



ANNEXURE A: SCOPE OF WORK

THE APPOINTMENT OF A SUPPLIER TO REMOVE AND PURCHASE THE EXISTING GENERATOR AND SUPPLY, DELIVER, INSTALL, COMMISSION AND MAINTAIN THE NEW REPLACEMENT 250KVA STANDBY GENERATOR OVER A PERIOD OF 12 MONTHS FOR CEF

1. INTRODUCTION

The current 130kVA diesel generator is unable to provide sufficient power for the CEF House building/office (operational areas) inclusive of the air-conditioning power supply should an electricity outage occur. Currently when outages occur, it necessitates that the Heating, Ventilation and Air conditioning (HVAC) chillers be switched off to avoid generator performance failure leading to overheating and power seizure. Due to the recent frequent power outages resulting in Stage 4-6 load shedding being implemented, CEF resolved to replace the current generator to meet the business requirements.

CEF together with the appointed professional Consulting Engineering contractor (principal contractor) evaluated the most cost-effective standby electricity provision by a 250KVA diesel generator. Corporate Services together with the professional service providers (Motla Consulting Engineers) to evaluate the most cost-effective standby electricity provision by a 250KVA diesel generator. The principal contractor includes a Mechanical Engineer, Civil Engineer, Electrical Engineer and a SHEQ Specialist which will support the project upon until commissioning and project handover.

DESCRIPTIONS OF WORKS

1. Client's Objective

Installation of a new standby generator for CEF.

2. Overview of the Works

Install a new 250kVA 3-phase diesel generator (Out-door Unit) complete with soundproof canopy, automatic change-over panel, fuel storage tank, fuel pump and pipes and generator concrete plinth.

3. Extent of the Works

3.1 Electrical Works:

- Install an outdoor generator set, complete with soundproof canopy (factory fitted) and one full fuel tank for first fill during construction, one full re-fill tank top-up for hand-over to the Client; concrete plinth (Refer to item C3.1.3.2 below) for mounting the generator- canopy unit.



- Install new cable between generator change-over panel and Main LV Panel. This will be mostly in a cable trench in the ground, and on cable trays inside the basement.
- Disconnect the existing generator. The CEF will separately dispose of the existing generator. Connect mains supply cables to the new generator change-over panel.
- Minor civil works, including drilling for sleeves installation.

3.2 Civil Works:

Civil works includes the bulk excavation, layer works construction and compaction for the placement of a new concrete foundation plinth for the new CEF Standby Generator. This will entail the following specific items as indicated in the BOQ.

- Site clearance – Clear and grub
- Bulk earth works - Cut to spoil within free haul distance.
- Excavation
- Layer works
- In situ preparation rip and compact of 150mm thick layer to a minimum of 90% of modified AASHTO maximum density.
- Import 150mm G6 from commercial sources and compacted to 93% MOD AASHTO to construct lower selected layer.
- Import 150mm G6 from commercial sources and compacted to 95% MOD AASHTO to construct upper selected layer.
- Import 150mm G5 from commercial sources and compacted to 95% MOD AASHTO to construct sub-base layer.
- Import 150mm G5 from commercial sources, stabilise with 3% cement to construct C4 base layer compacted to 97% MOD AASHTO.
- General landscaping and construction of temporary stormwater berms and channels.

The extent of the works applicable to this section entails the preparation, earthworks, layer works and in-situ improvements to ensure a sound foundation can be provided to house the new standby generator. Details of each installation is given in the technical schedules of this document.

The quantities of each type of work are given in the Schedule of Quantities. The schedule of quantities does not constitute a specification alone, and the quantities shall be read with the applicable paragraphs or sections and drawings included in this tender. The Employer reserves the right to adjust the quantities, based on the offers selected. No adjustment will be made to the rates where the scope of works varies. Adjustment will



only be made to the quantities to reflect the actual quantities measured at completion of the works. Any item may be omitted by the Employer from the Scope of the Works.

3.3 Location of the Works

At Central Energy Fund (CEF) House Block C, Upper Grayston Office Park 152 Ann Crescent Strathavon, Sandton (City of Johannesburg Metropolitan Municipality).

3.4 Construction program

It is specifically brought to the notice of the Contractor that time is critical on this project, and the construction period will be a major factor in the award of the tender.

Tenderers shall submit with their tender their preliminary weekly programme for the construction of the Works under this contract to suit their proposed method of executing the Works. The programme shall be sufficiently detailed to differentiate between the various activities so that the contract may be properly evaluated.

3.5 Change in works

The Engineer may, from time to time by order in writing without in any way vitiating the Contract or giving to the Contractor any claim for additional payment, require the Contractor to proceed with the execution of the works in such order as in his opinion may be necessary, and may alter the order of or suspend any part of the Works at such time and times as he may deem desirable and the Contractor shall not, after receiving such written order, proceed with work ordered to be suspended until he shall receive a written order to do so from the Engineer. Where the work must of necessity be carried out in conjunction with work of other Contractors, or with that of the Employer, it shall be co-ordinated and arranged in such a manner as to interfere as little as possible with the progress of such other work so as to offer every reasonable facility to other Contractors or to employees of the Employer.

3.6 ENGINEERING

3.6.1 Design services and activity matrix

Description	Responsibility
Concept, feasibility, and overall process	Engineer
Design of Works	Engineer
Basic Engineering and detail layouts to tender stage	Engineer
Final Design of Works	Engineer
Preparation of tender documentation & adverts	Client
Generator plinth	Contractor
Standby Generator	Contractor's supplier
Appointment of sub-contractors	Contractor

Supervision	Engineer on behalf of client Contractor is responsible for his own supervision
Preparation of as-built drawings	Contractor to submit redlined drawing to Engineer
Completion certificate	Engineer / Client / Contractor

3.6.2 Drawings

3.6.2.1 Electrical Works

The Engineer will provide the Contractor with one full set of drawings, which will be used exclusively for the recording of as built information by the Contractor.

Only dimensions, positions, levels, co-ordinates etc. that change from the original values, will be required to be entered on these drawings. These drawings, fully marked up, will be handed to the Engineer at the issue of the Certificate of completion, which will not be issued until the as-built information has been received.

The following drawings are applicable to this contract:

Drawing No. 12865EE-GA01 : Site Lay-out Plan (New Generator Position)

Drawing No. 12865EE-LD01 : Single Line Diagram

The applicable drawings mentioned above are attached at the end of this section (C3 – Scope of Work).

3.6.2.2 Civil Works

- **Civil Engineer Design:**

The Engineer is responsible for the basic engineering design, up to the bid stage, of the permanent Works as reflected in the Contract Documents unless otherwise stated. Tender drawings are included for the contractor to determine the scope of the work. Detailed construction drawings will be made available to successful tenderers. Where the successful tenderer must provide detailed drawings, these will be received and approved once orders have been placed on successful tenderers.

- **Contractor's Design:**

The Contractor is responsible for the detail design of the reinforced concrete plinth based on the properties of the new generator.

- Where contractor is to supply the design of designated parts of the permanent Works or temporary Works, he shall supply full working drawings supported by a professional engineer's design certificate.

- **Drawings:**

- All information in possession of the Contractor, required by the Engineer and/or the Engineer's Representative to complete the as built/record drawings, must be submitted to the Engineer's Representative before a Certificate of Completion will be issued.

The following drawing is applicable to this contract:

Drawing No. 12865EE-DL01 : Proposed Generator Plinth Position and Civil Works

- **Design Procedures**

The Contractor shall submit the designs, which he is responsible for in terms of the contract, to the Engineer for approval, before any fabrication and/or installation may take place.

No design changes shall be implemented unless approval is received in writing from the Engineer. Amended drawings, showing the design changes, shall be issued to all concerned, immediately after approval of such amendments.

All documentation, drawings and instructions shall be accompanied by a transmittal sheet, indicating whether it is for approval/construction/information etc.

3.7 PROCUREMENT

The Tenderers notice is drawn to the fact that the awarding of this tender will be in terms of the Supply Chain Management Policy of the Central Energy Fund (CEF) and the conditions of tender are the Standard Conditions of Tender as contained in Annex C of the CIDB Standard for Uniformity in Construction Procurement (August 2019) (Available on www.cidb.org.za).

3.8 SUB-CONTRACTING

No work may be sub-contracted to another party unless approval is given by the Engineer in writing. The Contractor is to submit to the Engineer in writing a request for



appointment of a particular sub- contractor. Accompanying this request is to be the full detail of the sub-contractor, including:

- Previous experience
- Work which will be sub-contracted to him/her
- Approximate value of the work to be sub-contracted

Before the Engineer in terms of Clause 38 hereof issues any certificate that includes any payment in respect of work done or goods supplied by any sub-contractor appointed in accordance with the provisions of Clause 4.4 of the General Conditions of Contract Second Edition (2010), he shall be entitled to call upon the Contractor to furnish reasonable proof that all payments (less retention moneys) included in previous certificates in respect of the work or goods of such sub-contractors have been made or discharged by the Contractor, in default of which, unless the Contractor:

- ✓Informs the Engineer in writing that he has reasonable cause for withholding or refusing such payment; and
- ✓Submits to the Engineer reasonable proof that he has so informed such sub-contractor in writing.

3.9 CONSTRUCTION

3.9.1 Plant and materials

All materials shall comply with the requirements of the South African Bureau of Standards and shall bear the official standardization mark. Where SANS standard does not exist for a certain material, or a material does not bear the official standardization mark, the Engineers approval of such material must be gained before use thereof.

3.9.2 Construction Equipment

All equipment on site shall be in a good working order and is to be in such a condition that it can achieve production rates which are typical of the industry standards.

Should any equipment, in the opinion of the Engineer, be substandard or breaks down frequently to such an extent that it affects the progress on the project, the Engineer may instruct the Contractor to replace such equipment.

3.9.3 Existing Services

The Contractor shall so carry out all his operations as not to encroach on, or interfere with, trespass on, or damage adjoining lands, building properties, roads, structures, places and



things in the vicinity of the Works, and he shall free and relieve the Employer of any liability that may be incurred in consequence of his failure to do so.

The services existing on the site will be either shown on the drawings or pointed out on site by the Engineer and / or the Municipality. No excavation work will commence unless a representative of the Municipality and/or the Engineer have been requested to point out existing services in the area under construction. Written confirmation of services that have been pointed out by the Municipality is to be obtained by the Contractor.

All existing services on the site may not be shown on the drawings or be visible on the site. The Engineer may order excavation by hand in order to search for and expose services. An item has been included in the Schedule of Quantities to cover the cost of such work if so ordered by the Engineer. Where a service is damaged because of the Contractors negligence he shall be liable for the cost involved in the repair of the services and any other consequent cost that may arise due to the interruption of the damaged services.

No excavation is to take place until a representative (building chief Inspector) from the Municipality (City of Johannesburg Metropolitan Municipality / Sandton /) has been contacted (for the relevant building chief Inspector contact details refer to the website: download the 'Building Development Management Information Booklet – Building Inspect Unit') and he has pointed out the existing services to the Contractor and confirmed it in writing. The same shall apply to all Telkom services in the area.

