS

The kiosks shall be fitted with a doors in the front of the kiosk. The maximum width per door shall be 800 mm. The doors shall provide free access to the equipment. The doors shall have well returning edges to fit into the channel of the door entry surrounds. Each door shall have three robust solid brass hinges each of length at least 100 mm. The hinges shall be completely concealed. Doors shall be fitted with lever locks equal or similar to the "Barker & Nelson" type. The locking mechanism shall facilitate three point latching at the top, side and bottom of the doors. In the case of double doors the first door shall be locked with two slides on the inside onto the kiosk shell. The second door shall close over a lip on the first one. Nylon door restraints shall be provided. The fixing points of the restraints at the door and the canopy shall be reinforced. The doors shall be earthed bonded to the frame by means of a copper braided strap, tooth washers, bolts and nuts.

35.7 ROOF

The kiosk shall have a pitched roof that slopes downwards at the front and at the back with an overhang of at least 75 mm all round. The panels shall be of 2mm minimum sheet steel.

35.8 CHASSIS

A suitably braced chassis for the mounting of switchgear and equipment shall be firmly secured to the frame of the kiosk. The chassis shall be designed so that the switchgear can be installed in accordance with the GTS. Circuit breakers and isolating switches which are not of the moulded case air-break type and insulators of busbars of ratings of 200A and more may be secured directly to the framework.

35.9 GROUPING OF SWITCHGEAR

The switchgear shall be logically arranged and grouped as described in GTS. Depending upon the number and size or components, a common front panel may be installed over one or more groups of equipment. All equipment shall be installed in accordance with the specification.

35.10 CABLE GLAND PLATE

A cable gland plate shall be installed across the full width of each power cubicle at a minimum height of 300mm above the bottom of the kiosk to house the glands. A P4000 "UNISTRUT" channel or other approved support shall be provided to carry the weight of the cable and remove mechanical stress from the cable glands. A minimum distance as required by the bending radius of outgoing cables shall be provided between the lowest terminals of major equipment and the gland plate.

35.11 VERMIN PROOFING

The kiosk shall be protected against vermin, especially from below. Where cables have to pass through the gland plate, rubber grommets shall be provided and enough non-hardening compound shall be delivered with the kiosk so that these holes can be sealed properly after installation of the cables.

35.12 MOUNTING OF EQUIPMENT

The mounting of equipment shall comply with SABS 1180 where applicable. Equipment to be mounted to the chassis shall be mounted by bolts, washers and nuts or by bolts screwed in to tapped holes in the chassis plate. In the latter case the minimum thickness of the chassis plate shall be 2,5mm. The latter method shall not be used where boards will be subject to vibration or mechanical shocks. Self-tapping screws will not be accepted.

35.13 PAINTING OF KIOSKS

CORROSION RESISTANCE

Painted metal shall be corrosion resistant for a period of at least 168 hours when tested in accordance with SABS Method 155.

EDGES

Care shall be taken to ensure that all edges and corners are appropriately covered.

SURFACE PREPARATION

Surface preparation shall comply with SABS 064. Prior to painting, all metal parts shall be thoroughly cleaned of rust, mill scale, grease and foreign matter to a continuous metallic finish. Sand or shot blasting or acid pickling and washing shall be employed for this purpose.

BAKED ENAMEL FINISH

Immediately after cleaning all surfaces shall be covered by a rust inhibiting, tough, unbroken metal phosphate film and then thoroughly dried.

Within forty eight (48) hours after phosphatising, a passivating layer consisting of a high quality zinc chromate primer shall be applied, followed by two (2) coats of high quality baked enamel.

The enamel finish on metal components shall comply with SABS 783 type III.

Other metal parts eg switchboard panels, etc, shall comply with SABS 783, Type IV with a minimum paint thickness after painting of 0,06mm. In coastal areas, the dry film thickness shall be increased to at least 0,1mm.

The paint shall have an impact resistance of 5,65J on cold-rolled steel plate and a scratch resistance of 2kg.

COLOUR

The colour of LV switchboards shall be RED for essential power boards and BLUE for critical power boards.

35.14 TENDER PRICE

The tender price for supply, delivery and installation include the complete board with all equipment as specified in the detailed specification.

The tender price for installation include the positioning and mounting of the board termination of all cables and commissioning thereof.

36 EARTHING

36.1 The earth terminal on the alternator shall be connected to the earth bar in the generator control board by means of the busbar earth bar.

36.2 All metal fuel lines, including the day tank metal frame shall be bonded and solidly earthed to the earth bar in the generator control board.

