
SCOPE OF WORK FOR THE INSTALLATION OF A DIESEL GENERATOR SYSTEM – DURBAN & EAST LONDON CAMPUS

FOR THE

SOUTH-AFRICAN BUREAU OF STANDARDS

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1. INTRODUCTION

This scope of work covers the implementation design, manufacture, supply, delivery, construction and commissioning of the required systems and auxiliary equipment to provide back-up power for the following buildings:

- SABS Durban campus
- SABS East London campus

2. SCOPE OF THE WORK

2.1 GENERAL

The following general items are included in the scope of work:

- The relevant co-ordination and the co-operation with the Client project team and other contractors;
- On site tracing of existing services and identification of suitable cable routes into buildings;
- The compilation of manufacturer's design drawings for approval by the Client and Consultant prior to manufacturing or ordering of equipment;
- The programming of activities and monitoring of progress;
- Supervision of the works and ensuring the quality of the work performed;
- Ensuring that all the required plant and equipment is available;
- The supply of all incidental work, services, information and data;
- Any other items not covered by the foregoing, but forming part of the contractor's obligations and responsibilities;
- Obtaining working permits for the relevant areas from the Client complete with all documentation for the type of work to be undertaken;
- The furnishing of expertise for the successful operation/functioning of the equipment;
- The offloading at site, storing, handling, construction, the installation, piping, cabling, laying, fixing, connecting up, painting and completion on site, including all work, materials and activities incidental thereto;
- The supply and delivery of commissioning spares;

- The supervision of and responsibility for the commissioning including preliminary trials, final testing, starting, setting to work, proving and handing over to the Client of all plant, equipment and materials in full working order under the stated operating conditions and complying with the performance and other guarantees specified;
- The supply of all specified operating, training and maintenance information including complete parts data, parts manuals (if applicable) and drawings as specified;
- The remedy of the plant and equipment during the "Defects Liability Period";
- Execution of a 12 month Service Level Agreement following hand-over of the generator systems.

2.2 SCOPE OF WORK - GENERATOR INSTALLATION

The Client requirements are for the Durban Office building to be on full emergency back-up with generator power and the East London building to be on partial back-up generator power.

The work includes the implementation design, manufacture, supply, delivery, construction and commissioning of the following systems:

- 1) Standby generator set and all ancillary equipment for both buildings.

2.2.1 Durban Offices

The proposed generator installation is depicted in fig. 1.

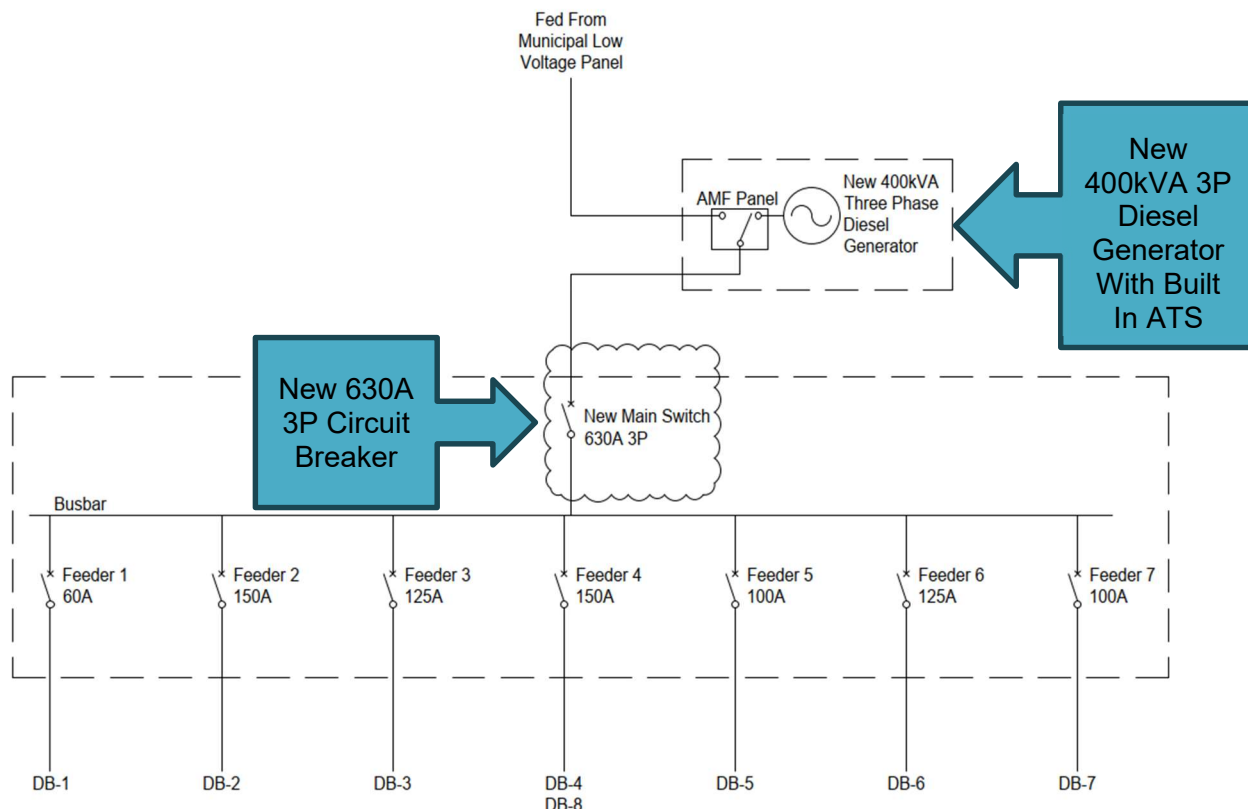


Figure 1 Generator Installation

The generator will be a single free-standing, 400kVA, 400V, 3 Phase, 50Hz, canopy enclosed unit with on-board control system including an auto transfer switch. It will be equipped with a ± 750 Ltr diesel double bunded day-tank which can be re-fueled as required by a bowser.

The Automatic Mains Failure panel will be installed inside the generator weatherproof/soundproof canopy.

Annexure E contains the datasheet for the generator.

The existing 1600Amp main circuit breaker must be removed, and provision and modifications will have to be implemented to install a new 630Amp 3 phase circuit breaker. New cable ladders must be installed for the new electrical cables.

The proposed position for the Generator is depicted in fig. 2 and the Municipal Demand Board is depicted in fig. 3.

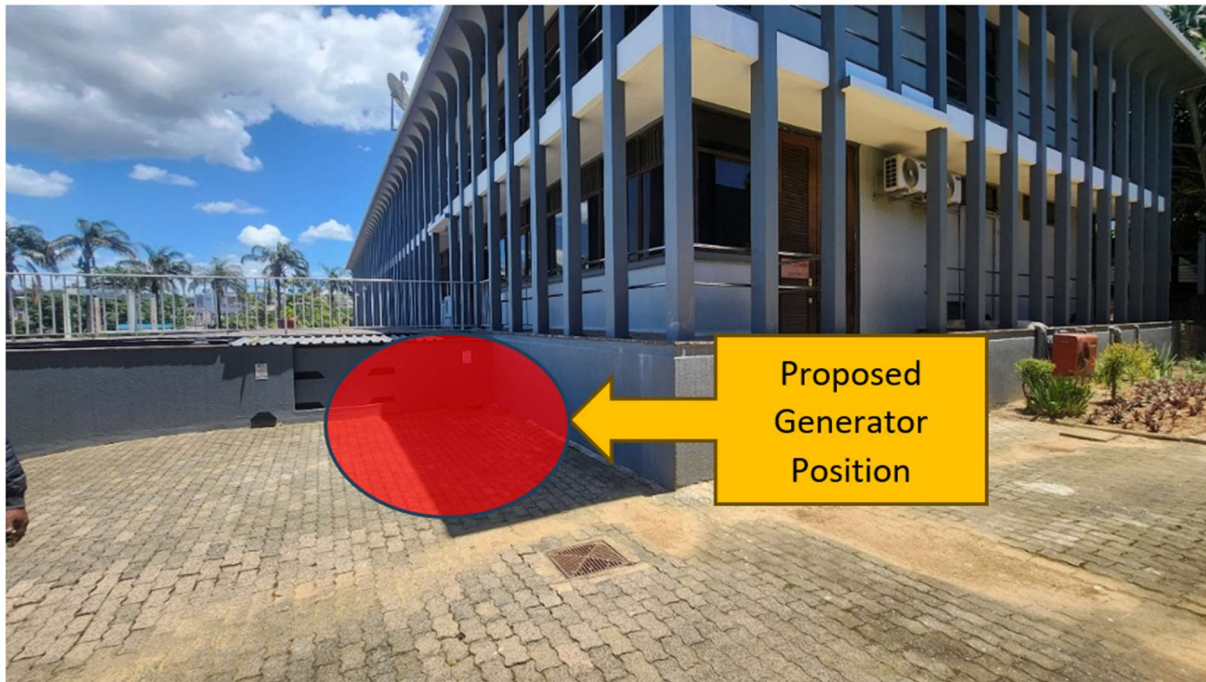


Figure 2 Proposed Generator Position

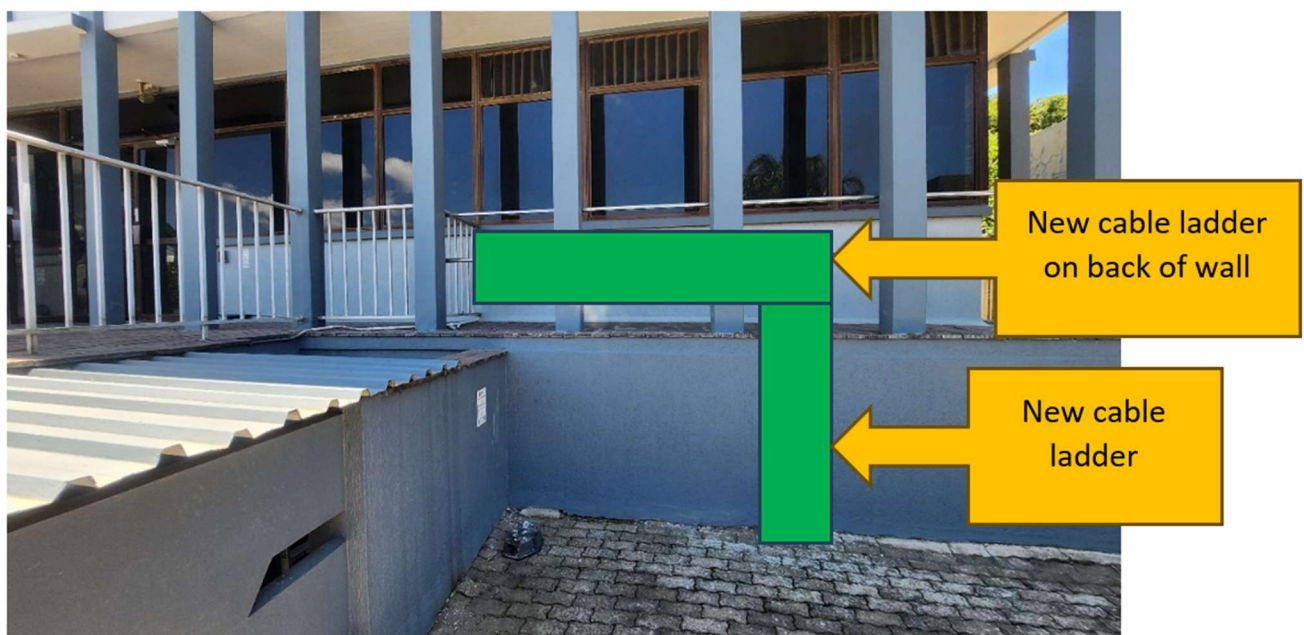


Figure 3 Cable Ladder Route

The scope of work includes:

- New generator installation;
- Generator concrete plinth with bund wall to accommodate 110% of fuel capacity (area uneven);
- Generator electrical earthing to building system;
- Generator system earth ring;
- ATS/AMF panel inside generator; The ATS/AMF should be equipped with 4 pole breakers to break the neutral conductors from main power and emergency power with an internal neutral/earth bond and earth fault contactor to interrupt the earth conductance once switch over to the normal power.
- New cables from ATS/AMF to existing 400V Main DB;
- New cables from existing 400V municipal DB to ATS;
- Cable routes as required:
 - Cable racking;
 - Enter building through new core drilled holes into the LV room.
- Remove existing main circuit breaker and install new 630amp circuit breaker

2.2.2 East London Offices

The proposed generator installation is depicted in fig. 4.