3.9.4 Site Establishment

- Source of Water Supply
Available at Central Energy Fund (CEF)
- Sources of power supply
Available at Central Energy Fund (CEF)
- Location of camp and depot
N/A
- Temporary offices
N/A
- Laboratory facilities



N/A

- Sanitary facilities

Available at Central Energy Fund (CEF). The contractor shall provide for his own sanitation of staff during construction.

- Name Boards

One name board shall be provided in positions as ordered by the Engineer. The Engineer will provide the lettering required once the tender is awarded.

- Survey assistant and equipment

The contractor shall provide all resources necessary to set out and execute the works.

3.9.5. Site Usage

- Ground and access to the works

The Contractor shall where necessary on or adjacent to roads which carry traffic, provide all the necessary barricades and signs in accordance with the stipulations of the South African Road Traffic Signs Manual. The vehicle restriction and loading & offloading is a 2-ton load limit therefore rigging should be done from outside the premises.

The Contractor shall further ensure that all public roads that are used for access to the site are kept free of debris at all times. The Contractor shall also take adequate measures to ensure that dust is kept to an acceptable level. The term acceptable is to be deemed as acceptable to the Engineer.

- Care, damage and protection

The Contractor shall at his own cost make full provision for all watching and lighting necessary for the protection of all persons, animals, vehicles, etc., from injury by reason of the Works.

He shall provide ample warning signs, guard rails, etc., around open excavations, stacks of materials, excavated material, debris or the like, and he shall be held liable for all claims made upon himself or upon the Employer by reason of his neglect of all such precautions and provisions.

During the periods of construction of the Works and the repair of defects, the Contractor shall, at his own cost, to the satisfaction of the Engineer and the relevant Authority, take sufficient and adequate measures to avoid interrupting the use of all roads, footpaths, water courses, drains, pipes, telephones, electric wires and cables, premises, places and

works, public or private, which may in any way be interfered with by the operations; and shall also afterwards permanently restore all structures and everything which may have been temporarily displaced or otherwise interfered with, all to the satisfaction of the Engineer and the relevant Authority, without extra charge beyond the Contract price.

- Survey beacons

The Contractor shall take care to safeguard any permanent survey beacons such as erf boundary pegs and reference beacons. Should the Contractor disturb any such pegs and beacons, he shall have them replaced at his own cost by a registered Land Surveyor. The Contractor is to provide the Engineer with written confirmation from the Land Surveyor that he has replaced the relevant beacons.

The Contractor's attention is drawn to article 35(i) of the Land Surveying Act No. 9 of 1927 (as amended) in this regard.

- Blasting

As the construction takes place within a built-up area, extreme care is to be taken during any blasting operations. No blasting shall be permitted without prior written consent from the Engineer. Written as well as verbal notice will be given to all house owners in the affected area 24 hours prior to the blast being set off, and the contractor is to do a survey of all the houses (internal and external) in the area prior to blasting.

A full daily report of all blasting operations (in duplicate) is to be completed by the Contractor.

This report shall inter alia contain the following information:

- Date and time of each blast
- Number of holes
- Charge per hole
- Use of relays, etc.

This report is to be submitted to the Engineer on a weekly basis and is to be countersigned by the Engineer.

The contractor must note that he is not to use or permit any person to use an explosive powered tool, unless -

- (a) it is provided with a protective guard around the muzzle end, which effectively confines any flying fragments or particles; and
- (b) the firing mechanism is so designed that the explosive powered tool will not function unless—

- (i) it is held against the surface with a force of at least twice its weight; and
- (ii) the angle of inclination of the barrel to the work surface is not more than 15 degrees from a right angle:

- **Protection of existing vegetation**

Before any tree is cut down and removed from the site, the Contractor shall confirm the necessity of such action with the Engineer or his Representative.

- **Access to individual erven**

Access to all public and private property must be maintained at all times. Where trenches cross the access point to any property, the Contractor is to arrange for adequate and safe vehicular and pedestrian crossings over the trenches.

The Engineer must approve the method of providing access before any excavation commences.

- **Use of construction vehicles and equipment**

Vehicles heavier than 2Ton is not allowed to drive on the premises. The contractor shall ensure that all construction vehicles and mobile plants–

- (a) are of an acceptable design and construction;
- (b) are maintained in a good working order;
- (c) are used in accordance with their design and the intention for which they were designed, having due regard to safety and health;
- (d) are operated by workers who-
 - (i) have received appropriate training and been certified competent and been authorised to operate such machinery; and
 - (ii) are physically and psychologically fit to operate such construction vehicles and mobile plant by being in possession of a medical certificate of fitness;
- (e) arrangements to guard against the dangers relating to the movement of vehicles and plant, in order to ensure their continued safe operation;
- (f) are prevented from falling into excavations, water or any other area lower than the working surface by installing adequate edge protection, which may include guardrails and crash barriers;
- (g) where appropriate, are fitted with structures designed to protect the operator from falling material or from being crushed should the vehicle or mobile plant overturn;
- (h) are equipped with an electrically operated acoustic signalling device and a reversing alarm; and
- (j) are on a daily basis inspected prior to use, by a competent person who has been appointed in writing and the findings of such inspection is recorded in a register.

- (j) no person rides or be required or permitted to ride on any construction vehicle or mobile plant otherwise than in a safe place provided thereon for that purpose;
- (k) every construction site is organised in such a way that, as far as is reasonably practicable, pedestrians and vehicles can move safely and without risks to health;
- (l) the traffic routes are suitable for the persons using them, sufficient in number, in suitable positions and of sufficient size;
- (m) every traffic route is, where necessary indicated by suitable signs for reasons of health or safety;
- (n) bulldozers, scrapers, loaders, and other similar mobile plant are, when being repaired or when not in use, fully lowered or blocked with controls in a neutral position, motors stopped, and brakes set;
- (o) whenever visibility conditions warrant additional lighting, all mobile plant are equipped with at least two headlights and two taillights when in operation;
- (p) when workers are working on or adjacent to public roads, reflective indicators are provided and worn by the workers.

3.9.6 Permits and Way leaves

N/A. Existing Services to be located by the Contractor

3.10 MANAGEMENT

3.10.1 Management of the Works

- **Planning and programme**

The Contractor shall deliver to the Engineer within the period stated in the contract, calculated from the commencement date, a realistic programme showing the order of procedure, the duration of activities making up the programme and method which he proposes to use in carrying out the Works in order to meet the due completion date for this project.

- **Setting out of the works**

Generally, the positions of the works have been fixed on the plans according to the existing stand boundaries. The Engineer is to approve all setting out prior to commencement of excavation.

- **Excavation of works & safety**

The contractor shall ensure that all excavation work is carried out under the supervision of a competent person who is been appointed in writing. The Contractor will evaluate,



as far as is reasonably practicable, the stability of the ground before excavation works begin and he/she shall not permit any person to work in an excavation which has not been adequately shored or braced.

The Contractor will cause convenient and safe means of access to every excavation area in which person are required to work and such access shall not be further than 6m from the point where any worker within the excavation is working.

The Contractor must ascertain as far as is reasonably practicable the location and nature of electricity, water, gas or other similar services which may in any way be affected by the work to be performed and shall before the commencement of excavation work that may affect any such service, take the steps that may be necessary to render the circumstances safe for all persons involved.

The Principal Contractor shall cause every excavation which is accessible to the public or which is adjacent to public roads or thoroughfares, or whereby the safety of persons may be endangered, to be:

- (i) adequately protected by a barrier or fence of at least one metre in height and as close to the excavation as is practicable; and
- (ii) provided with warning illuminants or any other clearly visible boundary indicators at night or when visibility is poor;

The Principal Contractor shall cause warning signs to be positioned next to an excavation within which persons are working or carrying out inspections or tests.

- **Inspection by engineer**

No stage of construction shall be proceeded with until the Engineer or his representative has examined and approved the previous stage. If any work is covered or hidden from view before the Engineer has inspected same, the Contractor shall at his own cost open the covered work for inspection. The Contractor shall also be responsible for making good any work damaged by such uncovering.

- **Employment of local labour**

It is a specific criterion of this project that should as far as possible adhere to RDP principles, and to meet these principles the following procedures will be followed:

All labour is to be sourced from the Local Municipal area of jurisdiction and the Contractor may only bring in key personnel from outside this area. The fixed rate for the appointment of local labour will be R [Not Applicable for this project]. This will be payable by the Contractor on [N/A] basis. The Contractor's attention is drawn to the standard



rates specification (Civil Engineering Industry Minimum Wage rates per hour;) found on the SAFSEC website at www.safcec.org.za. These standard rates should be implemented for payment of all employees of the Contractor.

Key personnel would typically include the Contracts Manager, Site Agent, and Supervisor for each discipline, and operators of plant where the operator must be seated.

A Monthly labour report on all local labour i.e., payments and labour days should be submitted to the Engineer at the end of each month in order for the Engineer to submit a report to the Employer.

None of the Works shall be executed except between sunrise and sunset on Monday to Saturday, inclusive, of any week, and none of the Works shall be executed on any special non-working days stated in the Contract Data, unless:

- ✓ The Engineer's permission in writing is obtained, subject to such conditions as may be laid down by the Engineer; or
- ✓ Provision is specifically made for it in the Contract; or
- ✓ Work is unavoidable or necessary for the saving of life or property or for the safety of the Works.

- **Site Meetings**

Regular meetings will be held between all relevant parties to establish the progress and / or delays and problems that might occur on site. Any problems of delays will be address accordingly and the Contractor will receive proper instructions with reference to this matter.

- **Daily Records**

Daily records of resources (equipment and people employed) must be kept and must be always available on site. These records will include i.e., site instruction book, site diary, site visit register, contractual documentation, and minutes of all project meetings. Labour information should be kept always updated.

- **Compliance with applicable laws**



The Contractor shall, in performance of the Contract, comply with all applicable laws, regulations and statutory provisions and agreements.

- **Payment Certificates**

As consideration for the construction, completion and defects correction of the Works, the Employer shall pay the Contractor in terms of the provisions of the Contract.

- **Clearance of site**

On completion of the Works, the Contractor shall clear away and remove from the site all Construction Equipment, surplus materials, rubbish and temporary works of every kind and leave the whole of the site and the works clean and in a safe condition. All streams and watercourses (where applicable) shall be cleaned and restored to the condition as at the commencement of the Works. If the Contractor does not, within a reasonable time, comply with this requirement, the Employer may have the site cleared and recover the cost thereof from the Contractor.

3.11 HEALTH AND SAFETY

- **Health & Safety Issues**

All work is to be carried out in accordance with the Occupational Health and Safety Act and Regulations (Act 85 of 1993) (a copy of which must be kept on site), the Explosive Material Act of (Act 26 of 1956), the Minerals Act of 1991, and the Factories Machinery and Building Work Act (No 22 of 1941).

The Contractor's notice is drawn to the stipulations of the Construction Regulations 2003, a regulation of the Health and Safety Act 1993 (Gov Notice No R1010 of 18 July 2003). The construction regulation will be applied vigorously on the project.

The Contractor to be appointed must have made provision for the cost of health and safety measures during the construction process. The contractor must have the necessary skills, competencies and resources to carry out the work safely. A proper Safety Plan is to be submitted by the Contractor and a copy thereof is to be made available to all applicable appointed labourers and permanent workers on this project.