STANDBY GENERATORS

TECHNICAL SCHEDULES

**TO BE COMPLETED ONLY IF THE EXISTING GENERATORS ARE CLASSIFIED AS DAMAGED AND
THE ELECTRICAL ENGINEER HAS ADVISED REPLACEMENT**

Technical Schedules – Standby Generators

1. SCHEDULE OF TECHNICAL DETAILS

1.1 The trade names and/or catalogue numbers of all equipment forming part of the tender offer must be submitted. The information schedule must be fully completed by the tenderer. Where equipment of a certain manufacture is required in this specification, an alternative may be offered. The item prices of such alternative items must be submitted with the tender offer.

1.2 The total tender price must however be based on the specified equipment and shall be based on offer A. Alternative offers (B and C) may be offered and separate price schedules shall be completed and submitted with the tender clearly marked as alternative B or C.

NO	DESCRIPTION	OFFER		
		A	B	C
2	POWER OUTPUT			
2.1	<u>Engine</u>			
2.1.1	Gross continuous output (kW)			
2.1.2	Less losses for site conditions :			
2.1.3	Height above sea level (kW)			
2.1.4	Ambient temperature (kW)			
2.1.5	Other (kW)			
2.1.6	Less losses for accessories at 1500 rpm :			
2.1.7	Fan (kW)			
2.1.8	DC-generator (kW)			
2.1.9	Water pump (kW)			
2.1.10	NETT CONTINUOUS OUTPUT AT SITE (kW) (X)			

2.2	<u>Alternator</u>			
2.2.1	Required nett output at site (kVA)			
2.2.2	x 0,8 power factor (a) (kW)			

NO	DESCRIPTION	OFFER		
2.2.3	Alternator efficiency (b) (%)			
2.2.4	GROSS REQUIRED INPUT AT SITE (kW) (Y)			
2.2.5	EXCESS POWER X - Y (kW)			
3.	ENGINE			
3.1	Manufacture			
3.2	Country of origin			
3.3	Model number			
3.4	Nominal speed (r.p.m.)			
3.5	Strokes/working cycle (2 or 4)			
3.6	Compression ratio			
3.7	Cyclic irregularity at engine shaft			
3.8	Fuel consumption of the complete generator set at site (in litre/hour) with a generator output of :			
a	full load			
b	³ / ₄ load			
c	¹ / ₂ load			
3.9	Fuel injection system manufacturer			
3.1	Is an oil cooler provided?			
3.11	Are thermostatically-controlled bypass valves provided?			
3.12	Are the oil filters equipped with service indicators?			
3.13	Is a turbo charger fitted? If so, what type?			
3.14	Type of governor			
3.15	Does the governor comply with the specification			
3.16	Mass of engine (kg)			
3.17	Are power curves attached?			

4	ALTERNATOR			
4.1	Manufacture			
4.2	Country of origin			

NO	DESCRIPTION	OFFER		
4.3	Type of enclosure			
4.4	Nominal speed at an output frequency of 50Hz (rpm)			
4.5	Output voltage at no load and adjustability (eg. 210/245V)			
4.6	Rated output at sea level and power factor of 0,8 lagging (kVA)			
4.7	Percentage output loss due to site conditions			
4.8	Percentage efficiency at :			
a	full load			
b	³ / ₄ load			
c	¹ / ₂ load			
4.9	Transient voltage drop due to application of full load (V)			
4.1	Time for voltage restoration after application of full load (ms)			
4.11	Reactance			
4.12	Transient reactance			
4.13	Is generator tropicalised?			
4.14	Insulation class of stator windings			
4.15	Insulation class of rotor windings			
4.16	Mass of generator			
4.17	Generator short-circuit current (kA)			
4.18	Dimensions of generator (LxWxH) (mm)			
5	EXHAUST SYSTEM			
5.1	<u>Exhaust pipe</u>			

5.1.1	Manufacturer			
5.1.2	Wall thickness (mm)			
5.1.3	Diameter at end (mm)			
5.1.4	Does the diameter vary over the length?			