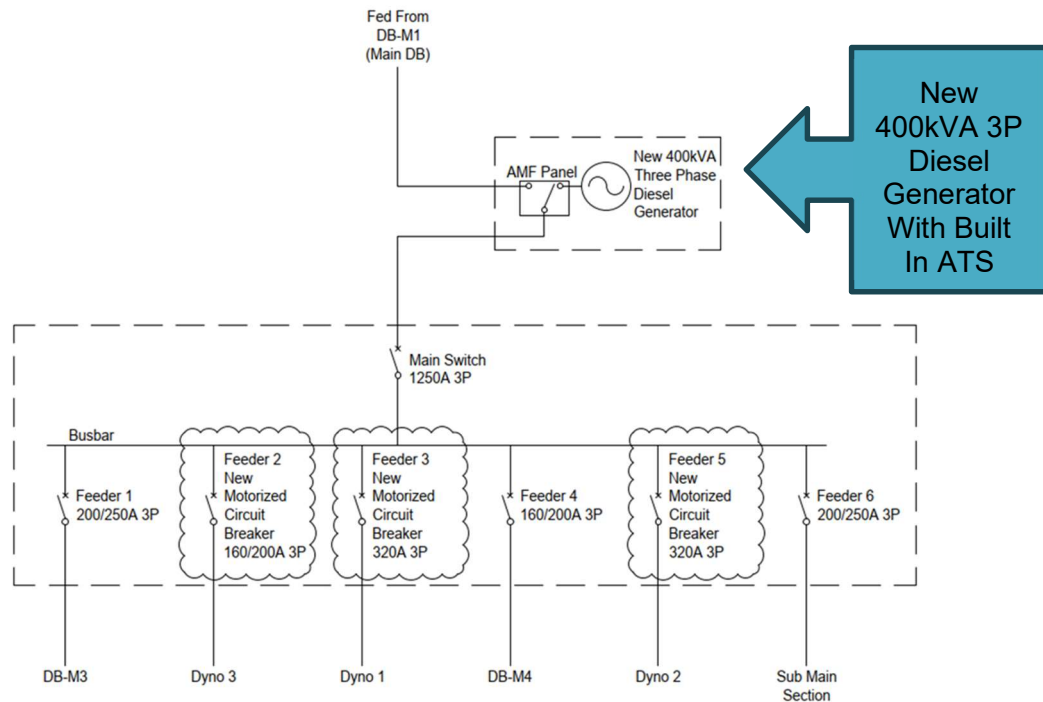


Figure 4 Generator Installation

The generator will be a single free-standing, 400kVA, 400V, 3 Phase, 50Hz, canopy enclosed unit with on-board control system including an auto transfer switch. It will be equipped with a ± 750 Ltr diesel double banded day-tank which can be re-fueled as required by a bowser.

The Automatic Mains Failure panel will be installed inside the generator weatherproof/soundproof canopy.

Annexure F contains the datasheet for the generator.

Fig. 5 indicates the existing supply cables from DB-M1 to DB-M2. These cables will have to be removed and then extended to the new AMF/ATS panel of the generator.

New 3 x 185mm² x 4c Cu PVC/SWA cables to be installed from the AMF/ATS panel to DB-M2. Cables to be installed on the new cable ladder.

Three existing circuit breakers inside DB-M2 will have to be replaced with motorized circuit breakers with the same ratings. Signals from the change-over switch will be installed to the motorized circuit breakers to switch-off in the event of power failure.

The proposed position for the Generator is depicted in fig. 6.



Figure 5 Proposed Cables That Require Relocation

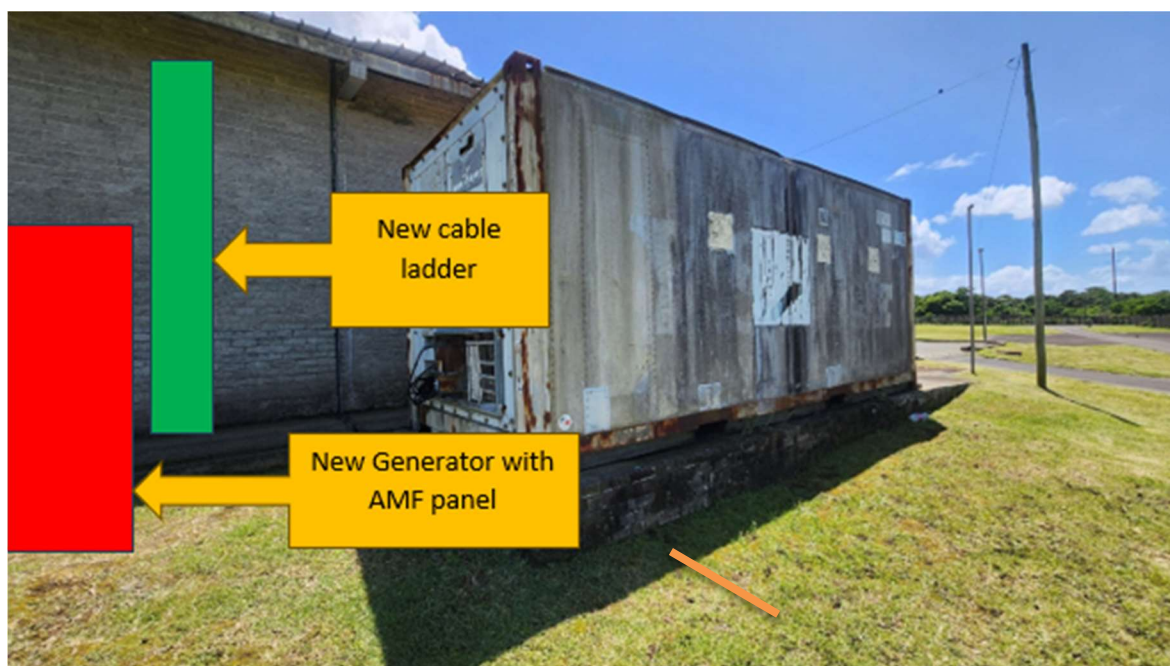


Figure 6 Generator Location

The scope of work for the includes:

- New generator installation;
- Generator concrete plinth with bund wall to accommodate 110% of fuel capacity (area uneven);
- Generator electrical earthing to building system;
- Generator system earth ring;
- ATS/AMF panel inside generator; The ATS/AMF should be equipped with 4 pole breakers to break the neutral conductors from main power and emergency power with an internal neutral/earth bond and earth fault contactor to interrupt the earth conductance once switch over to the normal power.
- New cables from ATS/AMF to existing 400V DB-M2;
- Relocating cables from existing 400V DB-M2 to AMF/ATS;
- Replacing existing breakers with motorized breakers inside DB-M2;
- Cable routes as required:
 - Cable racking;
 - Enter building through new core drilled holes into the building.

3. CODES AND STANDARDS

The design of the electrical services shall be in accordance with legislation and all the relevant SANS Standards.

Unless otherwise specified all equipment and installations shall comply with the codes and standards set out in this specification and all other relevant SANS codes as published by the South African Bureau of Standards. Should no local codes exist for a particular system or equipment, the relevant BS code shall apply. Where SANS and BS conflict, the SANS code shall take precedence.

Where codes other than SANS are specified, the equivalent SANS code shall be acceptable subject to agreement with the Employer and /Engineer.

Special reference is made to the following Standards:

- SANS10142/1: Wiring of premises;
- SABS0313: The protection of structures against lightning;

- SABS0292: Earthing of low voltage distribution systems;
- SABS0108: The classification of hazardous locations and the application of apparatus for usage in such locations.

4. GENERATOR SPECIFICATION

The specification for the generator is included in Annexure D. The datasheet for the generator is included in Annexures E & F.

The generators will be rated for standby operation and installed in weatherproof canopies on concrete plinths outside the buildings.

The generators will be self-starting, complete with remotely installed integrated automatic change-over systems, self-bunded day tanks and associated pumping systems.

Generators are to be housed in weatherproof, sound attenuated enclosures sufficient to not exceed a noise level of 65dBA at 7m distance.

The equipment shall conform to all SANS and SABS standards and be from reputable suppliers with a solid South-African footprint and back-up support structure.

5. GENERAL REQUIREMENTS

5.1 ALLOCATED SPACE

The physical sizes of the equipment offered will be suitable for the space allocation and will be positioned in such a manner to ensure reasonable access all around the equipment for maintenance purposes, as recommended by the suppliers of the equipment, or as per any relevant statutory requirements.

The Tenderer shall provide sufficient equipment dimensions with the tender to identify any major space constraints up front.

The contractor shall survey all areas with the Engineer post contract award to identify adequate accommodation for the equipment and routes for cables and auxiliary systems.

5.2 COORDINATION WITH OTHER TRADES

The contractor will plan his work in advance and will coordinate all space requirements in conjunction with the engineer and client, especially where other trades share the same space. Where conflicts occur, the contractor will request clarification from the client and/or Engineer.

5.3 BUILDER'S WORK

The Contractor will provide the Engineer with all work required to install his equipment such as holes, temporal removal of existing doors for bringing in equipment to the electrical rooms, access, chases, recesses, service ducts, sleeves and frames, cable seals, etc.

No structural element will be erected and no holes will be cut or made through the structure and no items of equipment will be supported from the structure without the prior approval of the Engineer.

The contractor will be responsible for all cutting, patching, making good, etc., as may be required to accommodate his equipment.

5.4 WATERPROOFING

Where any work pierces waterproofing, including waterproof concrete and roofing, the method of installation will be approved by the Engineer before the work is carried out.

All necessary sleeves, caulking, skirts, soaker sheets, flashing, etc., required to make the openings absolutely water-tight will be provided and installed by the contractor.

5.5 ALTERNATIVE MANUFACTURE AND PRICES

The tendered contract sum will be for work and materials as specified herein. Should the tenderer wish to offer alternative equipment, etc., the details will be submitted in a covering letter accompanying the tender and clearly identifying the extent, quality and advantages of the alternative(s).

Acceptance of the alternative(s) will be at the discretion of the Engineer.

Any price submitted for alternatives, variations, extras, saving, omissions, etc., whether prior to tender acceptance or during the construction stage of the works will be taken to include the applicable Value Added Tax (VAT), unless clearly identified otherwise at the time of its submission.