The Contractor is to ensure that the legal compliance for the Health and Safety issues are in place. Audits will be carried out to ensure that the Contractor is registered and in good standing with the Workmen's Compensation fund and that the Contractor has affected insurance indemnifying the Employer against penalties levied upon the Employer due to the acts of omissions of the Contractor in failing to comply with the provisions of the OHS

regulations 2003. A compliance audit will also be carried out to ensure that the Contractor has appointed a full-time competent person in writing to deal with the issues of the OHS and that a risk assessment has been conducted and a copy of the Safety plan is on site before any work commences.

Operational audits will be carried out on the following important issues:

- ✓ That the Safety Plan is on site at all times
- ✓ That the Contractor's Safety file is on site at all times
- ✓ That the Safety Officer is on site at all times
- ✓ That Safety meetings are conducted as per the Safety Plan
- ✓ That employees are working under safe conditions
- ✓ That the public is not placed in danger
- ✓ That there is no harm to the environment

▪ **Accommodation of traffic**

It is expected of the Contractor to ensure that the free flow of traffic is possible throughout the construction period.

The Contractor is to provide all necessary barricades, signs and lighting in accordance with the stipulations of the South African Road Signs Traffic Manual, and the Protective Services of the Local Municipality. All work is to be to the satisfaction of the Engineer.

▪ **Reporting of accidents**

In addition to any statutory regulations, the Contractor shall, as soon as practicable, report to the Engineer every occurrence on the Works or the site causing damage to property or injury or death of persons. If required by the Engineer, the Contractor will submit a report in writing to the Engineer within 48 hours of such requirement setting out full details of the occurrence. The Engineer shall have the right to make any enquiries either on the site or elsewhere as to the cause and results any such occurrence and the Contractor shall make available to the Engineer the necessary facilities for carrying out such enquiries.

3.12 PROJECT SPECIFICATIONS

3.12.1 Work Specifications

3.12.1.1 Electrical Works Specification:

The following applicable standardized and specifications are relevant to this contract:

a) Normative References

No.	Reference	Description
------------	------------------	--------------------

South African National Standards		
1	SANS 1200	Specification for Civil Engineering Construction
2	SANS 10198	The selection, handling, and installation of electric power cables of rating not exceeding 33 kV (Part 1 – 5)
3	SANS 8528	Internal Combustion Engine (Reciprocating internal combustion engine driven alternating current generating sets)
4	SANS 10103	Noise Levels (The measurement and rating of environmental noise with respect to annoyance and to speech communication)
5	SANS 1222	Enclosure (Enclosures for electrical equipment classified by IP code)
6	SANS IEC 34	Rotating Electrical Machines (Part 1 and 2)
7	SANS 1507	Electrical Cable (Electric cables with extruded solid dielectric insulation for fixed installations)
8	SANS 10292	Earthing (Earthing of low-voltage (LV) distribution systems)

b) Method statement

The contractor shall execute the works as follows:

1. Prepare the new plinth (refer to the civil project specification below).
2. The Contractor shall install the new generator and lay new cables from the generator to the existing main LV board.

Note: The Contractor shall submit the Manufacturer's Generator Shop Drawings for approval by the Electrical Engineer prior to manufacturing. The generator exhaust / extension pipe shall face away from the CEF entrance gate and from the road.

1. The site has a datacentre equipped with UPS's that can accommodate a power outage of no longer than 30 minutes. The contractor shall coordinate with the CEF that the batteries are fully charged prior to disconnection of the existing incomer cables on the main LV board and connection of the new cables.
2. The contractor shall ensure that the cables are connected already the generator change-over panel, that the terminations are prepared at the cable end at the main LV board prior to switch-off, and fully tested.
3. After connection of the new LV cables at the main LV board, the contractor shall energize the generator. This all must happen within 30 minutes such that the UPS batteries do not deplete.

4. The building will then be supplied by the generator while the contractor disconnects the cables from the incoming splitter box to the existing generator, and swing over to the change-over panel. The contractor shall aim to complete this task within three hours, inclusive of the testing of the cables.
5. Thereafter the installation can be changed over to the mains supply, the generator set to auto mode. And the fuel topped up.

3.12.1.2 Civil Works Specification:

- a) Applicable SABS 1200 Standardized Specifications SABS 1200 is applicable to all civil works.
- b) Normative References

No.	Reference	Description
South African National Standards		
1	SABS 0100	Structural use of concrete
2	SABS 0144	Detailing of steel reinforcement for concrete
3	SABS 053	Mineral Lubricating Oil
4	SABS 1024	Welded steel fabric for concrete reinforcement
5	SABS 1083	Aggregates from natural sources
6	SABS 109: 1975 Amendment No 2: 1989.	National colour standards for paint.
7	SABS 1143	Mushroom- and countersunk-head bolts and nuts
8	SABS 1149	Flat and taper steel washers
9	SABS 1195	Busbars
10	SABS 1200 A	Civil Engineering Construction: General
11	SABS 1200 AA	Civil Engineering Construction: General (Small Works)
12	SABS 1200 AH	Civil Engineering Construction: General (Structural)
13	SABS 1200 C	Civil Engineering Construction: Site Clearance
14	SABS 1200 D	Civil Engineering Construction: Earthworks
15	SABS 1200 DA	Civil Engineering Construction: Earthworks (Small Works)
16	SABS 1200 DB	Civil Engineering Construction: Earthworks (Pipe trenches)
17	SABS 1200 DK	Civil Engineering Construction: Gabions and pitching
18	SABS 1200 HC	Civil Engineering Construction: Corrosion protection of structural steelwork

19	SABS 1200 LB	Civil Engineering Construction: Bedding (Pipes)
20	SABS 135	ISO Metric bolts, screws, and nuts (hexagon and square)
21	SABS 136	ISO Metric precision hexagon-head bolts and screws, and hexagon nuts
22	SABS 150, SABS 1507	PVC Insulated Electric Cables
23	SABS 156: 1977 Amendment No 1: March 1987	Moulded case circuit breakers.
24	SABS 177	Insulators
25	SABS 455	Covered electrodes for the manual arc welding of carbon and carbon manganese steels
26	SABS 471	Portland cement (ordinary, rapid hardening and sulphate resisting)
27	SABS 555, IEC 296	Insulating Oil
28	SABS 626	Portland blast furnace cement
29	SABS 763	Galvanising
30	SABS 82	Bending dimensions of bars for concrete reinforcement
31	SABS 831	Portland cement 15 and rapid hardening cement 15
32	SABS 878	Ready-mixed concrete
33	SABS 920	Steel bars for concrete reinforcement
34	SANS 10044-1	Welding Part 1: Glossary of terms
35	SANS 10044-2	Welding Part 2: Symbols
36	SANS 10044-4	Welding Part 4: The fusion welding of steel (including stainless steel): Tests for the approval of welders working to approved welding procedures
37	SANS 10100-1	The structural use of concrete Part 1: Design
38	SANS 10100-2	The structural use of concrete Part 2: Materials and execution of work
39	SANS 10142-1	The wiring of premises Part 1: Low-voltage installations
40	SANS 10199	The design and installation of earth electrodes
41	SANS 10200	Neutral earthing in medium voltage industrial power systems
42	SANS 1024	Welded steel fabric for reinforcement of concrete
43	SANS 10400	The application of the National Building Regulations
44	SANS 1063	Earthing Rods and couplers
45	SANS 1083	Aggregates from natural sources – Aggregates for concrete

46	SANS 1186-1	Symbolic safety signs Part 1: Standard signs and general requirements
47	SANS 1200 A	Standardized specification for civil engineering construction Section A: General
48	SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods
49	SANS 1491-1	Portland cement extenders Part 1: Ground granulated blast- furnace slag
50	SANS 1491-2	Portland cement extenders Part 2: Fly ash
51	SANS 1491-3	Portland cement extenders Part 3: Silica fume
52	SANS 274	Quality management systems - Guidelines for quality management in projects
53	SANS 282	Bending dimensions and scheduling of steel reinforcement for concrete
54	SANS 32	Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic plants
55	SANS 558	Cast iron surface boxes and manhole and inspection covers and frames
56	SANS 5861-2	Concrete tests - Sampling of freshly mixed concrete
57	SANS 5862-1	Concrete tests - Consistence of freshly mixed concrete - Slump test
58	SANS 5862-2	Concrete tests - Consistence of freshly mixed concrete - Flow test
59	SANS 5862-3	Concrete tests - Consistence of freshly mixed concrete - Vebe test
60	SANS 5862-4	Concrete tests - Consistence of freshly mixed concrete - Compacting factor and compaction index
61	SANS 61024-1	Protection of structures against lightning Part 1: General principles
62	SANS 61230 [Equivalent to IEC]	Live working Portable equipment for earthing and short-circuiting.
63	SANS 6156	Water requirement of Portland cement extenders
64	SANS 6157	Fineness of cement and Portland cement extenders (45 μ m sieve method)
65	SANS 6250	Concrete tests - Density of compacted freshly mixed concrete

66	SANS 6252	Concrete tests - Air content of freshly mixed concrete - Pressure method
67	SANS 6253	Concrete tests - Tensile splitting strength of concrete
68	SANS 675	Zinc-coated fencing wire (plain and barbed)
69	SANS 677	Concrete non-pressure pipes
70	SANS 920	Steel bars for concrete reinforcement
71	SANS 986	Pre-cast reinforced concrete culverts

e) Site Location

The site (Central Energy Fund) is located in Sandton (Block C Building, Upper Grayston Office Park 152 Ann Crescent Strathavon Sandton)

f) Civil

Civil works includes the bulk excavation, layer works construction and compaction for the placement of a new concrete foundation plinth for the new CEF Standby Generator. This will entail the following specific items as indicated in the BOQ.

- Site clearance – Clear and grub
- Bulk earth works - Cut to spoil within free haul distance.
- Excavation
- Layer works
- In situ preparation rip and compact of 150mm thick layer to a minimum of 90% of modified AASHTO maximum density.
- Import 150mm G6 from commercial sources and compacted to 93% MOD AASHTO to construct lower selected layer.
- Import 150mm G6 from commercial sources and compacted to 95% MOD AASHTO to construct upper selected layer.
- Import 150mm G5 from commercial sources and compacted to 95% MOD AASHTO to construct sub-base layer.
- Import 150mm G5 from commercial sources, stabilise with 3% cement to construct C4 base layer compacted to 97% MOD AASHTO.
- General landscaping and construction of temporary stormwater berms and channels.