NO	DESCRIPTION	OFFER		
5.2	<u>Silencers</u>			
5.2.1	Manufacturer			
5.2.2	Type			
5.2.3	Attenuation over the full frequency spectrum (dBA)			
6	COOLING SYSTEM			
6.1	What type of system is it? (eg. air/water, etc.)			
6.2	Air louvers :			
a	manufacture			
b	type			
c	material			
6.3	Air flow required (m ³ /min)			
7	FUEL SYSTEM			
7.1	<u>Day Tank</u>			
7.1.1	Capacity (litre)			
7.1.2	Manufacturer			
7.1.3	Material and thickness			
7.1.4	Does it comply with the specification?			
7.1.5	Type of level indication			
7.1.6	Type of level sensors			
7.1.7	Fuel pumps :			
a	Type			

b	Number			
7.2	<u>Bulk Tank</u>			
7.2.1	Capacity (litre)			
7.2.2	Manufacturer			
7.2.3	Material and thickness			
7.2.4	Dimensions and form			

NO	DESCRIPTION	OFFER		
7.2.5	Does it comply with the specification?			
7.2.6	Type of level indication			
7.2.7	Finish			
7.2.8	Type of level sensors			
7.3	<u>Fuel Pipes</u>			
7.3.1	Material			
7.3.2	Diameter from fuel tank to engine			
8	SWITCHGEAR AND CONTROL EQUIPMENT			
8.1	<u>Control Board & Distribution Board</u>			
8.1.1	Manufacture			
8.1.2	Maximum dimensions			
8.2	<u>Equipment on boards (State manufacturer)</u>			
8.2.1	Circuit breakers			
8.2.2	On-load isolator			
8.2.3	Bypass switch			
8.2.4	Change-over switch			
8.2.5	Contactor			
8.2.6	Relays			
8.2.7	Time relays			

8.2.8	Selector switches			
8.2.9	Alarm indicators			
8.2.10	Push buttons			
8.2.11	Indicator lights			
8.2.12	Volt meters			
8.2.13	Ammeters			
8.2.14	Frequency meters			
8.2.15	Hour meters			

NO	DESCRIPTION	OFFER		
8.2.16	Current transformers			
8.2.17	Voltage/frequency sensor unit :			
a	Type of sensor			
b	Manufacturer of components			
c	Drop-out voltage adjustability (eg. 340/440V)			
d	Pull-in voltage adjustability (eg. 340/440V)			
e	Frequency sensor adjustability (eg. 47/53 Hz)			
8.2.18	Is the control equipment powered by the starter battery? (If not, describe in addendum to tender)			
8.2.19	Type tested to SANS 61439 / Tested according to SANS 61642			
9	BATTERY CHARGER			
9.1	Manufacturer			
9.2	Time to recharge battery after full discharge			
9.3	Maximum charge current			
9.4	Charge voltage (V)			
10	BATTERIES			
10.1	Manufacturer			
10.2	Country of origin			

10.3	Type of battery			
10.4	Voltage of battery (V)			
10.5	Capacity (Amp-hours)			
10.6	Is the battery in one container?			
11	OTHER EQUIPMENT			
11.1	<u>Emergency Lights</u>			
11.1.1	Manufacturer			
11.1.2	Country of origin			
NO	DESCRIPTION	OFFER		
11.1.3	Model number			
11.2	Sound attenuating ventilators			
11.2.1	Manufacturer			
11.2.2	Country of origin			
11.2.3	Model number			
12	SPARES AND MAINTENANCE FACILITIES			
12.1	Approximate value of spares kept in stock for this type of machine			
12.2	Where are the spares kept?			
12.3	Maximum time for service team to reach site after notification of a fault condition			
13	DIMENSIONS OF EQUIPMENT			
13.1	<u>Generator set (complete)</u>			
13.1.1	Control board			
13.1.2	Distribution Board			
13.1.3	Fuel tanks :			
a	Day			
b	Bulk			
13.1.4	Sound Attenuating Air louvers :			
a	In front of radiator			

b	Elsewhere in machine room			
c	% Free air opening			

**TEMPLATE TO BE COMPLETED ONLY IN THE EVENT THAT THE ELECTRICAL ENGINEER HAS
CONFIRMED THAT NEW GENERATORS ARE REQUIRED**

SIGNATURE OF TENDERER : _____

**NAME AND ADDRESS
OF TENDERER** : _____

DATE : _____

2. DELIVERY AND INSTALLATION

I, we the undersigned undertake to install the generator power supply unit complete as specified in accordance with the following programme.

The information indicated below shall be calculated from the date of official tender acceptance.

Delivery of all equipment	Weeks
Installation	Weeks
Total time required to complete the installation	Weeks
NAME AND ADDRESS OF TENDERER (COMPANY)	
NAME OF COMPANY REPRESENTATIVE	
Signature	Date
Witnesses :	
1.	Date
2.	Date