5.6 MATERIALS, WORKMANSHIP AND EQUIPMENT OFFERED

Materials, workmanship and equipment offered will be as specified and comply with the specifications and datasheets.

The term 'approved equal', as used herein, will mean an item generally the same as the specified one, but of different manufacture. It will meet all the specified parameters and approval for its use will be obtained in writing from the Engineer.

5.7 GUARANTEE

The Contractor shall guarantee that the equipment offered will give satisfactory and efficient service, for a period of one year from the date of practical completion, and to replace or repair, with a minimum of delay and free of charge, any components which may fail other than by fair wear and tear during this period.

The complete installation shall be guaranteed against defects whether patent or latent as well as against faulty materials and workmanship.

The guarantee shall cover all materials, plant and equipment whether or not it is covered by a manufacturers guarantee. The one year guarantee in terms of this contract on the entire installation shall not be affected by the prior expiry of any guarantee provided by the manufacturer of any item of equipment or plant.

The Contractor shall cede to the client the remainder of any equipment guarantee which he has received from his suppliers and which extends beyond the one year period. It shall be the responsibility of the Contractor to ensure that the guarantee is transferable.

The Engineer may at his discretion allow the guarantee period on any item of equipment or section of the installation start at a date prior to final handover if it is put into operation for beneficial use of the client prior to final handover. This will not be permitted in cases where final handover is delayed due to the contractor not carrying out remedial work in good time.

Back-up support structure for all major equipment with an emphasis on spares availability and generator service ability; can be broken down as follows:

- Backup Support Structure: The contractor should explain their backup support structure, including the mechanisms in place to provide technical assistance, maintenance, and repairs for the equipment supplied. This could include dedicated support teams or partnerships with local service providers.
- Spares Availability: The contractor should list the critical spares required for the generator and demonstrate their ability to provide timely access to spare parts for the equipment. This could be through indication of lead times for ordering and delivery and arrangements for emergency or critical spare parts.
- Generator Service Ability: The contractor should demonstrate their ability to respond to a service request within a period of 24 hours to site (East London and or Durban). This could be information on response times for service requests, service level agreements (SLAs) or partnerships with local service providers.
- Detailed equipment brochures and datasheets of the generators.
- Twelve months warranty confirmation;

5.8 SUPPORTS

No supports for the cables and racking etc. are shown on the drawings. The Contractor will allow for sufficient supports as recommended by the manufactures/suppliers and specified in the Standard Specifications for Electrical Installations.

5.9 PERFORMANCE OF SYSTEMS AND EQUIPMENT

The systems and equipment layout designed by the Engineer will conform to the requirements about installation and system performance. This suggests that the performance of the equipment in the system supplied and installed by the contractor, will be in accordance with the design and performance figures as published by the manufacturers and/or suppliers.

It is furthermore accepted that the contractor has assured himself that all equipment supplied and installed under the contract will perform within the given limits, as stated by the supplier/manufacturer, conforming to the specification.

5.10 SITE INFORMATION

The site where work is to be carried out is the SABS, Durban & East London Campuses with address: 15 Garth Road, Waterval, Mayville, Durban & 1a Teichmann Pl, Sunnyridge, East London.

5.11 DRAWINGS

The contractor is to supply all drawings required for manufacture and installation and drawings shall be in accordance with SABS 0111, Code of Practice for Engineering Drawings.

Engineers' drawings issued for the service are not manufacturing drawings and the dimensions given are sufficient for tendering purposes only or to enable the contractor to complete his working drawings.

Three copies of the following drawings shall be submitted by the Contractor to the Engineer/Client for approval before the supply/delivery of the equipment.

5.11.1 Contractor's working drawings

Contractor's working drawings shall include positions, sizes and masses of major pieces of equipment, positions, sizes and masses of bases for the equipment, all electrical connections, cable routes, as well as all other building requirements necessary for the successful installation and operation of the generator unit.

5.11.2 Electrical drawings

These are all line diagrams, schematic drawings, general arrangements and equipment layout drawings required for the erection of the installation.

The Contractor shall survey and measurements on site before workshop drawings are issued for construction or equipment is manufactured, to ensure that the equipment will fit into the space available. Positions and sizes of openings through walls, floors, etc., as indicated on the Engineering drawings shall be adhered to.

All cable routes and racking accessories shall be shown in detail on the lay-out drawings.

Drawings, except Contractor's drawings, shall be submitted for approval but shall in any event not be submitted later than one week after the date of acceptance of the tender.

The Contractor is advised to submit three copies of the drawings for comments by the representative after which his original drawings shall be updated and submitted for signature to ensure that all drawings issued for construction are certified as approved by the Engineer.

The following information shall be supplied with workshop drawings:

- Certified dimension drawings, equipment sizes, location of equipment, component parts and installation details.
- Manufacturer's specifications, including materials, type and capacity ratings.
- A list of all deviations from the plans and specifications and reasons for the deviation.
- Electrical control panel wiring diagrams and panel layout drawings.
- Cable routes and cable support construction detail drawings.

Any work carried out by the Contractor without approved drawing shall be at the Contractor's own risk and any changes required to conform to the contract documents or to co-ordinate his work with other trades shall be for the account of the Contractor.

Approval of drawings by the Engineer shall not relieve the Contractor of his responsibilities to carry out the work in terms of the contract documents.

The mechanical drawings shall be updated (if applicable) during the contract period and shall be included in the O and M manual as required.

The Vendor's design responsibilities include the provision of general arrangement drawings, schematic drawings, terminal schedules, operating and maintenance documents, technical literature and a recommended spares list all as required by the Engineer.

The spares list shall also indicate the nearest point of resource. A detailed listing of documentation to be provided by the Vendor is to be found in the Vendor Document Requirements Schedule issued as part of the Enquiry Requisition or Purchase Documentation.

5.12 MAINTENANCE

The contractor will provide free maintenance for a period of 1 (one) year following the hand over to the client. The maintenance will include for all management, labour, lubricating materials, cleaning materials and transport.

The maintenance visits shall be carried out at regular monthly intervals.

In addition to the monthly maintenance visits, the Contractor shall carry out all necessary visits due to failure of any item of the plant or equipment. The contractor shall attend to all complaints by the client.

The Contractor shall report to the client's nominated representative, both on arriving and leaving the site. The Contractor shall provide the client and the Engineer with a Service Report for each visit whether scheduled or breakdown.

At each maintenance visit, the Contractor shall check the function of each item of plant and equipment and shall ensure that the plant is performing to specification. All automatic controls and bulbs, etc. shall be checked and adjusted or replaced as necessary.

The equipment and plantrooms shall be cleaned at each scheduled visit.

The Contractor shall notify the Engineer prior to the final monthly service so that the Engineer may accompany the Contractor.

The Engineer may at his discretion allow the maintenance period on any item of equipment or section of the installation start at a date prior to final handover if it is put into operation for beneficial use of the client prior to final handover. This will not be permitted in cases where final handover is delayed due to the Contractor not carrying out remedial work in good time.

The Contractor shall provide one set of all special tools, gland keys, valve keys, etc. required for testing, maintaining and operating of all items of equipment.

Duplicate keys shall be provided for all control panels, instrument locks, safety valve locks, etc.

All special tools etc. referred to above shall be handed to the client when the system handover is done.

5.13 OPERATOR TRAINING

On completion of all tests to the satisfaction of the Engineer, the Contractor shall continue to be responsible for the complete operation and maintenance of the plant

for a period of one week during which time instruction shall be given to the Employer's staff on the proper operation and maintenance of the plant.

The operation and maintenance of the plant for the duration of the instruction period shall not in any way relieve the Contractor of his responsibility under the terms of the contract.

The staff must receive enough instructions to ensure that they are fully conversant with the equipment concerned. Site staff shall be instructed on:

- a) The full installation, commissioning, testing and operating methods of the equipment.
- b) All instructions and problem solving of equipment.
- c) Stopping the equipment in emergency and warning against restarting after an emergency.
- d) Positions and settings of all control equipment.
- e) Operating temperatures, pressures, etc.
- f) All safety measures including electrical.
- g) Name, address and telephone number of the equipment suppliers and contractor that can be contacted during installation and maintenance of the equipment.

The operating and maintenance manual must be available during the training of the staff. Staff must also be made conversant with the contents of the manuals.

All instruments such as thermometers, pressure gauges, indicators, etc. shall be marked at the operating point under normal conditions. Such markings shall be neatly done on the scale itself and not on the protecting glass cover.

5.14 TENDER SUBMISSIONS

Tender submissions will conform strictly to the specification requirement. Tenders that are not in accordance with the specification will not be considered.

5.15 COMMISSIONING

Commissioning of the works will form part of the contract. Commissioning will be meticulous, and all procedures as stipulated by the suppliers of the equipment will be strictly adhered to.

The contractor will prepare detailed commissioning schedules well in advance of the programmed practical completion inspection date.

The schedules will make allowance for all measurements that will be required, checking of operational and safety set-points, test results, etc., and will be submitted to the Engineer for approval prior to the start of commissioning.

The contractor will submit the completed schedules to the Engineer for checking after commissioning has been completed, and prior to the practical completion inspection.

The contractor is forewarned that the Engineer will under absolutely no circumstances deviate from the above procedure. The Engineer furthermore reserves the right to refuse to carry out the practical completion inspection until the contractor has complied with the above stipulations. The contractor will accept this reserved right by the act of tendering.

Each task in these schedules will be countersigned by the contractor's Commissioning Engineer to ensure that any discrepancies between site and commissioning conditions/data can be clarified.

Commissioning shall be in accordance with the requirements stipulated in Annexure D.

All testing operations shall be witnessed and approved by the Engineer.

5.16 OPERATING AND MAINTENANCE MANUALS

Three sets of operating and maintenance manuals will be prepared by the contractor. These manuals will be submitted to the Engineer for approval 1 week prior to the programmed date for the practical completion inspection.

Tenderers are to note that the said practical completion inspection will not be carried out prior to the approval of these operating and maintenance manuals. The manuals will be properly bound and titled. Each set will consist of 4 sections. Each section will have the following sub-sections:

5.16.1 Section 1 - Operation

Introduction:

Short description of the complete system to familiarise laymen with the system layout and operation.

Detailed description:

A detailed description of each system and its equipment, complete with schematic drawings. The purpose of this system is to explain the intended operation of each system and item of equipment to technical personnel. Detailed descriptions of the operation, set-points, adjustments, etc., are thus to be included.

5.16.2 Section 2 - Commissioning data

Schedules of data:

Detailed schedules of commissioning data of all the systems will be included in this section for future reference. These schedules will include all measured electrical and mechanical parameters.

5.16.3 Section 3 - Maintenance

Schedules:

This section will contain detailed maintenance and service schedules for the complete installation.

Equipment details:

This section will contain manufacturers' brochures, spare parts lists, etc., of all the items of equipment.

List of suppliers:

The list of suppliers (complete with addresses and telephone numbers) for each item of equipment will be included in this section.

5.16.3.1 Section 4 - Drawings

As-built drawings:

A complete set of as-built drawings will be enclosed in this section.

6. LOCAL CONTENT

The Client welcomes the inclusion of reputable international brands and emphasizes the importance of quality in the selection of units. While local content is valued, there is flexibility regarding the percentage requirement, with an emphasis on ensuring the procurement of high-quality equipment.