All civil work shall be carried out as per SANS 1200, the Bill of Quantities and Design Drawings.

g) Generator Plinth & foundation layers

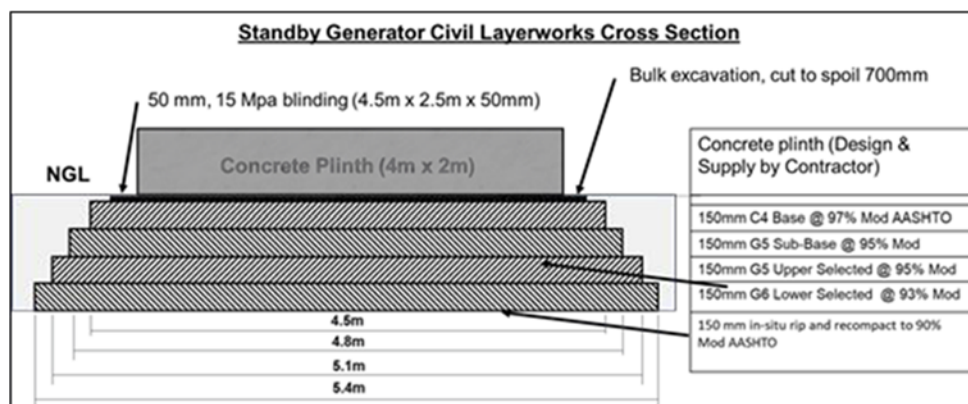
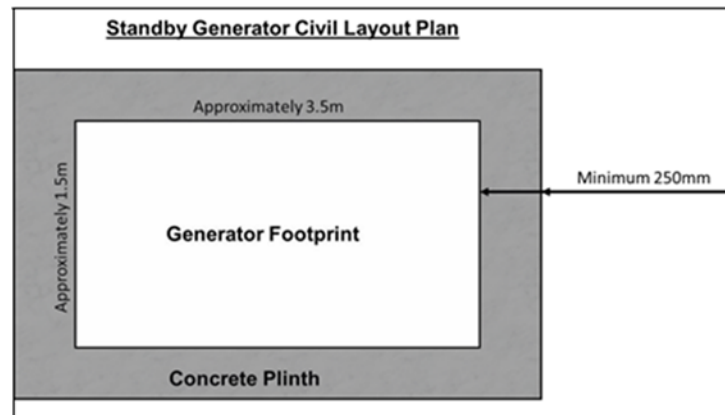
Taking the geotechnical report recommendations into consideration approximately 700mm of in-situ soil could be unsuitable and need to be excavated to spoil and

replaced with suitable material compacted in layers of 150mm maximum as per design drawings at optimum moisture content (approximately 9%).

The final level of earthworks, layer works, and blinding shall be at current natural ground level (NGL) to ensure the new concrete plinth is always free of surrounding standing water.

The natural ground level around the new generator position needs to be shaped to ensure storm water run-off flows away from the newly constructed plinth and generator position.

The current design allows for a minimum clearance around the generator footprint of at least 250mm. All layer works need to be benched at 150mm to ensure good stability of new backfilled founding layers once the generator and plinth has been placed. In the event that the generator size increases greater than 3.5m x 1.5m in its footprint, a redesign of layer works might be required. The following illustrates the layer works design required.





PART A: STANDARD SPECIFICATION FOR THE REMOVAL, SUPPLY, INSTALLATION AND COMMISSIONING OF AN OUTDOOR EMERGENCY GENERATOR SET

SECTION 1 – GENERAL

1.1. Intent of Specification

The specification is intended to cover the complete installation and commissioning of the generator plant. The minimum equipment requirements are outlined, but do not cover all the details of design and construction. Such details are recognized as being the exclusive responsibility of the contractor.

For the purposes of this document the following applies:

- Generator Contractor shall be referred to as the Generator Contractor or simply Contractor;
- The masculine includes the feminine;
- The singular includes the plural.

1.2. Standards and Codes

All standards referenced shall be the latest editions.

SANS 10142-1	the wiring of premises: Low Voltage Installations
SANS 8528	Reciprocating internal combustion engine driven alternating current generating sets.
SANS 60034	Rotating electrical Machines
SANS IEC 60947	Low Voltage Switchgear
OHSACT	Occupational Health and Safety Act.

1.3. Compliance with Regulations

The installation shall be erected and tested in accordance with the following Acts and regulations:

- a) The Occupational Health and Safety Act, 1993 (Act 85 of 1993) as amended,
- b) The Local Government Ordinance 1939 (Ordinance 17 of 1939) as amended and the municipal by-laws and any special requirements of the local supply authority,
- c) The Fire Brigade services Act 1987 (Act 99 of 1987) as amended,
- d) The National Building Regulations and Building Standards Act 1977 (Act 103 of 1977) as amended,
- e) The Electricity Act 1984 (Act 41 of 1984) as amended.
- f) The environmental Act and regulations

1.4. Scope of Work

Included in this Outdoor Generator Specification

Supply, delivery, installation and commissioning of the complete outdoor emergency generator inside an IP65 canopy/container set on a concrete plinth as specified in this document.

The successful tenderer shall supply, deliver and install a complete single enclosed diesel driven standby generator set in a position that will be determined on site. The machine shall be totally enclosed in a 3CR12 stainless steel housing powder coated or within 50km from the coast with grade 316 steel housing powder coated. The exhaust shall be manufactured from stainless steel.

The housing is to be provided on galvanized 3CR12 stainless steel skids so that the generator set can be transported to site and placed in position on a concrete plinth, casted by the successful tenderer. The skids must be of sufficient height to allow for the passage of storm water under the set.

1.5. Co-ordinating

The Contractor shall familiarise himself with the requirements of the other professional disciplines and shall examine the plans and specifications covering each of these sections.

The generator space, noise and vibration requirements shall be carefully checked with other professional disciplines to ensure that the equipment can be installed in the proper sequence in the space allotted.

1.6. Tests Certificates and Inspections

The following tests are to be carried out:

- a) At the supplier's premises, before the generating set will be delivered to site Representatives of the CEF must be present during the test to satisfy themselves that the generating set complies with the specification and delivers the specified output. The test must be carried out in accordance with SANS 8528. The Representative/Agent must be timeously advised of the date for the test.
- b) After completion of the works and before practical completion 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.

- c) 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.
- d) Test reports of both tests as specified under (a) and (b) are to be submitted to the Representative/Agent.

The total costs for these tests shall be included in the tendered amount.

In the event of the plant, equipment or installation not passing the test, the Representative/Agent shall be at liberty to deduct from the Contract amount all reasonable expenses incurred by the Employer and/or the Representative/Agent attending the test.

1.7. Operating and Maintenance Manuals

The Contractor shall be responsible for the compilation of a complete set of Operating and Maintenance manuals.

This shall be done in accordance with Section 4 – Operating and Maintenance manuals.

All information shall be recorded and reproduced in electronic format as well as supplying the Representative/Agent with three sets of hard copies.

Approval of the final Operating and Maintenance Manuals shall be a prerequisite for issuing of a Certificate of Practical Completion of the installation.

1.8. Guarantee

After works completion of the installation have been achieved, there will follow a 12-month free maintenance period.

During this period the generator contractor shall maintain the generator installation as per the requirements of the Occupational Health and Safety Act. This maintenance shall include systematic examinations, adjustments, and lubrication of all generator equipment. Electrical and mechanical parts shall be repaired or replaced whenever it is required to maintain optimum performance without additional cost to the CEF, unless the condition was caused by misuse or vandalism of the generator equipment or natural hazards/force majeure.

The work under this section shall be performed by competent, qualified accredited personnel under the supervision and in the direct employment of the Generator Contractor and shall not be transferred to any non-affiliated agent. Contract maintenance and repair work shall be done during normal working hours and shall further



provide emergency call-back service twenty-four (24) hours a day, seven (7) days a week.

1.9. Materials and Workmanship

- a) The work throughout shall be executed to the highest standards and to the entire satisfaction of the Representative/Agent who shall interpret the meaning of the Contract Document and shall have the authority to reject any work and materials, which, in his judgement, are not in full accordance therewith. All condemned material and workmanship shall be replaced or rectified as directed and approved by the Representative/Agent.
- b) All work shall be executed in a first-class manner by qualified accredited tradesman.
- c) The Contractor shall be fully responsible for his work and shall replace any of the work which may be damaged, lost or stolen. The Contractor shall protect the building and its contents against damage by him, his employees or sub-contractors and shall make good any damage thereto.
- d) The Contractor shall indemnify the Employer of all liability for damages arising from injuries or disabilities to persons or damage to property occasioned by any act or omission of the Contractor or any of his sub-contractors, including any and all expenses, legal or otherwise, which may be incurred by the Employer or Representative/Agent in the defence of any claim, action or suit.
- e) The Contractor shall warrant that the materials and workmanship shall be of the highest grade, that the equipment shall be installed in a practical and first-class manner in accordance with the best practices and ready and complete for full operation. It is specifically intended that all material or labour which is usually provided as part of such equipment as is called for and which is necessary for its proper completion and operation shall be provided without additional cost whether or not shown or described in the Contract Document.
- f) The Contractor shall thoroughly acquaint himself with the work involved and shall verify on site all measurements necessary for proper installation and commissioning work. The Contractor shall also be prepared to promptly furnish any information relating to his own work as may be necessary for the proper installation work and shall co-operate with and co-ordinate the work of others as may be applicable.
- g) The Contractor shall inspect and verify that the existing power feeder system is compatible with the equipment offered and any changes or upgrading of the electrical supply shall be brought to the attention of the Representative/Agent.
- h) Material and equipment damaged in transit shall be replaced with undamaged material without additional cost to the CEF.
- i) All components and their respective adjustment, which do not form part of the equipment installation work but influence the optimum and safe operation of the equipment shall be considered to form part of and shall be included in the Contractor's scope of works.
- j) All control equipment and serviceable items shall be installed and positioned such that they will be accessible and maintainable.

- k) The Contractor shall make sure that all safety regulations and measures and environmental regulations are applied and enforced during the installation and guarantee period to ensure the safety of the public and the User Client.

1.10. Brochures

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

SECTION 2 – EQUIPMENT REQUIREMENTS

2.1. Engine

2.1.1. General

The engine must comply with the requirements laid down in SANS 8528 and must be of the atomized 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.

Curves furnished by the engine makers, showing the output of the engine offered against the speed, for both intermittent and continuous operation as well as fuel consumption curves when the engine is used for electric generation, must be submitted with the Tender.

2.1.2. 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 SANS 8528.

2.1.3. De-Rating

The engine must be de-rated for the site conditions as set out in the Technical Specification, Section 3 of this document.

The de-rating of the engine for site conditions shall be strictly in accordance with SANS

8528 as amended to date. Any other methods of de-rating must have the approval of the CEF and must be motivated in detail. Such de-rating must be guaranteed in writing and proved by the successful Tenderer at the site test.

2.1.4. 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.

2.1.5. Starter Battery

The set must be supplied a fully charged lead-acid type or maintenance free type battery, complete with necessary electrolyte. The battery must have sufficient capacity to provide the starting torque stipulated by the engine manufacturer. 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, house in a suitable battery box.

2.1.6. 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 pressurized 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. 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 enclosure.

2.1.7. 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.

2.1.8. Fuel Pump

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

2.1.9. Fuel Tank

The fuel tank shall be an integral part of the base frame of the generator set. The tank shall have sufficient capacity for standby sets to run the engine on full load for a period of 12 hours.

The diesel fuel storage system / tank which will be provided with the standby generator installation must be fitted with a fuel filtration and water separation system (filter & separator) which is entirely separate from the fuel supply line and line filter to the engine. This filtration and water separation system must be dedicated to purifying the content of the storage system / tank by way of the cleaning processes which are applied while circulating the fuel through the filter & separator unit.