7. RETURNABLE DOCUMENTS

- Completed Technical Datasheets – Annexures E & F;
- Proof of team or personnel experience (CV) including wireman's license;
- CIDB grading;
- Performance on similar past projects with reference letters;
- Project plan and schedule. Please keep separate for each site Durban and East London.

ANNEXURE A

SPECIFICATION - CABLE INSTALLATION AND ACCESSORIES

1 GENERAL

- The installation of cables for distribution of power in buildings, structures and in the ground for system voltages up to 11000 volt, 50 Hz, comprise the following:-

2 Cable Types

- The following cable types shall be used, unless specified to the contrary in the detail technical specification:
 - Low voltage supplies in ground: PVC insulated armoured.
 - Low voltage supplies in Substation: PVC insulated armoured
 - Low voltage supplies to main distribution boards and sub-distribution boards: PVC insulated armoured, Unarmoured PVC insulated cables may only be used for supplies to sub-distribution boards if such cables are installed in conduit, sleeves or metal trunking.
 - Connections to equipment: PVC insulated armoured or unarmoured when installed in conduit or metal trunking.
 - Cables with copper conductors shall be used throughout. All cable installations shall conform to the SABS Code of Practice 10142: 2021.
 - Low voltage cables manufactured shall comply with SANS 1507/SABS 1507: 2007

3 Routes

- Cables shall be installed in the positions indicated on the drawings. Deviations are to be pointed out to the Engineer before installation commences.
- Cable routes, or portions thereof, may be altered in advance of laying cables. Price adjustment, in respect of additional work shall be at the documented rates.
- Obstructions along the cable routes shall be brought to the attention of the Engineer.

4 INSTALLATION OF CABLES IN CONCRETE TRENCHES

Installation

- Cables shall be installed in concrete trenches in one of the following ways:
 - On horizontal cable trays.
 - On horizontal metal supports with suitable clamps,
or
 - on vertical cable trays or metal supports fixed to the side of the trench. Cables shall be clamped in position.
- Cables shall not be bunched and laid on the floor of the building trenches.

Covers

- The covering of concrete trenches shall as a rule fall outside the scope of the electrical installation. The Contractor shall however be responsible for the cutting or drilling and smoothing of holes for cables through chequer plates, concrete or other covering as required.

Filled trenches

- Floor trenches shall be filled with sand only when it is a specific requirement of the Local Authorities.
- If a sand filling is required the cables shall be fixed to non-corroding supports.
- Sand-filled trenches if required shall be covered as follows:-

Reinforced concrete covers

Sand and cement screed or

Removable chequer plates.

- Method 1 above shall be used where vehicular traffic may be encountered over trenches, in which case the covers must be designed to withstand the predetermined mass.

5 FIXING OF CABLES TO TRAYS OR STRUCTURES**Installation**

- Cables may be installed in one of the following ways:
 - on horizontal cable trays,
 - against vertical cable trays with suitable clamps,
 - against horizontal or vertical metal supports or brackets with suitable clamps, or
 - on clamps which are fixed to the structure.
- Cable trays installed between steel columns must be supported by means of vertical suspension rods to prevent the tray from sagging or warping.

Clamps

- Suitable clamps (cleats) which will secure cables without damage shall be used. Clamps shall consist of adjustable metal wings which clamp to a metal support, or consist of two halves bolted together. The correct clamp size to fit the cable shall be used. Cables of different sizes may only be fixed by a common clamp when the clamp is specially made to accommodate the various cables.

Spacing of Supports

- The maximum spacing between cleats (clamps) to which cables are fixed in horizontally and vertical routes shall be determined from Table 1 below. Additional cleats shall be installed at each bend or offset in the cable run. Spacing of supports for cables for high voltage lighting shall be in accordance with Table 8 of SABS 10142.

TABLE 1

Cross Sectional Area of Cable Conductors (sq.mm)	Maximum spacing of supports (cleats) (mm)			
	Armoured Cables		Unarmoured Cables	
	Horizontal Cable Routes	Vertical Cable Routes	Horizontal Cable Routes	Vertical Cable Routes
1.5 4 core	450	750	300	400
2.5 4 core	450	750	300	400
4.0 4 core	600	750	300	400
6.0 4 core	600	750	300	400
10.0 4 core	750	900	400	450
16.0 4 core	750	1000	400	550
25.0 4 core	900	1000	450	550
35.0 4 core	900	1000	450	550
50.0 and above	900	1000	450	550
Multi core	30 X outside dia with max of 900 mm		20 X outside dia with max of 550mm	

Spacing correction factors

- Cables shall be spaced apart. Should this not be possible, the grouping correction factor, according to SABS 10142 shall apply.

Cables on Different Levels

- Where parallel cable runs are installed at different levels (e.g. on parallel cable trays) a minimum spacing of 300 mm shall be maintained between each level.

High Voltage Cables

- High voltage cables shall be separated from other cables and services throughout the installation and shall as far as possible be installed in separate floor trenches, pipes or metal channels. Where this is not feasible a minimum spacing of 300 mm shall be maintained.

Cables for other Services

- Cables for telephones, communication systems and other low voltage systems (less than 50 V) shall be separated from power cables. In vertical building ducts a physical barrier shall be provided between power cables and cables for other services. Where armoured cables are used for such other services, they shall be installed on separate cable trays or shall otherwise be at least 300 mm away from power cables. Where unarmoured cables are used for these other services, they shall be installed in separate conduits or metal channels.

6 TERMINATION OF CABLES**General**

- Cable ends shall be terminated with glands and the associated accessories such as clamps, shrouds, etc. conforming to the requirements of SABS 10142.
- Connection of cables to switchgear shall always be effected in such a way that the various phases, seen from the front of the switchgear will be in the following positions:
 - No. 1 conductor : left (red) (A)
 - No. 2 conductor : centre (white) (B)
 - No. 3 conductor : right (blue) (C)
- Cable cores shall be marked with coloured tape where necessary to identify the phases, but standard phase colours are preferable.
- The current-carrying capacity and breakdown voltage of the cable end shall be the same as for the complete cable.

PILCSTA and PILCSWA Cables

- Paper insulated cables shall be manufactured in accordance with SABS 597.
- Cable end boxes shall comply with BS 542 and the filling compound to BS 1858.
- The ends shall be terminated in cable end boxes filled with bituminous cold filling or resin oil semifluid compound or heat shrinkable terminations in accordance with the specification, and to the manufacturer's recommendation.
- Before terminating or jointing PILCSTA and PILCSWA cables a test to establish the presence of moisture must be carried out. The test procedure must be forwarded to the Engineer for approval.
- The armouring shall be bonded to the main earth bar of the switchgear or transformer, but the bond shall be easily removable for testing purposes.
- All cut cable ends which will be exposed to the atmosphere for more than two hours shall be sealed and wiped to prevent penetration of moisture.

PVC Insulated Cables

- PVC insulated cables shall be manufactured in accordance with SABS 150.
- PVC cable glands shall be made of nickel plated bronze or brass and must consist of a barrel carrying a cone bush screwed into one end and a nickel-plated brass nipple and galvanised steel lock nut on the other end.
- Flameproof glands shall comply with SABS 808 groups 1, 2a and 2b.

- All cable ends shall be terminated with approved glands ensuring a watertight connection between the sheath, gland and equipment. In cases where copper ECC earth conductors are jointed to the armouring special glands adhering to SABS 150-1970 paragraph 5.8.3(c) shall be used for ECC cables.
- The glands to be used shall be constructed so that the armouring of the cable is clamped between two bevelled cores with a screw-clamp, with the cable gland screwed to the gland plate or equipment and fixed with a lock nut.
- A Neoprene or PVC shroud of the correct size shall be used to seal the gland and sheath watertight.
- Cable ends shall be supplied with the necessary earth connection.
- A supporting channel or other approved means of support shall be provided to remove mechanical stress from the cable glands.

XLPE Cables

- Cable ends shall be terminated strictly in accordance with manufacturer's specifications. The termination shall withstand the same test voltage as the rest of the cable.
- Termination for high voltage XLPE cables must have a satisfactory stress relief in order to keep the partial discharges extinguished.
- Outdoor termination must be able to withstand air pollution and bad weather without any signs of surface current tracking.
- Taped or prefabrication terminations may be used, in accordance with the manufacturers recommendation.

JOINTS

- No joints in cable runs will be allowed unless a cable run exceeds the maximum length available on a cable drum.
- Jointing shall be carried out strictly in accordance with the manufacturer's instruction and by personnel competent in jointing the types of cables used.
- The joint shall not impair the anti-electrolysis characteristics of the cable.
- The Contractor shall notify the Engineer timeously of the day on which jointing is to be carried out in order that an inspection may be arranged if so required. Any cable joint not inspected by the Engineer because of insufficient notice being given, shall be opened for inspection and redone at the discretion of the Engineer and at the cost of the Contractor.
- Joints shall be fully water and air tight and shall be free of voids and air pockets.
- The crossing of cores in joints will not be permitted under any circumstances.

7 CONNECTION OF CABLE CORES

- Suitable lugs shall be used, preferably crimped to cable core ends using mechanical or pneumatic tools designed for this purpose
- Cables that are connected to clamp type terminals where the clamping screws are not in direct contact with the conductor, need not be lugged but the correct terminal size shall be used.
- Contact surfaces shall be thoroughly cleaned and smoothed and fixing bolts shall match the hole size of the lug.

- Ferrules shall be used as far as possible where cable cores are connected directly to equipment with screws against the conductor strands.
- When cutting away insulation from cable cores to fit into lugs, care shall be taken that no strands are left exposed. Under no circumstances may any of the conductor strands be cut away to fit into lugs.

8 TESTING

- Each cable shall be tested after installation SABS 150 (Up to 1000V) and SABS 97 (Up to 11 requirements of the Local and Supply Author
- LV Cables shall be tested by means of a suitable megger 1000V and the insulation resistance shall be tabulated and certified.
- HV. Cables shall be pressure tested in accordance with the following table and the exact leakage current shall be tabulated and certified.

Cable rating (volts)	Test Voltage (Applied for 15 minutes)			
	Between conductors		Conductors to sheath	
	AC (r.m.s.)	DC	AC (r.m.s.)	DC
3300	6000	9000	3500	5000
6600	12000	18000	7000	10500
11000	20000	30000	11500	17000

- The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The costs of testing must be included in the tender price. The tests are to be witnessed by the Engineer after timeous notification by the Contractor.
- On completion of the tests on any cable, the Contractor shall with-out delay, submit three copies of the certified Test Reports to the Engineer.

9 CABLE TRAYS AND LADDERS

- Cable trays and ladders shall comply with SABS 763 with respect to finishes. PVC trays shall be rigid unplasticised.
- The Contractor shall supply and install all cable trays and/or ladders as specified or as required including the necessary supports, clamps, hangers, fixing materials, bends, angles, junctions, reducers, T-pieces etc. He shall further liaise with the Main Contractor for the provision of holes and access through the structure and finishes.

Supports

- Trays shall be supported at the following maximum intervals:
- 1,6 mm thick metal trays with 12 mm return 1m spacing
- Metal trays with folded over return and 50 mm upstand spacing 1.22
- 2,4 mm thick metal trays, and 75 mm return spacing 1.5m
- Metal cable ladders other than SCALLADDER 1.5m
- SCALLADDER or similar 1.0 spacing
- 3,0 thick PVC trays with 40 mm return spacing 1.0m
- 4.0 mm thick PVC trays with 60 mm return spacing 1.5m
- In addition trays and ladders shall be supported at each bend, offset and T-junction. The above spacing of supports are applicable to both vertical and horizontal installation of trays and ladders.

Joints

- Joints shall be smooth without projections or rough edges that may damage the cables. The Contractor will be required to cover joints with rubber cement or other non-hardening rubberized or plastic compound if in the opinion of the Engineer joints may damage cables. Joints shall as far as possible be arranged to occur at supports. Where joints do not coincide with supports, joints shall in the case of trays with single returns be made by means of wrap-around pieces of the same thickness of the tray and at least 450 mm long. The two cable tray ends shall butt tightly at the centre of the splice and the splice shall be bolted to each cable tray by means of at least 8 round head bolts, nuts and washers.
- Splices shall have the same finish as the rest of the tray. Where joints which do not coincide with supports occur in trays with folded over returns, tight fitting metal guide pieces, at least 450 mm long, shall be inserted in the folded return to provide the necessary support to the two cable tray ends. Splices as described above shall be provided at joints which do coincide with supports if the loaded tray sags adjacent to the joint due to the interruption of the bending moment in the tray.

Fixing

- Trays and cable ladders shall be bolted to supports by at least two round head bolts per support. Bolts shall be securely tightened against the tray surface to avoid projections which might damage cables during installation.

Fixing to the Structure

- The supports for cable trays and ladders shall in all cases be securely fixed to the structure by means of heavy duty, expansion type anchor bolts. Cantilevered trays shall be supported at two points with a minimum of 2 expansion bolts per support. It is the responsibility of the Contractor to ensure that adequate fixing is

provided since cable trays and ladders that work loose shall be rectified at his expense. The fixing shall take into account site conditions that prevail during installation.

Earthing

- Metal trays and ladders shall be bonded to the earth bar of the switchboard to which the cables are connected. Additional bare copper stranded conductors or copper tape shall be bolted to the tray or ladder where the electrical continuity cannot be guaranteed. These additional conductors or tapes shall always be installed in all outdoor applications and in coastal regions.

EARTHING OF INSTALLATION

Main earthing

The type of main earthing must be as required by the supply authority if other than the Departments, and in any event as directed by the Department's representative, who may require additional earthing to meet test standards.

Where required an earth mat shall be provided, the minimum size, unless otherwise specified, being 1,0m x 1,0m and consisting of 4mm diameter hard-drawn bare copper wires at 250mm centres, brazed at all intersections.

Alternatively or additionally earth rods or trench earths may be required as specified or directed by the Department's authorised representative.

Installations shall be effectively earthed in accordance with the "Wiring Code" and to the requirements of the supply authority. All earth conductors shall be stranded copper with or without green PVC installation.

Expansion Joints

- Where cable trays/ladders have to cross expansion joints, the trays/ ladders must form a gap of at least 25 mm between the two sections. Cables installed across expansion joints, must have enough slack to accommodate the expansion of the building.

ANNEXURE B
FIXING MATERIALS FOR ELECTRICAL SERVICES

1 GENERAL

- This section covers the general requirements for fixing materials forming part of the electrical installation.

2 Responsibility

- It is the responsibility of the Contractor to position and securely fix conduits, ducts, cables and cable channels, switchboards, fittings and all other equipment or accessories as required for the installation. The Contractor shall provide and fix all supports, clamps, brackets, hangers and other fixing materials.

3 Finishing

- All supporting steelwork installed by the Contractor shall be wire brushed and given one coat of rust-resisting primer, followed by one coat of high quality enamel paint before any other equipment is fixed.

4 Welding

- Supports, brackets, hangers, etc. may only be welded to steel structural members where prior permission of the Engineer has been obtained.

5 Screws and Bolts

- Equipment with securing holes shall be fixed with bolts and fixing screws as specified. Where sizes are not specified, the largest bolt or screw that will fit into the hole shall be used.

6 Wall Plugs

- Where the fixing holes in brick or concrete walls are smaller than 10 mm dia. anywhere the mass of the equipment is less than 15 kg, wall plugs may be used to fix conduits, cables and other equipment. Aluminium fibre or plastic plugs only may be used. Wooden plugs are not acceptable. Plugs installed in seams between bricks are not acceptable. A masonry drill of the correct size shall be used to drill holes for plugs. Round-headed screws of the correct diameter to match the specific plug shall be used throughout.

7 Anchor Bolts

- Where the fixing holes are 10 mm and larger or where the mass of the equipment is 15 kg or more, equipment shall be fixed by means of expanding anchor bolts or by means of bolts cast into the concrete or built into walls.

8 Galvanised Equipment

- Brass screws, bolts and nuts shall be used to fix galvanised equipment.

9 Shot-Fired Fixing

- Materials such as metal cable ducts or channels may be fixed against wall and concrete slabs by means of the shot-fired method designed for this purpose.
- The Contractor shall ascertain whether this method of fixing will carry the weight of the material including conductors, cables and other items of equipment to be installed later. Should it be found that the method of fixing is inadequate and joints tend to loosen the Contractor will be required to fix the material by an alternative method to the satisfaction of the Engineer.
- Where the shot-fired method is used warning signs shall be placed at all entrances leading to the area where this work is in progress. The Contractor shall take all reasonable precautions to prevent accidents. Nails recommended by the manufacturer of the shot-fired equipment shall be used. Refer to clause C49 of Factories, Machinery and Building Work Act.

10 Clamps and Brackets

- Clamps and brackets used to fix or support equipment such as cable trays, ducts, etc. shall be of a purpose made type suitable for the specific application. Specially made brackets or clamps may only be used after approval of the Engineer has been obtained.

ANNEXURE C
TESTING AND COMMISSIONING

1 GENERAL

- The Engineer or his representative shall be advised of all testing and commissioning and shall be given the opportunity to witness all tests. However the Engineer will only be on site to witness the tests and takes no responsibility for the acceptance of test results.
- The testing and commissioning procedure shall form part of the Quality Verification Plan submitted by the Contractor and shall be the subject to the same prior approval by the Engineer. The testing and commissioning procedure shall embody the following principles:
- All plant shall be tested off site prior to delivery. No plant or equipment will be accepted and paid for if it is not accompanied by the manufacturer/supplier certificate verifying that it has been tested.
- All plant and systems on site shall be tested as early as possible after installation to verify that the plant/system/subsystem is operating correctly.
- No testing or commissioning shall take place without an approved written procedure.
- The responsibility for the proper testing and commissioning of the system rests fully with the Contractor. This includes the provision of all necessary test equipment, measuring and test points, valves and dampers, etc. to test and commission the system.
- At the time of submitting equipment for approval full details of the commissioning requirements shall be provided.

2 TESTING AND COMMISSIONING PROGRAM

- At least four weeks before commencing any testing and commissioning the contractor shall submit a complete program for such work so that the Engineer can arrange to be on site at the appropriate time. The programme shall embody the agreed testing and commissioning procedure.
- The programme shall include -
- A bar chart covering all activities.
- Names and addresses of companies involved in each activity.
- The way in which each test will be carried out complete with pro forma forms for tabulating results.

3 EQUIPMENT AND PROCEDURE

- The equipment supplied under this Contract shall be subject to inspection by the Engineer or his Nominated Agent at all stages of manufacture.
- The tests and commissioning procedure as laid down and such additional tests as the Engineer may reasonably require to prove compliance with the Specification shall be carried out at the Contractor's Works and at Site.
- The Contractor shall give reasonable notice of time and place in writing to enable the Engineer to inspect and witness tests of materials and equipment. He shall provide the Engineer with facilities for witnessing the tests and for any additional tests or inspection of any portion of the works as required by the Engineer.
- The Contractor shall at his own cost render all assistance and supply all labour, appliances and any other materials, as the Engineer may require to check the

setting out, measure up and inspect any portions of the works at any stage during fabrication, construction, erection or painting. During such operations, the Contractor shall if required, suspend any or all of the Works, with-out having claim for loss or damage as a result thereof.

- The testing of the plant (or any part thereof) supplied under this contract shall be carried out through its full operating range (or part thereof) as required by the Engineer.
- All such tests and inspections and the necessary inspection facilities shall be provided as part of the Tendered price for the Contract.
- At the commencement of and during the whole of the Commissioning and Testing Periods, the Contractor shall have available on site all essential spares and tools considered necessary to enable repair work of defective parts to be carried out immediately in the event of a breakdown or adjustments being necessary.
- The Contractor shall be responsible for the proper operation and maintenance of the plant throughout the period of the tests and until the operator training period is complete.
- Acceptance by the Engineer of any plant item, following such inspection or tests, shall not relieve the Contractor of any obligations under this Contract.
- All pumps shall be lined up and tested as a complete set. Test certificates shall be supplied before dispatch.
- All rotors and motor/impeller combinations shall be statically and dynamically balanced. Test certificates shall be supplied before dispatch.
- All such other tests as required by the Engineer to prove compliance with the specification, shall be carried out.

4 TEST CERTIFICATES

- The Contractor shall provide three copies of test certificates in respect of all materials and equipment, further copies are to be bound into the operating and maintenance manuals.

5 INSULATION TESTS

- All electrical wiring and equipment shall be subjected to insulation tests. All instruments and other equipment for the tests shall be provided by the Contractor.

6 DRAINING AND CLEANING

- On completion of the pressure test on a section of pipework the water used for testing shall be drained away as quickly as possible to remove as much dirt and dross as possible. After completion of a pipework circuit the circuit shall be flushed through to remove all pipe scale, dross and similar materials.
- The Contractor shall provide all necessary connections, by-pass pipes, temporary strainers, temporary make-up pieces, to enable the systems to be drained and cleaned.
- Additionally, on boiler commissioning, steam lines are to be charged with steam to full operating pressure and allowed to cool. This procedure is to be carried out three times over a period of two days. Following the third cycle the pipes are to be open ended and blown through. These procedures are to be supervised by the Engineer.

7 PLANT COMMISSIONING

- The Contractor shall arrange at his cost for the manufacturer's representatives to check over and fully commission all major items of equipment. This work is to be carried out by skilled engineers preferably employed by the manufacturers, who are completely familiar with the equipment involved and shall be capable of training the operating and maintenance staff in the duties they are to perform.
- On completion of the plant commissioning the Contractor shall obtain written confirmation from the various manufacturers that they have completed all commissioning work and are satisfied that the items of plant for which they are responsible are functioning satisfactorily
- Copies of the manufacturer's written confirmation shall be sent to the Engineer.

8 TESTS ON COMPLETION

- On completion of the balancing and commissioning of equipment the plant shall be put into normal operation and the final adjustments of the equipment shall be made.
- Thereafter the Tests on Completion shall be carried out to ensure that the plant meets the specification.
- Such tests shall include the following:
- Simulated tests for all alarm and safety cut out equipment to prove the operation of the equipment.
- Simulated tests on automatic controls to prove the ability of the controls to correct conditions which are outside the required design conditions. The tests shall be carried out by manually changing the desired values to produce an incorrect condition and then re-setting the controls to the design conditions and checking the operation of valves, etc. to restore the design conditions.
- Operational tests on the Plant to demonstrate that it is giving the rated output and efficiency.
- The Contractor shall provide all necessary temporary measuring and recording equipment. The equipment shall be of a type generally used for this type of testing and shall be to the approval of the Engineer. All instruments shall be accurately calibrated before the tests begin.
- On completion of the whole of the tests and when the Contractor is satisfied that the entire plant is operating satisfactorily and will fulfil the function for which it has been supplied, he shall submit to the Engineer triplicate copies of all test records and charts together with reports on all the tests required in terms of the approved Quality Verification Plan. The Engineer shall reserve the right to ask for any reasonable additional tests or for the repetition of previous tests in order to prove that the operation of the plant is satisfactory and in accordance with the Performance Specification.