The filtration system must be able to handle diesel fuel of "high" and of "low" sulphur content for an indefinite period. The suction line of the system must be connected to the lowest part of the storage system / tank. The return line must be connected in the top section of the storage system / tank in such a position and in such a way that the flow of fuel within the storage system / tank between the fuel return point and the fuel suction point will induce scouring of the bottom of the system / tank to effectively capture sediment and water in the to be filtered fuel.

The filtration unit must filter the diesel fuel, removing suspended particles of effective diameters down to 5 microns. In addition, it must separate all water from the fuel and the fuel storage system and automatically dispose of / dump such water into an open, removable receptacle for disposal at the installation or in a suitable position outside the building. Separation of the fuel and water must be sufficiently effective that the discharged water will meet the standard required for it to be disposed of into a municipal drain and sewer system.

The filter and water separator unit must draw its power from the DC batteries used to power the relevant generator set. The circulating pump shall be provided with a controller programmed to switch the pump through not more than three complete on and off cycles of equal time (i.e., 50% on; 50% off) , per hour, with a deviation of not more than 10 % \pm . The pump must be capable of a duty cycle of not less than 60% running time. The flow rate through the circulating pump must be between 1 L/min and 1.25 L /min.

The filter cartridge of the filter and water separator unit must be replaceable, and, in normal operational conditions, not require replacement within periods shorter than three months. The replacement units must be readily available.

The filtration & separator system may be mounted against the wall of the plant room or on the inside of a container, which may house the installation as may be specified elsewhere in this document.

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.

An electrically operated pump with sufficient length of oil resistant hose to reach 2m beyond the door of the canopy/container, shall be supplied, for each set for filling the fuel tank/s from 200 litre drums.

The interconnection fuel piping shall consist of copper tubes and the connection to vibrating components shall be in flexible tubing with armoured covering.

The contractor shall allow for the supply and installation of a fuel shut off fusible link in the container. The fusible link shall shut off the fuel at a temperature of 130 degrees in an event of a fire in the self-contained enclosure.

The fusible link shall be mounted above the engine and coupled to the shut off valve by means of a 2mm stainless steel cable. The cable shall be installed to the shut off valve without any possibility of kinking the cable which may cause malfunctioning of the protection device.

2.1.10. Governor

The speed of the engine shall be controlled by a governor in accordance with ECM of SANS 8528 if not otherwise specified in the Detailed Specification.

The permanent speed variation between no load and full load shall not exceed 4.5% of the nominal engine speed and the temporary speed variation shall not exceed 10%. External facilities must be provided on the engine, to adjust the nominal speed setting by $\pm 5\%$ at all loads between zero and rated load.

2.1.11. 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 SANS 8528.

2.1.12. Exhaust Silencer

It is essential to keep the noise level as low as possible. An effective exhaust silencing system of the residential type must be provided and shall be capable of providing 20 to 30 decibels of suppression.

The exhaust system shall consist of 3CR12 steel for inland areas (greater than 50km from the coast) or Grade 304 stainless steel in coastal areas.

The exhaust pipe shall be installed in such a way that the expelled exhaust fumes will not cause discomfort to the public. The exhaust pipe must be flexibly connected to the engine to take up vibrations transmitted from the engine, which may cause breakage. The exhaust piping and silencer shall be lagged and then cladded in stainless steel sheet to reduce the heat and noise transmission in the generator enclosure and shall be protected against the ingress of driving rain at 45° to the horizontal. The exhaust pipe must extend 0,5m above the canopy.

2.1.13. 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.

2.1.14. Exhaust emissions

The exhaust emissions shall comply with US Tier III/EU stage III standards.

2.2. Alternator

2.2.1. General

The alternator shall be of the self-excited brushless 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 SANS 60034-1 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.

2.2.2. Regulation

The alternator must preferably be self-regulated without the utilization 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 0,9

lagging and within the driving speed variations of 4,5% between no-load and full load.

2.2.3. Performance

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%.

2.2.4. Coupling

The engine and alternator must be directly coupled by means of a high-quality flexible coupling, ISO 9001:2000 approved and must be designed and manufactured to this quality system.

2.3. Switchboard

2.3.1. General

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

The switchboard must conform the specification as set out in the following paragraphs.

2.3.2. Construction

The switchboard shall be enclosed in the steel enclosure.

All equipment, connections and terminals shall be easily accessible from the front. The front panels may be either hinged or removable and fixed with studs and chromium-plated cap nuts. Self-tapping screws shall not be used in the construction of the board.

All pushbuttons, pilot lights, control switches, instrument and control fuses, shall be mounted on hinged panels with the control wires in flexible looms.

The steelwork of the boards must be thoroughly de-rusted, primed with zinc chromate and finished with two coats of signal red quality enamel, or a baked powder epoxy coating.

Suitably rated terminals must be provided for all main circuits and the control and protection circuits. Where cable lugs are used, these shall be crimped onto the cable strands. Screw terminals shall be of the type to prevent spreading of cable strands. All terminals shall be clearly marked.



For the control wiring, each wire shall be fitted with a cable or wire marker of approved type, and numbering of these markers must be shown on the wiring diagram on the switchboard. Control wiring shall be run in PVC trunking. The trunking shall be properly fixed to the switchboard steelwork. Adhesives shall not be acceptable for the fixing of trunking or looms.

The modular generator set controller and protection equipment shall be mounted on a separate easily replaceable panel.

All equipment on the switchboard, such as contactors, isolators, busbars, etc., shall have ample current carrying capacity to handle at least 110% of the alternator full load current.

Access to the cubicle will be such that all components can be conveniently reached for testing and maintenance purposes.

The necessary bushes and a screen over the terminals will be provided where the power feeds enter and leave the cubicle.

The cubicle will be so constructed that the ac and dc components are screened from one another.

2.3.3. Protection and Alarm Devices

All switchboards 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.

Reset push buttons are required on the modular generator set controller and a visible signal are required and the engine must stop 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 indication on the modular generator set controller must be in ENGLISH.

"OVERLOAD"

"TEMPERATURE HIGH"



"OIL PRESSURE LOW"

"OVERSPEED"

"START FAILURE"

"LOW WATER LEVEL"

In addition, an audible and visible flashing signal shall be provided, when:

- a) The fuel level in the service tank is low. The indication on the modular generator set controller shall be "FUEL LOW".
- b) The battery charger failed. The indication on the modular generator set controller shall be "CHARGER FAIL"

A low-low level sensor must be provided. At this level the engine must stop to prevent air entering the fuel system.

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

All alarm conditions 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.

2.3.4. Modular Generator Set controller

The modular generator set controller shall be an electronic unit to match those of the other modular generator set controllers and of a high quality i.e., Levato, Deep Sea Electronics, Circom. It must be provided with IO and communication facilities.

The modular generator set controller will be supplied with all its functions and shall be mounted on a separate easily replaceable panel with plug in termination blocks for easy installation and replacement.

The modular generator set controller interface will be implemented with relays,



contactors etc.

The modular generator set controller will have a mimic display of the alternator/mains/ change over contactors configuration with LED's showing the status of the mains, alternator and change over contractors.

Configuration software shall be supplied with the system. The software will be capable of the following:

- Fault management (event log)
- Configuration management (software upgrades and function changes)
- Account management (energy management)
- Performance management (generator set point changes)
- Security management (passwords)

The modular generator set controller will have a standard RS 232/485 or Ethernet interface suitable for TCP I/P transport medium. All communication including configuration management will be done through this port.

Equipment connected at each end of the RS 232 or Ethernet cable shall be adequately protected against transient over-voltages, lightning effects (particularly if the set and remote alarms are in separate buildings), switching surges, power system surges or mains and alternator borne noise/interference.

The controller will incorporate the following functions:

- Mains sensing
- Alternator output-voltage sensing
- Alternator over- frequency sensing
- Control of processor unit (self-diagnostics)
- Alarm/ Status indications
- Control selector and operation
- Phase rotation monitor

A 4- position control selector on the controller will be provided to facilitate the following modes of operation:

- OFF: Diesel/ alternator generator set switched off
- MANUAL: Mains bypassed: Diesel/ alternator will not take load
- AUTO: Diesel /alternator takes load on mains failure
- TEST: Diesel /alternator takes load on mains failure
- A standby failure alarm (SF) will be given on the controller and to the output alarms when "Not in Auto" is selected.

The modular generator set controller must monitor the following:



When the voltage of the incoming mains varies by more than a pre-program value (default $\pm 10\%$) from the normal voltage on any phase, the controller will signal that the incoming mains will be disconnected, and the engine-starting sequence initiated.

When the frequency of the incoming mains varies by more than pre-program value (default $\pm 5\%$) from the normal frequency, the controller will signal that the incoming mains will be disconnected, and the engine-starting sequence initiated.

Upon restoration of the incoming mains to the pre-program value (default $\pm 10\%$) of the normal voltage on all phases, the monitor will signal that the load will be disconnected from the alternator and reconnected to the incoming mains.

If the alternator has been disconnected from the load and the incoming mains within the voltage limits of $\pm 10\%$ on all phases, the controller will signal that the load will be reconnected to the incoming mains.

Should the incoming mains fail or not in the specified limits while the engine is running under control of the cooling-off timer, the control for the cooling –off timer in the controller will be cancelled and the load connected to the alternator.

When the output voltage of the alternator varies by more than the pre-program value (default value $\pm 10\%$) on ANY phase, the controller will signal that the load will be disconnected from the alternator and the engine stopped.

A software over and under-frequency monitor will be provided in the controller if the frequency exceeds or drop below pre-programmed values. It will meet the requirements of class G2 governing. The monitor will not be influenced by harmonics.

Note: Software monitors will include adjustable overshoot and undershoot timers to be fully compatible with Class G2 governing.

All timers will be implemented in software.

Incoming supply failure timer

It is essential that incoming supply failures, occurring at short intervals, do not cause a series of starts and stops.

A timer adjustable from 1 s to 10 s required

The timer default value will be generator set to 3 s

The signal generated by the mains voltage monitor will start the timer. If the duration of the signal is less than the generator setting on the timer, the signal is suppressed to that

the switching and starting sequence is initiated. However, if the duration of the signal is more than the generator setting on the timer, the signal will be transmitted to initiate the switching and starting sequence.

Incoming supply restoration timer

It is essential that incoming supply failures, occurring at short intervals, do not cause a series of starts and stops.

A timer adjustable from 1 s to 10 s required.

The timer default value will be generator set to 3 s.

The signal generated by the mains voltage monitor will start the timer. If the duration of the signal is less than 150 sec, the signal is suppressed, and the timer is regenerator set. However, if the duration of the signal is more than 150 sec, the signal will be transmitted to initiate the switching sequence.

Alternator supply/ incoming supply change-over timer

It is essential that the supply be disconnected from the load before the incoming supply is reconnected to the load. This will be software generator settable in the controller with a minimum of 5 seconds and maximum of 20 seconds.

On receipt of the switching signal, the alternator supply will be disconnected from the load and timer started. After 5 sec, the incoming supply will be reconnected to the load.

Engine cooling-off timer

After the load has been transferred to the incoming supply the engine will run without load for a period to cool off and then stop.

A timer, software adjustable in the controller from 5 to 10 min is required.

Repeat- start control

A repeat- start control is required in the controller software adjustable so that in the event of the engine falling to start on the first start attempt, the starter motor will be released and repeat the start attempt.