ANNEXURE D
DIESEL GENERATOR SPECIFICATION

DIESEL GENERATOR SPECIFICATION

1. General

The Diesel Generator must be of the Silent Type installed in a suitable enclosure and comply with the following specification:

- 3 Phase, 400V
- Automatic start-up on sensing mains failure
- Automatic Shut-down on mains return – Adjustable delay time.
- Automatic Change-Over of power supply equipped with 4 pole switchgear to interrupt neutral conductor
- Noise Level <65 dBA at 7m at 100% loading
- Low Oil Alarm to be provided
- Emergency STOP button provided accessible and visible from outside the enclosure
- Integrated starting battery charger to be included
- Integrated Diesel Tank – Capacity for 8 Hours operating at full load.
- Corrosion resistant construction (Generator will be subjected to coastal conditions)
- Double bund wall diesel tank.
- Internal neutral earth bonding with earth interruption once switch over to normal power
- Concrete plinth with a bund wall to accommodate 110% of the fuel capacity.

2. Construction

The engine and alternator of the set shall be built together on a common frame, which must be mounted on a skid base on anti-vibration mountings. The set must be installed in a weatherproof canopy for outdoor use.

3. Operation

The set is required to supply the lighting and power requirements in the case of a mains power failure.

The set shall be fully automatic i.e. it shall start when any one phase of the main supply fails or get switched and shall shut down when the normal supply is re-established. In addition it shall be possible to manually start and stop the set by means of pushbuttons on the switchboard.

The automatic control shall make provision for three consecutive starting attempts. Thereafter the set must be switched off, and the start failure relay on the switchboard must give a visible and audible indication of the fault.

To prevent the alternator being electrically connected to the mains supply when the mains supply is on and vice versa, a safe and fail proof system of suitably interlocked contactors/breakers shall be supplied and fitted to the changeover switchboard.

4. Test Certificates and Inspections

The following tests are to be carried out:

A Factory Acceptance Test at the supplier's premises, before the generating set will be delivered to site Representatives of the Department may be present during the test to satisfy them that the generating set complies with the specification and delivers the specified output. The test must be carried out in accordance with BSS 5514, Part 2 and 3. The Department must be timorously advised of the date for the test.

After completion of the works and before first delivery is taken, a full test will be carried out on the installation for a period of sufficient duration to determine the satisfactory working thereof. During this period the installation will be inspected and the contractor shall make good, to the satisfaction of the Representative/Agent, any defects which may arise.

The Contractor shall provide all instruments and equipment required for testing and any water, power and fuel required for the commissioning and testing of the installation at completion.

Test reports of both tests as specified under (a) and (b) are to be submitted to the Department.

The Contractor will issue a Certificate of Compliance (COC) in terms of SANS 10142:1 for each installation prior to hot commissioning.

5. Guarantee and Maintenance

The Contractor shall guarantee the complete plant for a period of twelfth months after the first delivery has taken place.

If during this period the plant is not in working order, or not working satisfactorily owing to faulty material, design or workmanship, the Contractor will be notified and immediate steps shall be taken by him to rectify the defects and/or replace the affected parts on site at his own expense.

The Contractor shall maintain the plant in good working condition for the full twelfth month period to the final delivery of the installation. However, should the Contractor fail to hand over the plant in good working order on the expiry of the specified twelfth months, the Contractor shall be responsible for further monthly maintenance until final delivery is taken.

During this period the contractor will undertake to arrange that the plant be inspected at least once per month by a qualified member of his staff who shall: -

- a) Report to the Officer-in-charge, keeping the maintenance records, and enter into a log book the date of the visit, the tests carried out, the adjustments made, and any further details that may be required.
 - Grease and oil moving parts, where necessary.
 - Check the air filter and, when necessary, clean the filter and replace filter oil.
 - Check the lubricating oil and top-up when necessary.
- b) After the plant has run one oil change for the number of hours stipulated by the manufacturers, drain the sump and refill with fresh lubricating oil. The reading of the hour meter on the switchboard will be taken to establish the number of hours run by the plant.

Under this heading only the cost of the actual oil used, shall be charged as an extra on the monthly an account.

- c) Clean the lubricating oil filter and/or replace the filter element at intervals recommended by the engine manufacturer, the cost of a new filter element to be charged as an extra on the monthly account.
- d) Check and when necessary adjust the valve settings and the fuel injection equipment.
- e) Check the battery and top-up the electrolyte when necessary.
- f) Test-run the plant for 0,5 hour and check the automatic starting with simulated faults on the mains, the proper working of all parts, including the electrical gear the protective devices with fault indicators, the changeover equipment and the battery charger. Make the necessary adjustments.
- g) Report to the Department and to the Contractor on any parts that become unserviceable through fair wear and tear, or damaged by causes beyond the control of

the Contractor.

- h) The Contractor on receiving the report, shall immediately submit a detailed quotation for the repair or replacement of such parts to the Department.
- i) Advise the Department when it has become necessary to de-carbonise the engine and submit a quotation for this service.
- j) Top up the water of the radiator, if applicable.
- k) Clean the plant and its components.

6. Brochures

Detailed brochures of all equipment offered shall be presented together with the tender documents.

7. Diesel Generator Specific Technical Requirements

7.1 Engine

The engine must comply with the requirements as laid down in BS 5514 and must be of the atomised injection, compression ignition type, running at a speed not exceeding 1500 r.p.m. The engine must be amply rated for the required electrical output of the set, when running under the site conditions. The starting period for either manual or automatic switching-on until the taking over by the generating set, in one step, of a load equal to the specified site electrical output, shall not exceed 15 seconds. This must be guaranteed by the Tenderer.

Turbo-charged engines will only be accepted if the Tenderer submits a written guarantee that the engine can deliver full load within the specified starting period.

7.2 Rating

The set shall be capable of delivering the specified output continuously under the site conditions, without overheating. The engine shall be capable of delivering an output of 110 % of the specified output for one hour in any period of 12 hours consecutive running in accordance with BS 5514.

7.3 De-Rating

The engine must be de-rated for the site conditions applicable to the project.

The de-rating of the engine for site conditions shall be strictly in accordance with BS 5514 of 1977 as amended to date. Any other methods of de-rating must have the approval of the Department and must be motivated in detail. Such de-rating must be guaranteed in writing and proved by the successful Tenderer at the site test.

7.4 Starting and Stopping

The engine shall be fitted with an electric starter motor and be easily started from cold, without the use of any special ignition devices under summer as well as winter conditions.

Tenderers must state what arrangements are provided to ensure easy starting in cold weather. Full details of this equipment must be submitted. In the case of water cooled engines, any electrical heaters shall be thermostatically controlled. The electrical circuit for such heaters shall be taken from the control panel, and must be protected by a suitable circuit breaker.

7.5 Starter Battery

The set must be supplied with a fully charged lead-acid type battery, complete with necessary electrolyte. The battery must have sufficient capacity to provide the starting torque stipulated by the engine makers. The battery capacity shall not be less than 120 Ah and shall be capable of providing three consecutive start attempts from cold and thereafter a fourth attempt under manual control of not less than 20 seconds duration each. The battery must be of the heavy duty "low maintenance" type, housed in a suitable battery box.

7.6 Cooling

The engine may be either of the air or water cooled type. In the case of water-cooling, a built-on heavy duty, tropical type pressurised radiator must be fitted. Only stand-by sets that are water cooled shall have electric heaters.

For either method of cooling, protection must be provided against running at excessive temperatures. The operation of this protective device must give a visual and audible indication on the switchboard on the switchboard. Water-cooled engines shall in addition be fitted with a low water cut-out switch, installed in the radiator, to switch the set off in the event of a loss of coolant. The protection shall operate in the same way as the other cut-outs (e.g. low oil pressure). All air ducts for the cooling of the engine are to be allowed for. The air shall be supplied from the cooling fan cowling/radiator face to air outlet louvers in the plant room wall.

7.7 Lubrication

Lubrication of the main bearings and other important moving parts shall be by forced feed system. An automatic low oil pressure cut-out must be fitted, operating the stop solenoid on the engine and giving a visible and audible indication on the switchboard.

7.8 Fuel Pump

The fuel injection equipment is suitable for operation with the commercial brands of diesel fuel normally available in South Africa.

7.9 Fuel Tank

An integrated fuel tank shall be installed in the unit. The tank shall have sufficient capacity for standby sets to run the engine on full load for a period of 8 hours.

A water trap is fitted in the fuel pipeline from the tank to the engine.

The tank shall be fitted with a suitable filter, a full height gauge glass, "low fuel level" alarm, giving an audible and visible signal on the switchboard as well as a low-low fuel level cut-out.

The diesel tank to be double banded.

7.10 Governor

The speed of the engine shall be controlled by a governor in accordance with class A2 of BS 5514 of 1977 if not otherwise specified in the Technical Specification.

The permanent speed variation between no load and full load shall not exceed 4,5% of the normal engine speed and the temporary speed variation shall not exceed 10% External facilities must be provided on the engine, to adjust the normal speed setting by $\pm 5\%$ at all loads zero and rated load.

7.11 Flywheel

A suitable flywheel must be fitted, so that lights fed from the set will be free from any visible flicker.

The cyclic irregularity of the set must be within the limit laid down in BS 5514 of 1977.

7.12 Canopy

The generator, including all ancillary equipment, shall be installed in a weather and soundproof canopy. The canopy construction shall be such that the machine can be installed in the open, with no additional sheltering. Details of the tendered generator and canopy shall be submitted with the tender.

7.13 Accessories

The engine must be supplied complete with all accessories, air and oil filters, 3 instruction manuals, spare parts lists, the first fill of all lubricating oils, fuel, etc.

7.14 Alternator

The alternator shall be of the self-excited brush less type, with enclosed ventilated drip proof housing and must be capable of supplying the specified output continuously with a temperature rise not exceeding the limits laid down in BS 5000 for rotor and stator windings.

The alternator shall be capable of delivering an output of 110% of the specified output, for one hour in any period of 12 hours consecutive running.

Both windings must be fully impregnated for tropical climate and must have an oil resisting finishing varnish.

The alternator must preferably be self-regulated without the utilisation of solid state elements. The inherent voltage regulation must not exceed plus or minus 5% of the nominal voltage specified, at all loads with the power factor between unity and 0,8 lagging and within the driving speed variations of 4,5% between no-load and full load.

The excitation system shall be designed to promote rapid voltage recovery following the sudden application of the load. The voltage shall recover to within 5% of the steady state within 300 milli-seconds following the application of full load and the transient voltage dip shall not exceed 18%.

7.15 Coupling

The engine and alternator must be directly coupled by means of a high quality flexible coupling, equal and similar to the "HOLSET" type.

7.16 Control Panel/Switchboard

A switchboard must be supplied and installed to incorporate the equipment for the control and protection of the generating set and battery charging.

The Control Panel shall be equipped with protection and alarm devices as described below.