The repeat-start attempt will be repeated 3 times.

The duration of each start attempt will be 6 sec with a period of 15 sec between successive start attempts. Should the engine fail to start after the third start attempt, the controller will transmit a signal for alarm purposes.

In addition to the requirement for the switchboard instruments listed elsewhere in this document metering will also form part of the modular generator set controller and must be accessible on the software.

The modular generator set controller shall display the following alarm/status indications:

- High engine temperature.
- Low Oil pressure
- High/low alternator output voltage
- Over and under speed (frequency)
- Low water level
- Emergency stop activated
- Mains fail
- Battery charger fail
- Dummy load in operation (When provided)
- Unit not in Auto
- Engine running
- Low fuel alarm
- Engine start failure

Conditions one to six above will stop the engine.

The Contractor shall provide a remote alarm mimic panel and the associated control wiring for the set. The panel shall be installed in the duty/security room at the entrance to the building approximately 70m from the generator set position.

The mimic panels must fit into furniture and blend with the design. Before manufacture, the Contractor shall submit and obtain the approval, from the Engineer, for the mimic panel.

The remote alarm must have potential free relay contacts which shall indicate the following on each set:

- 1) Mains on/off
- 2) Alternator running
- 3) Common fault alarm
- 4) Buzzer which can only be reset at the generator panel
- 5) Fuel low

The cable between the remote alarms is to be a signal cable with a screen and this option must be able to operate from a 12 / 24 V dc supply so that it can be powered from the generator set batteries.

A facility to originate a fault message should a warning or shutdown fault occur.



A facility to allow the mode of the control system to be changed to any of the four modes to allow the set to be run from a remote location.

A facility to originate a call to the control cellular and to transfer a fault message should a warning or shutdown fault occur. The alarm conditions above from the controller will be extended to four relays with a make and break contact and terminal strip to allow for remote monitoring of the following alarms:

- Mains fail
- Standby run
- Standby fail
- Low Fuel

A remote start facility must be supplied, software controllable in the controller.

All events relating to the status of the generator set shall be logged with date and time in a non-volatile memory (which can retain information for a period of 6 months in the absence of power to the controller) and the user shall be able to contain a hard copy on site.

The modular generator set controller system must be able to operate with a minimum DC supply voltage of 4 volts (without making use of either an internal or an external auxiliary battery) to allow cranking and starting under conditions of low battery capacity. Control cables between the set and the control panel shall be fitted with sockets for ease of undoing in the event the modular generator set controller has to be removed.

2.3.5. Manual Starting

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

2.3.6. Battery Charging 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 provided for charging the battery while the set is operational. Failure of this alternator must also activate the battery charger failure circuit.

The starter battery voltage will be software monitored by the modular generator set controller. The voltage will be digitally displayed.

2.3.7. 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 generators. In this case a six position and off selector switch must be installed for reading all phase and phase to neutral voltages.
- b) 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. This instrument shall be supplied complete with the necessary current transformer.
- c) One flush square dial vibrating type frequency meter, indicating the alternator frequency.
- d) A six-digit running hour meter with digital counter, reading the number of hours the plant has been operating. The smallest figure on this meter must read 1/10 hour.
- e) Fuses or m.c.b.'s for the potential voltage circuits of the meters.
- f) One flush square dial ampere meter suitably scaled for the battery charging current.
- g) One flush square dial voltmeter with a spring-loaded pushbutton or switch for the battery voltage.

2.3.8. Marking

All labels, markings or instructions on the switchgear shall be in English.

2.3.9. 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.

2.3.10. Operation Selector Switch

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

2.3.11. Automatic Change-over System

A fully automatic change-over 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.

The contactors for this system must be electrically and mechanically interlocked.

2.3.12. 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 4 pole 4 position by-pass switch, which shall switch the connected loads as follows:

NORMAL: will allow for the normal connection i.e., connects the incoming mains to the Automatic control gear or directly to the outgoing feeder.

In the GEN BY-PASS position the switch will disconnect the automatic changeover control gear and will connect the municipal mains directly the essential supply busbar which will allow for the maintenance of either or both the generator and the automatic changeover equipment.

MAINS BY-PASS switching position would allow the generator to be connected directly to the essential supply busbar. This is when there is a problem with the automatic changeover equipment and there is no municipal power available.

The final position is an OFF position which will remove all power downstream of this switch.

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 are operated from the front of the compartment.

Contractor to note: The by-pass and mains isolator switch shall also break the main neutral.

2.3.13. 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.

2.3.14. 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.

2.4. Installation

Except for the supply of the incoming mains cable and outgoing feeder cables, the tenderer must include for the complete installation and wiring of the plant in running order, including the connection of the incoming cable and outgoing feeder cables.

The connecting of the cable and control cabling to the generator and the control terminals in the LV board remains the responsibility of the tenderer.

2.5. Warning Notices

Notices, in English, must be installed on the outside of the steel enclosure.

The successful tenderer must consult the Occupational Health and Safety Act 83 of 1993 and get approval of the wording from the CEF's representative, prior to ordering the notices.

The notice 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.

An engraved label shall be installed next to the fuel cap that indicates the following:

Base Tank Capacity

Bulk Tank Capacity (if provided)

Full load litres per hour consumption



2.6. 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 placed inside an IP65 canopy/container. A drip tray must be fitted under the engine. The tray must be large enough to catch a drip from any part of the engine.

The frame must be of the 'DUPLEX' type.

2.7. 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 shall be supplied and fitted to the changeover switchboard.

3. SECTION 3 – TECHNICAL SPECIFICATION

3.1. General

Supply, deliver, install, commission, test and maintain an emergency generating set at the CEF, Sandton (Upper Grayston Office Park, 152 Ann Crescent Strathavon, Sandton).

This installation must comply fully with all the sections and drawings of this document. This technical specification is supplementary to the Equipment Requirements, Section 2, and must be read together where they are at variance the Technical Specification shall apply.

Supply, delivery, installation, and commissioning of the complete outdoor emergency generator set inside an IP65 canopy/container on a concrete plinth as specified in this document and indicated on the drawings.

Concrete plinth to be provided as per drawing 12865EE-DL01 if current plinth proved to

be inadequate.

The surface of the concrete plinth shall be 50mm higher than the existing ground level. The thickness and strength of the plinth shall be designed by the consulting engineer and are detailed on the drawings.

A tap to be provided to drain all the water that accumulates inside the bund wall. Final position of the tap will be determined on site. It is the engineer's responsibility to ensure plinth design complies with generator dimensions and weights. The bund wall shall contain 110% of the fuel, oil and water capacity of the generator. The bund wall shall not constrain the canopy doors from opening completely.

The contractor shall install an earthing system in the concrete plinth. The contractor shall install two (2) earth studs 1.8 meters long on opposite corners of the concrete plinth into the ground. The earth studs shall be connected by means of a 70mm² bare copper earth wire to the main earth bar in the control panel. The earth conductor shall be connected to the earth bar, canopy, base, skid and earth bar by means of suitably crimping lugs and brass bolts.

3.2. Site Information and Conditions

The site is at Sandton (Upper Grayston Office Park, 152 Ann Crescent Strathavon, Sandton).

3.2.1. Site Conditions

The following site conditions will be applicable, and equipment shall be suitably rated to develop their assigned rating and duty at these conditions.

- a) Height above sea level: 1567Meter
- b) Maximum ambient temperature: 28 °C
- c) Maximum ambient humidity at lowest temperature: 32 %

3.2. Output and Voltage

After the de-rating factors for the engine and generator due to site conditions have been taken into account, the set must have a site output and voltage as follows: -

No load voltage: 400/230 Volt

Rating (Prime Power): 250kVA Power at 0.8 power factor:

200kW Frequency: 50Hz

Fault Level: 5kA

The generating set is required to feed the following electrical load:



	Load KW	Power factor
Central Energy Fund (CEF): Main Building C	233kVA	0.8

3.3. Switchboard/Control Panel Unit

All switch- and control gear shall be rated for a fault current level of 5kA.

The switchboard/control panel unit shall be enclosed in the IP65 canopy/container.

3.4. Cables

The contractor will be responsible for all electrical cable connections associated with the complete generating set installation.

The following cables will be supplied, installed and terminated at the Main LV Distribution Board. Adequate provision shall be made for the termination of these cables at the Main LV Distribution Board:

Main LV Distribution Board	PVC SWA PVC Cu Cable	2 x 70mm ² 4Core Cu
----------------------------	----------------------	--------------------------------

3.5. Engine

A sump drainpipe must be fitted with a shut-off valve placed in a convenient position outside the base frame to facilitate drainage.

Recommended oil types must be indicated on the engine, or base frames, by means of suitable labels.

All engine instruments shall have clear markings on the faceplates, indicating the normal operating zone(s), maximum and minimum allowable values/limits and danger zone(s).

The flywheel shall be covered by approved hoods.

3.6. Alternator

The Alternator shall be of the low harmonic type.

3.7. Load Acceptance

The generator set shall be capable of accepting 75% of the specified site electrical output 10 seconds after the starter motor is energized and the remaining 25%, 5 seconds thereafter, i.e., 100% load acceptance shall not exceed 15 seconds.

3.8. Enclosure



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

3.8.1 General

The enclosure, shall be completely vermin-proof, powder coated and shall be constructed of 3CR12 stainless steel or within 50km from the coast with grade 316 steel housing 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 3CR12 stainless steel or within 50km from the coast with grade 316 steel 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.

3.8.2 Design

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

3.8.3 Roof

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

3.8.4 Lamp fitting

A lamp fitting and its 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.

3.8.5 Soundproofing

The soundproofing on canopy engine sets shall be such that the maximum noise level generated by the set under any load condition shall not exceed 65 dB measured in any direction at a distance of 5m from the centre of the set with the doors closed.

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

3.8.6 Padlock and keys

The contractor shall supply padlocks and keys for all the doors of the enclosure. The padlock shall be of 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.

3.9. Alarms

The successful tenderer must pay particular attention to the requirements of the alarms as described in the Equipment Requirements, Section 2.

One alarm hooter and red light shall be supplied and installed on the outside of the generator container in a position as indicated by the CEF's Representative.

The hooter shall consist of an electronic unit similar and equal to a "Klaxon" - type SY2/725 hooter with a continuously rated output and 110 dB at a distance of 2 metres and shall be IP55 weatherproof rated.

The warning light shall consist of a 40W flashing red light, which shall be mounted on a galvanized steel frame together with the hooter.

The hooter and light shall be switched on or off simultaneously after initiation or cancellation of an alarm condition. The supply and installation of the wiring between the control board and the alarm unit forms part of this contract.

The successful tenderer must ensure that the hooter control circuit resets automatically after cancellation due to a low fuel condition or battery charger failure, but the visible fault indication must remain, i.e., should the operator continue to run the set, the hooter must sound, should any other condition develop.

A remote alarm panel shall be supplied and installed by the contractor in the control room. This shall be of surface mounting, enamelled sheet metal (colour to approval), minimum depth construction, and shall incorporate a flashing red pilot alarm light, adjustable electronic sounder, and a silence push button. The silence button shall not switch off the pilot light - this shall only be switched off when the alarm is reset at the Generator Panel.

A 2,5mm² x 4-core PVC SWA PVC cable will be supplied, installed and terminated by others between the Generator Panel and the Charge Office. The Contractor shall connect this cable at both ends and shall supply and install all switch gear relays, etc. to ensure satisfactory operation of the Remote Alarm Panel.

3.10. Remote Control Generator Switch

A Remote-Control Generator "ON/OFF/AUTO" switch will be supplied and installed by others in the control room, and a 2,5mm² x 4-core PVC SWA PVC cable will be supplied and installed by others between the control room and the Generator Panel.

The contractor shall connect this cable at both ends, and shall supply and install all switch gear, relays, etc. to ensure satisfactory operation of the remote-control switch.

3.11. Fuel Drip Tray

A drip tray approximately 100mm deep shall be mounted below the generator and must be large enough to collect any fuel that drips from the generator fuel accessories. The drip tray shall be manufactured from black mild steel. The thickness of the drip tray sheet steel shall not be less than 2mm.

3.12. Completion Time

The Generator Set is required to be commissioned in conjunction with the building contract.

3.13. Inform

The successful tenderer shall inform the Engineer when the set is ready for installation.

3.14. Fuel Supply Tank

The fuel tank shall be an integral part of the base frame of the generator set. The tank shall have sufficient capacity to run the engine on full load for a period of 24 hours. The base tank shall be an open channel self-bund walled type that shall be of sufficient capacity to contain a spillage equivalent to 110% in volume of the base tank. The

containment tank shall be manufactured from black mild steel with a thickness of not less than 2mm.

A float level alarm connected to the generator controller shall be incorporated into the bund area located such that the alarm will be activated when 50% of the volume of the bund area has been reached in the event of any diesel fuel leakage.

4. SECTION 4 – SCHEDULES OF TECHNICAL INFORMATION

4.1. Engine

NO	ITEM	TENDERER'S REMARKS
1.	Manufacturer's Name	
2.	Country of Origin	
3.	Manufacturer's model No. and year of	
4.	Continuous sea level rating after allowing for ancillary equipment : a) In b.h.p. b) In kW	
5.	Percentage de-rating for site conditions, in accordance with SANS 8528 a) For altitude b) For temperature c) For humidity d) Total de-rating	
6.	Net output on site in kW	
7.	Nominal speed in r.p.m.	
8.	Number of cylinders	
9.	Strokes per working cycle	
10.	Stroke in mm	
11.	Cylinder bore in mm	
12.	Swept volume in cm ³	
13.	Mean piston speed in m/min	
14.	Compression ratio	

15.	Cyclic irregularity	
16.	Fuel consumption of the complete generating set on site in l/h of alternator output at: Full load $\frac{3}{4}$ load $\frac{1}{2}$ load NOTE : A tolerance of 5% shall be allowed above the stated	

4.2. Alternator

NO	ITEM	REMARKS
1.	Maker's name and model no.	
2.	Country of Origin and year of manufacture	
3.	Type of enclosure	
4.	Nominal speed in r.p.m.	
5.	Number of bearings	
6.	Terminal voltage	
7.	Sea level rating kVA at 0,9 power factor	
8.	De-rating for site conditions	
9.	Input required in kW	
10.	Method of excitation	
11.	Efficiency at 0,9 power factor and: a) Full load b) $\frac{3}{4}$ load c) $\frac{1}{2}$ load	
12.	Maximum permanent voltage variation in %	
13.	Transient voltage dip on full load	
14.	Voltage recovery on full load application in milli- seconds	
15.	Is alternator brushless?	
16.	Class of insulation of windings	
17.	Is alternator tropicalised?	

18.	Symmetrical short circuit current at terminals n Ampere	
19.	Type of Coupling	

4.3. Switchboard

NO	ITEM	REMARKS
1.	Maker's Name	
2.	Country of Origin	
3.	Is board floor mounted?	
4.	Finish of board	
5.	Make of volt, amp, and frequency meters	
6.	Dial size of meters in mm	
7.	Scale range of voltmeter	
8.	Scale range of ammeters	
9.	Ratio of current transformers	
10.	Make of hour meter	
11.	Range of cyclometer counter	
12.	Smallest unit shown on counter (Item 11)	
13.	Make of circuit breaker	
14.	Type of circuit breaker	
15.	Rating of circuit breaker in Amp and fault	
16.	Setting range of overload trips	
17.	Setting range of instantaneous trips	
18.	Make of change-over equipment	
19.	Make of voltage relay	
20.	Is control and protection equipment	
21.	Type of control equipment	
22.	Make of mains isolator	
23.	Type of indicators for protective devices	
24.	Make of rectifier	
25.	Type of rectifier	
26.	Is battery charging	
27.	Are volt- and ammeters provided for	

28.	Is the alarm hooter of the continuous duty	
29.	Rating in Amps of:	
30.	Is manufacture of switchboard/control	
31.	If yes, state name and address of specialist	

4.4. Battery

NO	ITEM	REMARKS
1.	Maker's Name	
2.	Country of Origin	
3.	Type of battery	
4.	Voltage of battery	
5.	Number of cells	
6.	Capacity in cold crank amp	

4.5. Dimensions

NO	ITEM	REMARKS
1.	Overall dimensions of set-in mm	
2.	Overall mass	
3.	Is the canopy/container adequate for the installation of the set, switch board and fuel tank	

4.6. Deviation from the Specification as an Alternative (State Briefly)

NO	DESCRIPTION

4.7. Spare Parts and Maintenance Facilities

NO	ITEM	REMARKS
----	------	---------

1	Approximate value of spares carried in stock for this particular diesel engine and alternator	
2	Where are these spares held in stock	
3	What facilities exist for the servicing of the equipment offered	
4	Where are these facilities available	

PART B: STANDARD SPECIFICATION FOR CABLES AND ACCESSORIES

5. SECTION 5 – CABLES AND ACCESSORIES

5.1. GENERAL

- 5.1.1. The cables shall have the number of cores at the cross-sectional areas as specified in the Schedule of Cables. Only cables with high conductivity annealed copper conductors, and shaped or circular cores, shall be accepted.
- 5.1.2. Cables shall be new, of the best quality and free from any defects.
- 5.1.3. Cables must be adequate for continuous use under the site conditions. Cables shall normally have double steel tape or single wire armouring unless otherwise specified in the Project Specification.
- 5.1.4. The installation work shall be carried out strictly in accordance with the Municipal by laws and other special requirements of the local supply authorities, as well as the relevant SANS, BS and IEC Specifications.

5.2. PAPER INSULATED CABLES

- 5.2.1. Impregnated paper insulated lead sheath cables shall be manufactured according to SANS 97 (as amended) and shall bear the SANS mark.
- 5.2.2. The conductor insulation shall consist of impregnated paper tapes, either pre-impregnated or mass- impregnated with a non-drawing compound.
- 5.2.3. The bedding shall consist of a bitumen impregnated fibrous tape.
- 5.2.4. The sheath shall be lead or lead alloy.
- 5.2.5. Armouring shall be either double steel tape or galvanized steel wire.
- 5.2.6. The outer sheath shall be black extruded, graphite coated PVC, unless otherwise specified in the Project Specification, clearly and indelibly marked "ELECTRIC CABLE 11000V" (or the applicable voltage) to SANS and IEC Specifications.
- 5.2.7. The cable insulation shall be suitable for the specified supply voltage and the cable must be suitable for a system with an unearthed neutral.

5.3. LOW VOLTAGE PVC INSULATED CABLES

- 5.3.1. 600/1000V PVC SWA PVC sheathed cables shall comply with SANS 1507 and bear the SANS mark.
- 5.3.2. Cables shall have stranded copper annealed conductors. The cores shall be twisted together, bedded, sheathed with PVC (black), armoured with a layer of galvanized steel wire and again sheathed with PVC (black).

5.4. HIGH TENSION (ABOVE 1 000V)

- 5.4.1. Paper insulated PILC, SANS 97 Table 18 or 17 upon Engineers approval.
- 5.4.2. Only cables wearing the SANS mark will be acceptable.
- 5.4.3. Cables for the different applications are described elsewhere in this Document.
- 5.4.4. Unless specifically called for in the Project Specification only cables and wires with stranded copper conductors shall be used.
- 5.4.5. All Cables shall be 3-core Copper PILC accompanied by a half size earth conductor strapped onto the main supply cable.

5.5. CABLE DRUMS

- 5.5.1. Cable drums shall be manufactured from dry wood and lagged with strong, closely fitted battens to prevent damage to cables. They shall be capable of taking round spindles and shall be equipped with steel spindle bearing plates of at least 90mm inner diameter. Maximum drum width shall be 1100mm and diameter 3000mm.
- 5.5.2. Steel cable drums may be used if preferred by the cable manufacturer.
- 5.5.3. Both ends of all cables shall be sealed with a PVC cover to prevent penetration of moisture.
- 5.5.4. Cable drums shall be secured in such a way during transport that they will not roll and cause damage to the cables.
- 5.5.5. Special care shall be taken when cable drums are unloaded on site. Drums must always be rolled in the direction of the arrow on the side. It is not recommended to install cables when the ambient temperature is below 10 degrees C or has been for some time. The following particulars shall appear on both sides of each drum:
- 5.5.6. Manufacturer's name, Voltage, Actual length, Conductor size, Number of cores, Gross and Nett mass, Direction of rotation and Drum number.
- 5.5.7. Such cables shall be replaced by the Contractor at his own expense.

5.6. JOINTS AND TERMINATIONS

- 5.6.1. Only proven, custom made jointing and terminating materials such as HENLY MIRP-P1, 15 kV, and moulded resin projected straight joints, approved by both the Engineer and the cable manufacturer shall be permitted.
- 5.6.2. Cable Joints and terminations shall be carried out by a qualified cable jointer using only approved standard methods for the particular cable. Proof of training will be required.
- 5.6.3. Materials shall be suitable for in or outdoor use where applicable. Within 14 days of the awarding of the contract, the Contractor shall submit copies of the instructions, and drawings by the manufacturer, to the Engineer for approval. HT cables shall be terminated in suitable end boxes and LT cables by means of glands and suitably sized lugs crimped onto conductor ends. All cables shall be secured with either K and U clamps or suitable clamps cable where needed.
- 5.6.4. Corresponding cores (colour codes or numbers) shall be followed through, and phase rotation maintained. Cores shall be joined through by means of crimping ferrules. Insulation and continuity tests shall be done prior to and after jointing of cables.
- 5.6.5. Joints in cables shall be avoided as far as possible. Cable joints shall normally be limited to cases where the whole length from a full drum of cable will be insufficient to complete a cable run. In all other cases approval for the installation of cable joints shall be obtained from the Engineer.
- 5.6.6. Where cable joints have to be made in trenches, suitable measures shall be taken to prevent moving of the cable and/or joint, thus obviating stresses in the joint. Indication of such a joint shall be put on the surface.
- 5.6.7. Connections shall be made by means of crimped lugs, firmly bolted, one plain and one lock washer are against the lug. Crimped Lugs up to 70mm² shall be fitted using manual crimpers and hydraulic tools from this size upwards (Calibration Certificates may be required).
- 5.6.8. Suitable measures shall be taken by the Contractor to prevent foreign matter, such as water from entering the cable.