A circuit breaker and an adjustable current limiting protection relay must be installed for protection of the alternator. The protection relay shall be of the type with inverse time characteristics. The relay shall cause contactor to isolate the alternator and stop the engine.

Protection must be provided for overload, high engine temperature, low lubricating oil pressure, over speed, start-failure, and low water level.

Individual relays with reset pushed are required, to give a visible signal and stop the engine when any of the protective devices operate. In the case of manual operation of standby sets, it shall not be possible to restart the engine.

The indicators and re-set pushes must be marked in both official languages respectively.

“OVERLOAD”

“TEMPERATURE HIGH”

“OIL PRESSURE LOW”

“OVER-SPEED”

“START FAILURE”

“LOW WATER LEVEL”

In addition two relays with reset pushes must be fitted giving an audible and visible signal when:

- a) The fuel level in the service tank is low. The reset push of this relay must be marked “FUEL LOW”

In addition, a low-low level sensor must be provided. At this level the engine must stop to prevent air entering the fuel system.

The battery charger failed. The reset push of this relay must be marked “CHARGER FAIL” -

This is also applicable to the engine driven generator/alternator.

All relays must operate an alarm hooter. A pushbutton must be installed in the hooter circuit to stop the audible signal, but the fault indicating light on the control panel must remain lit until the fault has been rectified.

An on/off switch is not acceptable. After the hooter has been stopped, it must be re-set automatically, ready for a further alarm.

The hooter must be of the continuous duty and low consumption type. Both hooter and protection circuits must operate from the battery.

Potential free contacts from the alarm relay must be brought down to terminals for remote indication of alarm conditions.

A test pushbutton must be provided to test all indicators lamps.

7.18 Manual Starting

Each switchboard shall be equipped with two pushbuttons marked “START” and “STOP” for manual starting and stopping of the set.

7.19 Battery Starting Equipment

Each switchboard shall be equipped with battery charging equipment.

The charger shall operate automatically in accordance with the state of the battery and shall generally consist of an air-cooled transformer, a full wave solid state rectifier, and the necessary automatic control equipment of the constant voltage system.

The charger must be fed from the mains. An engine driven alternator must be also a provided for charging the battery while the set is operational. Failure of this alternator must also activate the battery charger failure circuit.

7.20 Switchboard Instruments

Each generating set shall have a switchboard equipped as follows:

a) One flush square dial voltmeter, reading the alternator voltage, scaled as follows:

- (i) 0-300V for single phase generators.
- (ii) 0-500V for three phase generator. In this case a six position and off selector switch must be installed for reading all phase and phase to neutral voltages.

A flush square dial combination maximum demand and instantaneous ampere meter for each phase, with resettable pointer suitably scaled 20% higher than the alternator rating. A red arc stripe above scale markings from 0-20A and a red radial line through the scale at full-load current shall be provided. These instruments shall be supplied complete with the necessary current transformer.

One flush square dial vibrating type frequency meter, indicating the alternator frequency.

A six digit running hour meter with digital counter.

Fuses or m.c.b.'s for the potential voltage circuits of the meters.

One flush square dial ampere meter suitably scaled for the battery charging current.

One flush square dial voltmeter with a spring loaded pushbutton or switch for the battery voltage.

7.21 Marking

All labels, markings or instructions on the switchgear shall be in both official languages.

7.22 Earthing

An earth bar must be fitted in the switchboard, to which all non-current carrying metal parts shall be bonded.

The neutral point of the alternator must be solidly connected this bar by means of a removable link labelled "EARTH". Suitable terminals must be provided on the earth bar for connection of up to three earth conductors, which will be supplied and installed by others.

Earthing shall be provided to meet the system protection and safety requirements for the DG Set.

The minimum earth fault current dictates the generator protection settings for correct operation.

The maximum earth fault current and its duration determine the cross-sectional area of the earth conductors to be used.

Independent earthing is required in order to eliminate electromagnetic disturbances in control circuitry, and also to prevent mechanical damage to the shaft and bearings in the set, caused by induced and stray currents.

7.23 Generator neutral earthing

Neutral earthing implies interconnection of the generator's neutral and the customer's power system's neutral, which is generally earthed.

Multiple earth connections can cause neutral circulating currents between parallel systems. Care shall be taken to avoid this phenomenon and the consequent unnecessary operation of the protection.

The neutral earthing method employed shall be in accordance with [11] SANS 8528 and will depend on the existing site earthing philosophy, DG mode of operation and level of protection required.

The neutral connector shall be able to carry the full earth-fault current of the generator.

The supplier shall provide protection of the generator against internal earth faults, and details of such protection shall also be supplied.

7.24 Earth and bonding of components

Each main component of equipment shall be earthed direct to a solid copper earth bar, which shall be connected to the Employer's earth system at a point as specified.

As a general rule, the earth continuity conductor shall be of a nominal cross-sectional area at least half that of the largest phase conductor, but not more than 70 mm².

Earth conductors may be bare copper, insulated copper, aluminium or an anti-theft copper/steel compound. Where aluminium is used as an earth conductor, bimetal connections shall be used between different materials and these cannot be installed underground.

On batteries and battery chargers, the negative pole shall be earthed to the frame of the set unless specified differently.

The frame of the DG Set shall be flexibly earthed to the earth continuity conductor with due regard to the magnitude and duration of possible local earth faults.

Electrolytic corrosion shall be avoided. A suitable earthing facility shall be provided on the frame.

If so recommended, bypass earthing of insulated bearings shall be carried out by means of an earthed brush, to prevent damage caused by induced shaft currents.

Tanks shall have an earthing facility provided on the tank, for connection of an earth conductor between the tank and the frame of the set.

7.24 Operation Selector Switch

A four position selector switch must be provided on the switchboard marked "AUTO", "MANUAL", "TEST" and "OFF".

With the selector on "AUTO", the set shall automatically start and stop, according to the mains supply being available or not.

With the selector on "TEST", it shall only be possible to start and stop the set with the pushbuttons, but the running set shall not be switched to the load.

With the selector on "MANUAL", the set must take the load when started with the pushbutton, but it must not be possible to switch the set on to the mains, or the mains onto the running set.

With the selector on "OFF", the set shall be completely disconnected from the automatic controls, for cleaning and maintenance of the engine.

7.25 Automatic Mains Failure System

A fully automatic mains failure system must be provided to isolate the mains supply and connect the standby set to the outgoing feeder in case of a mains failure and reverse this procedure on return of the mains.

7.26 By-pass Switch and Main Isolator

The switchboard shall be equipped with an on-load isolator to isolate the mains and a manually operated on-load by-pass switch, which shall either connect the incoming mains to the automatic control gear or directly to the outgoing feeder. In the latter position the automatic control gear, including the main contractors, shall be isolated for maintenance purposes. It shall not be possible to start the engine except with the selector switch in the "TEST" position.

It is required that this by-pass switch and mains isolator be mounted away from the automatic control gear, in a separate compartment either on the side or in the lower portion of the switchboard cubicle, and that the switches operated from the front of the compartment.

7.27 Start Delay

Starting shall be automatic in event of a mains failure. A 0-15 second adjustable start delay timer shall be provided to prevent start-up on power trips or very short interruptions.

7.28 Stop Delay

A stop delay with timer is required for the set, to keep the set on load for an adjustable period of one to sixty seconds after the return of the mains supply, before changing back to the supply. An additional timer shall keep the set running for a further adjustable cooling period of 5 to 10 minutes at no-load before stopping.

7.29 Warning Notices

Notices, in both official languages, must be installed in the plant rooms.

The contents of these notices are summarised below.

- (a) Unauthorised entry prohibited.
- (b) Unauthorised handling of equipment prohibited.

The motive shall be made of a non-corrodible and non-deteriorating material, preferable plastic, and must read as follows:

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

The Contractor will only be responsible for the supply and installation of the cable connections between the Standby Generator and the Minisub (MSB-SR01) LV Compartment.

All major equipment are listed in the Schedule of Cables and measured in the Bills of Quantities.

7.30 Enclosure

The standby set is a free standing unit and shall be mounted in an enclosure as detailed below:-

General

The enclosure, shall be completely vermin-proof, removable from the set and shall be constructed of 3CR12 stainless steel or equally approved of a minimum thickness of ± 1.5 mm.

The enclosure shall allow easy access to the engine, alternator, radiator filler cap and control cubicle for maintenance purposes.

The door shall be flush with the rest of the canopy and of the side opening type. A minimum of four doors are required i.e. two on either side.

The door hinges and locking bars shall be of a heavy duty type and be manufactured of an alloy or mild steel which is hot dip galvanized and shall be fitted with a grease nipple.

The doors and panels shall be suitably braced and stiffened to ensure rigidity and to prevent bending and warping.

Suitable door restraints shall be fitted to all the doors, enclosure including the control panel to prevent wind damage. The restraint shall consist of a steel rod in a steel groove or slide with a spring loaded catch, which is to be manually reset to close the door.

No flexible restraints will be accepted.

The diesel fuel level indicator and alternator rating plate shall be clearly visible with the doors open.

Unless specified the silencers shall be mounted within the enclosure.

Perforated sheeting shall be fitted over all the insulating material inside the canopy of all soundproof sets.

Rubber seals on doors shall be equal to or similar to rubber pinch weld, wind lace. (Max-Norton's.).

Design

The enclosure shall be designed to be weather-proof and sound-proofing as specified. Rivets or self-tapping screws will under no circumstances be allowed for fixing the various sections of the enclosure. Stainless steel nuts and bolts are acceptable.

The roof of the enclosure shall be constructed for proper drainage of water as per the drawing.

A lamp fitting and it's associated on/off door switch shall be provided inside the enclosure for illumination of the control panel.

The power for the lamp shall be obtained from the starter battery.

The sound-proofing on canopy engine sets shall be such that the maximum noise level generated by the set under any load condition shall not exceed 70 dB measured in any direction at a distance of 7m from the centre of the set with the doors closed.

The supply and discharge air paths will require separate attenuators on soundproof sets.

Enclosures shall be rated IP54 as per [15] SANS 60529, unless specified otherwise in [15] SANS60529.

Colour shall be as specified in [15] SANS 60529.

Cable entry shall be from the bottom using removable gland plates.

A stud shall be provided for earth connections from inside and outside the enclosure. Where studs are not welded to the plate, flat washers shall be used as the final mating surface in the case of a conductive gland plate.

A bolt and nut arrangement may also be used.

An earth bar shall be provided. The earth bar shall be connected to the earth stud inside the enclosure by the shortest possible path. All earth connections shall follow the shortest path, and no 'pigtailed' (wire coils for neatening purposes) are permissible.

The connection between the earth stud and the earth bar shall be made using a suitability sized conductor, and shall be appropriately lugged for the purpose.

Gland plates shall be fabricated from a conductive material, and shall be protectively coated against corrosion using a conductive coating, such as cadmium.

The gland plate shall be bolted to the enclosure in at least four places, in such a manner as to ensure galvanic continuity between the plate and the enclosure is ensured.

Doors shall be bonded to the enclosure using earth studs.

Doors > 0,5 m in length shall be bonded in at least two different locations, with 0,5 m spacing between each bond.

Bonds shall be made using braided copper strapping ≥ 10 mm wide and having a width to thickness ratio > 5:1. (larger machines).

Padlock and keys

The contractor shall supply padlocks and keys for all the doors of the enclosure. The padlock shall be off the "Viro A82 keyed alike with stainless steel shackles" type.

Suitable brass metal plates shall be installed behind each lock for the protection of the enclosure against scratching or damaging, where the locks are hanging.

Annexure E
Generator Datasheet
DURBAN

400 kVA (Approx)

400V, 3 Phase

NB: The contractor will be required to supply a suitable rated diesel generator set.

C. DUTY

CONTINUOUS BASE LOAD		INTERMITTENT LOAD		STANDBY EMERGENCY POWER	X
-------------------------	--	----------------------	--	-------------------------------	----------

D. LOAD

Motor Loads	Load kW	Negligible
	Load kVA	
	Starting kW	
	Starting kVA	
	Starting duration sec.	

Other loads Small Power, Lighting, HVAC

E. PARALLELING ARRANGEMENTS

AUTOMATIC SYNCHRONISING	N/A	CHECK SYNCHRONISING	N/A	MANUAL SYNCHRONISING	N/A
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YES	X	NO	
-----	---	----	--

TECHNICAL DATA TO BE PROVIDED BY THE CONTRACTOR

A. ENGINE

- 1 Maker's name _____
- 2 Country of origin _____
- 3 Manufacturer's type no. and year of manufacture _____
- 4 Continuous sea level rating after allowing for ancillary
 - a) in bhp bhp
 - b) in kW kW
- 5 Percentage derating for site conditions, in accordance with IEC 60034-22
 - a) for altitude %
 - b) for temperature %
 - c) for humidity %
 - d) total derating %
- 6 Nett output on site kW
- 7 Nominal speed rpm
- 8 Number of cylinders
- 9 Strokes per working cycle
- 10 Stroke mm
- 11 Cylinder bore mm
- 12 Swept volume cm³
- 13 Mean piston speed m/min
- 14 Compression ratio
- 15 Cyclic irregularity
- 16 Fuel consumption of the complete generating set on the site in l/h of alternator output at:
 - a) Full load l/h
 - b) 3/4 load l/h
 - c) 1/2 load l/h

NOTE: A tolerance of 5% shall be allowed above the stated value of fuel consumption

- 17 Make of fuel injection system _____
- 18 Capacity of fuel tank in litres l
- 19 Is gauge glass fitted to tank

YES		NO	
-----	----------------------	----	----------------------

21	Method of starting	_____				
22	Voltage of starting system	V				
23	Method of cooling	_____				
24	Type of radiator if water-cooled	_____				
25	Type of heater for warming cylinder heads	_____				
26	Capacity of heater	kW				
27	Method of protection against high temperature	_____				
28	Method of protection against low oil pressure	_____				
29	Type of governor	_____				
30	Speed variation in %					
	a) temporary	%				
	b) permanent	%				
31	seconds	sec				
32	Recommended interval in running hours for					
	a) Lubricating oil change	hr				
	b) Oil filter element change	hr				
	c) Decarbonising	hr				
33	Type of base	_____				
34	Can diesel alternator set be placed on a solid concrete floor	<table border="1"> <tr> <td>YES</td> <td> </td> <td>NO</td> <td> </td> </tr> </table>	YES		NO	
YES		NO				
35	Are all accessories and ducts included	<table border="1"> <tr> <td>YES</td> <td> </td> <td>NO</td> <td> </td> </tr> </table>	YES		NO	
YES		NO				
36	Is engine naturally aspirated	<table border="1"> <tr> <td>YES</td> <td> </td> <td>NO</td> <td> </td> </tr> </table>	YES		NO	
YES		NO				
37	Are performance curves attached	<table border="1"> <tr> <td>YES</td> <td> </td> <td>NO</td> <td> </td> </tr> </table>	YES		NO	
YES		NO				
 B. ALTERNATOR						
1	Maker's name and type no.	_____				
2	Country of origin and year of manufacture	_____				
3	Type of enclosure	_____				
4	Nominal speed	rpm				
5	Terminal voltage	V				
6	Sea level rating kVA at 0.8 power factor	kVA				
7	Derating for site conditions	_____				

8	Input required		kW
9	Method of excitation		
10	Efficiency at 0.8 p.f. at:		
	a) Full load		
	b) 3/4 load		
	c) 1/2 load		
11	Max. permanent voltage variation		%
12	Transient voltage dip on full load application		V
13	Voltage recovery on full load application		ms
14	Is alternator brushless	YES	NO
15	Class of insulation of windings		
16	Is alternator tropicalised	YES	NO
17	Symmetrical short circuit current at terminals		A
18	Type of coupling		
 C. SWITCHBOARD			
1	Maker's name		
2	Country of origin		
3	Is board floor mounted	YES	NO
4	Finish of board		
5	Make of:	Voltmeter	
		Ammeter	
		Frequency meter	
6	Dial size of meters		mm
7	Scale range of voltmeter		
8	Scale range of ammeters		
9	Ratio of current transformers		
10	Make of running hour meter		
11	Range of cyclometer running hour meter/counter		
12	Smallest unit shown on running hour meter/counter		
13	Make of circuit breaker		
14	Type of circuit breaker		

18	Make of change-over equipment				
19	Make of voltage relay				
20	Is control and protection equipment mounted on a small removable panel	YES		NO	
21	Type of control equipment				
22	Make of mains isolator				
23	Type of indicators for protective devices				
24	Rating in Amps of				
	a) Change-over equipment		Amps		
	b) Mains Isolator		Amps		
	c) By-pass switch		Amps		
25	Make of rectifier				
26	Type of rectifier				
27	Is battery charging automatic	YES		NO	
28	Are volt- and ammeters provided for charging circuit	YES		NO	
29	Is the alarm hooter of the continuous duty type	YES		NO	
 D. BATTERY					
1	Maker's name				
2	Country of origin				
3	Type of battery				
4	Voltage of battery				
5	Type of battery housing				
6	Capacity in Ah		Ah		

Annexure F
Generator Datasheet
EAST LONDON

400 kVA (Approx)

400V, 3 Phase

NB: The contractor will be required to supply a suitable rated diesel generator set.

C. DUTY

CONTINUOUS BASE LOAD		INTERMITTENT LOAD		STANDBY EMERGENCY POWER	X
-------------------------	--	----------------------	--	-------------------------------	----------

D. LOAD

Motor Loads	Load kW	Negligible
	Load kVA	
	Starting kW	
	Starting kVA	
	Starting duration sec.	

Other loads Small Power, Lighting, HVAC

E. PARALLELING ARRANGEMENTS

AUTOMATIC SYNCHRONISING	N/A	CHECK SYNCHRONISING	N/A	MANUAL SYNCHRONISING	N/A
----------------------------	-----	------------------------	-----	-------------------------	-----

TECHNICAL DATA TO BE PROVIDED BY THE CONTRACTOR

A. ENGINE

- 1 Maker's name _____
- 2 Country of origin _____
- 3 Manufacturer's type no. and year of manufacture _____
- 4 Continuous sea level rating after allowing for ancillary
 - a) in bhp bhp
 - b) in kW kW
- 5 Percentage derating for site conditions, in accordance with IEC 60034-22
 - a) for altitude %
 - b) for temperature %
 - c) for humidity %
 - d) total derating %
- 6 Nett output on site kW
- 7 Nominal speed rpm
- 8 Number of cylinders
- 9 Strokes per working cycle
- 10 Stroke mm
- 11 Cylinder bore mm
- 12 Swept volume cm³
- 13 Mean piston speed m/min
- 14 Compression ratio
- 15 Cyclic irregularity
- 16 Fuel consumption of the complete generating set on the site in l/h of alternator output at:
 - a) Full load l/h
 - b) 3/4 load l/h
 - c) 1/2 load l/h

NOTE: A tolerance of 5% shall be allowed above the stated value of fuel consumption

- 17 Make of fuel injection system _____
- 18 Capacity of fuel tank in litres l
- 19 Is gauge glass fitted to tank

YES		NO	
-----	----------------------	----	----------------------

21	Method of starting	_____				
22	Voltage of starting system	V				
23	Method of cooling	_____				
24	Type of radiator if water-cooled	_____				
25	Type of heater for warming cylinder heads	_____				
26	Capacity of heater	kW				
27	Method of protection against high temperature	_____				
28	Method of protection against low oil pressure	_____				
29	Type of governor	_____				
30	Speed variation in %					
	a) temporary	%				
	b) permanent	%				
31	seconds	sec				
32	Recommended interval in running hours for					
	a) Lubricating oil change	hr				
	b) Oil filter element change	hr				
	c) Decarbonising	hr				
33	Type of base	_____				
34	Can diesel alternator set be placed on a solid concrete floor	<table border="1"> <tr> <td>YES</td> <td> </td> <td>NO</td> <td> </td> </tr> </table>	YES		NO	
YES		NO				
35	Are all accessories and ducts included	<table border="1"> <tr> <td>YES</td> <td> </td> <td>NO</td> <td> </td> </tr> </table>	YES		NO	
YES		NO				
36	Is engine naturally aspirated	<table border="1"> <tr> <td>YES</td> <td> </td> <td>NO</td> <td> </td> </tr> </table>	YES		NO	
YES		NO				
37	Are performance curves attached	<table border="1"> <tr> <td>YES</td> <td> </td> <td>NO</td> <td> </td> </tr> </table>	YES		NO	
YES		NO				
 B. ALTERNATOR						
1	Maker's name and type no.	_____				
2	Country of origin and year of manufacture	_____				
3	Type of enclosure	_____				
4	Nominal speed	rpm				
5	Terminal voltage	V				
6	Sea level rating kVA at 0.8 power factor	kVA				
7	Derating for site conditions	_____				

8	Input required		kW
9	Method of excitation		
10	Efficiency at 0.8 p.f. at:		
	a) Full load		
	b) 3/4 load		
	c) 1/2 load		
11	Max. permanent voltage variation		%
12	Transient voltage dip on full load application		V
13	Voltage recovery on full load application		ms
14	Is alternator brushless	YES	NO
15	Class of insulation of windings		
16	Is alternator tropicalised	YES	NO
17	Symmetrical short circuit current at terminals		A
18	Type of coupling		
 C. SWITCHBOARD			
1	Maker's name		
2	Country of origin		
3	Is board floor mounted	YES	NO
4	Finish of board		
5	Make of:	Voltmeter	
		Ammeter	
		Frequency meter	
6	Dial size of meters		mm
7	Scale range of voltmeter		
8	Scale range of ammeters		
9	Ratio of current transformers		
10	Make of running hour meter		
11	Range of cyclometer running hour meter/counter		
12	Smallest unit shown on running hour meter/counter		
13	Make of circuit breaker		
14	Type of circuit breaker		

18	Make of change-over equipment				
19	Make of voltage relay				
20	Is control and protection equipment mounted on a small removable panel	YES		NO	
21	Type of control equipment				
22	Make of mains isolator				
23	Type of indicators for protective devices				
24	Rating in Amps of				
	a) Change-over equipment		Amps		
	b) Mains Isolator		Amps		
	c) By-pass switch		Amps		
25	Make of rectifier				
26	Type of rectifier				
27	Is battery charging automatic	YES		NO	
28	Are volt- and ammeters provided for charging circuit	YES		NO	
29	Is the alarm hooter of the continuous duty type	YES		NO	
 D. BATTERY					
1	Maker's name				
2	Country of origin				
3	Type of battery				
4	Voltage of battery				
5	Type of battery housing				
6	Capacity in Ah		Ah		