5.7. CABLE TRENCHES

- 5.7.1. The excavation, bedding, backfilling, danger tape, consolidating and making good of all cable trenches shall be the responsibility of the Contractor unless otherwise specified in the Project Specification. All trenches shall follow normal building layout or pre-defined for the project

- 5.7.2. The bottoms and sides of all cable trenches shall be smooth and free from protrusions likely to damage the cable and unless specified otherwise elsewhere shall follow the normal ground contour. HT and LT cables shall be installed at least 1000mm and 600mm below final ground level respectively.
- 5.7.3. An even layer of river sand or similar approved material at least 80mm thick shall be provided at the bottom of the trench prior to the laying of the cables. A further layer of sand shall be installed over the cables such that the top part of the cables is covered to a depth of at least 80mm.
- 5.7.4. No cable shall be laid, or trenches backfilled before the bedding layer, cable/s in the trench and top layer have been inspected and approved by the Engineer or the client's representative.
- 5.7.5. Special Drawings and/or Schedules shall be handed to the Contractor, and he shall obtain a signature of approval for each of the three phases from the Engineer or the client's representative. Failure to comply with the above will lead to the rejection of the cables.
- 5.7.6. The spacing between cables shall be as follows:
- Between two HT cables - 300mm
 - Between two LT cables - 150mm
 - Between LT, street lighting and service cables - 50mm
- 5.7.7. When called for in the Project Specification, reinforced concrete slabs shall be placed 250mm above any cable. The dimensions of these slabs are: 1000mm long x 300mm wide x 50mm thick.
- 5.7.8. Prior to backfilling, all large rocks and similar sharp objects and foreign matter, such as bottles, tins, pieces of paper, etc. shall be removed from the backfilling material.
- 5.7.9. Backfilling shall be done in layers and each layer shall be thoroughly compacted. Subsidence which may occur with time shall be repaired to the satisfaction of the Engineer. Special surfaces such as paving, broken or damaged during the installation, shall be repaired by the Contractor. The cost of such repairs shall be deemed as being included in the Tender price and no additional payment shall be due to the Contractor for such repair work.
- 5.7.10. Water shall not be allowed to accumulate in the trenches. The Electrical Contractor will therefore ensure that no cable is laid until the trenches are free from water. Any side channels, sumps or temporary excavations for dewatering purposes shall be filled in after use. The cost of such measures shall be deemed as being included in the Tender price and no additional payment shall be due to the Contractor for dewatering of trenches.

5.7.5. The following definitions will be applicable to excavations:-

- **Pick able soil:**
Soil that can be removed with a hand- pick and shovel, including loose gravel, clay, fillings, loose of soft shale and small rocks.
- **Soft rock:**
Rock that can be removed with jack hammers or other mechanical means, such as granite, quartzite sandstone, slate and rock of similar or greater hardness.
- **Hard rock:**
Rock that can only be excavated with the aid of explosives.

5.8. INSTALLATION OF CABLES

- 5.8.1. Suitable measures shall be taken to prevent damage to the cable.
- 5.8.2. Proper hoists, rollers, drum lifters, trestles, etc.; together with sufficient manual labour shall be available when cables are installed.
- 5.8.3. Cable installations shall be done under the continuous supervision of a suitably qualified person. The contractor shall not be permitted to pull any cable into and along a trench with a power-driven vehicle. Cables installed in this manner shall be classified as scrap and shall be rejected by the Engineer.
- 5.8.4. Care shall be taken in handling Drums of cable, cable drums shall not be dropped or rolled unchecked. A cable drum may only be rolled in the direction the arrow indicates.
- 5.8.5. In running a cable off a drum, it shall be securely mounted to rotate freely.
- 5.8.6. Should a cable or drum be damaged or punctured in any way it must be reported to the engineer immediately.
- 5.8.7. Danger tape shall be installed with all cable for the full length of the cable at least 300mm below surface

5.9. BENDING RADII

- 5.9.1. Although cables have certain flexibility, bending and/or straightening should always be done slowly and carefully.
- 5.9.2. The following minimum bending radii shall always be exceeded:
 - 5.9.3.1 Paper insulated cables
 - Single core Cables 20d (up to and including 11kV) 25d (22kV)
 - Multi core Cables 12d (up to and including 11kV) 15d (22kV)

Where d is the overall diameter of the cable.

- 5.9.3.2. XLPE Cables
- Unsheathed Cables 4d
 - Sheathed but unarmoured Cables 8d
 - Armoured Cables 10d

Where d is the overall diameter of the cable.

- 5.9.3.3 600/1000V PVC SWA PVC Cables
- Single core 20d
 - Multi core 12d

Where d is the overall diameter of the cable.

5.10. CABLE SLEEVES

- 5.10.1 The Electrical Contractor shall supply and install asbestos cement or earthenware sleeves in the positions as indicated on the Drawings, except if specified otherwise in the Project Specification. This applies to road crossings, entries into buildings, substations, etc. At road crossings, sleeves shall extend at least 1000mm beyond the road edge or kerb on both sides of the road.
- 5.10.2 Sleeves shall be nominal 100mm diameter unless otherwise specified. Each sleeve shall be provided with a draw wire.
- 5.10.3 Sleeves shall be installed in accordance with SABC 1200(LC) at a depth of 900mm a straight line, without obstructions or protrusions that might damage the cables. Sleeve shall be laid on a 100mm compacted layer of selected bedding material or sand bedding.
- 5.10.4 The radius of the bends shall not be less than six times the diameter of the sleeve and the sleeve not less than double the size of the cable diameter.
- 5.10.5 All sleeves for telecommunication shall be 110mm or Project specified and lay at a depth of 800mm and not less than 300mm above a power cable. One end must be marked Telecommunication.
- 5.10.6 The sleeve end inside the building shall be at a higher level than the end outside the building and sleeve ends shall be sealed with an approved

sealant to prevent the ingress of water.

- 5.10.7 Only one cable shall be installed per sleeve, unless otherwise specified in the Project Specification. A maximum of 4 service cables and/or street lighting cables shall be installed per sleeve. Unless specified otherwise in the Project Specification sleeves shall have a diameter of at least 110mm.

5.11. CROSSINGS

5.11.1 GENERAL

Cable routes may from time-to-time cross other services including water, sewerage, post office, etc.

5.11.2 ROADS

Where sleeves are installed at road crossings, it will be done in two stages to ensure that a part the road is always open for traffic. The repair of the road shall be off the same quality as the road were. The Contractor shall allow in his price for all road and caution signs and the liaising and coordinating with the authorities. Crossings shall be carried out in accordance with the requirements of the Local Authorities, Provincial Roads Department or the Department of Transport.

Excavations for road crossings shall be deep enough for the top of the sleeves to be 1200 mm below the lowest surface of the road. Special care shall be taken with consolidation to ensure that no subsidence will occur. Three additional sleeves shall be installed with each road crossing. Manhole access to be project specific.

5.11.3 SEWERAGE AND STORM WATER

Sewerage and storm water pipes will normally be installed so deep that the cables will cross above them. A length of half sleeve shall be installed over the cable at such crossings.

5.11.4 WATER PIPES

Water pipes will normally be installed at a depth of approx. 1000 mm. Cables shall be installed at least 200 mm below the water pipes, with a length of half sleeve directly on top of the bedding layer to protect the cable.

5.11.5 TELEPHONE CABLES OR SLEEVES

Telephone cables or sleeves will normally be installed at a depth between 750 to 1000 mm. The same procedure shall be followed as for water pipes (Refer to

previous paragraph).

5.11.6 IN RESIDENTIAL STANDS

Cables shall be installed on a depth of 1000 mm and as close as possible to the stand boundary. Reinforced concrete slabs shall be installed 250 mm above the cables and the cable warning tape 300 mm above the cables.

Please note:

Tenderers preferring to use reinforced concrete slabs instead of half sleeves can do so, but they are obliged to indicate it at the time of tendering, as an alternative. Rates for slabs shall also be quoted.

5.12. MARKING OF CABLE ROUTES AND CABLES

- 5.12.1 All cables shall be labelled with approved labels manufactured from lead or other non-deteriorating material. These labels shall contain the cable number as indicated in the Cable Schedules. Labels shall be affixed in an approved manner at both cable ends, as well as along the length of the cables at intervals not exceeding 10m (trenches or cable ducts) or 5m (cable racks).
- 5.12.2 A suitable and approved orange coloured PVC tape indelibly marked "HIGH TENSION CABLE" shall be buried in the cable trenches, 300mm above cables. The tape shall be at least 300mm wide.
- 5.12.3 Suitable and approved cable route markers shall be installed along all cable routes. These cable markers shall be installed at intervals of at least 100m along straight runs at each change of direction in the cable route and immediately above each cable joint.
- 5.12.4 The cable markers shall be constructed of reinforced concrete with the following dimensions: Height - 500mm, top surface - 200 x 200mm and bottom surface 300 x 300mm.
- 5.12.5 A 2,5mm thick lead, copper or aluminium plate with fixings shall be cast into the top surface of the block. The codes, to be punched onto the plate in 5mm lettering, shall be given to the Contractor at a later stage. The top of the route marker shall be painted red once the lettering is completed.

5.13. SITE TESTS

5.13.1 Prior to joints or terminations

The following tests shall be performed on paper insulated cables before they are

made off or joined:

- 5.13.1.1 Continuity and earth resistance tests shall be performed on each section of each cable by means of a Mugger (5000V for 11kV and 500V for 600/1000V).
- 5.13.1.2 Crackle tests shall be carried out on samples of the paper from both ends of the cables. Should moisture be present, the cables shall be cut back, until satisfactory results are obtained.

5.13.2 Prior to connecting to equipment

Once the cable ends have been made off and all joints have been completed, but before connecting to equipment, the following tests shall be carried out to ensure continuity and check the insulation between the three phases and phases and earth:

- 5.13.2.1 Paper insulated
- 5.13.2.2 Insulation tests
- 5.13.3 The following test voltages (either AC or DC) shall be applied and maintained for 15 minutes between conductors and between each conductor and the metal sheath, which should be kept at earth potential.

1	2	3	4	5	6	7
Rated voltage of cable	Test voltage, Volts (r.m.s.)					
	Belted cables				Single core and screened cables	
	Between conductors		Between any conductor and sheath		Between any conductor and sheath or screen (as relevant)	
Cables for earthed systems						
	AC	DC	AC	DC	AC	DC
1 000	2 000	3 000	2 000	3 000	2 000	3 000
3 000	6 000	9 000	3 500	5 000	3 500	5 000
6 600	12 000	18 000	7 000	10 500	7 000	10 500
11 000	20 000	30 000	11 500	17 500	12 000	18 000
22 000	40 000	60 000	23 000	35 000	25 000	37 500

Cables for unearthed systems						
3 000	6 000	9 000	6 000	9 000	6 000	9 000
6 600	12 000	18 000	12 000	18 000	12 000	18 000
11 000	20 000	30 000	20 000	30 000	20 000	30 000

5.14. SERVING TESTS

5.14.1 The following test voltages (DC) shall be applied and maintained for 1 minute between the armouring and earth:

5.14.2 Standard PVC sheath - 4kV, Graphite coated PVC sheath - 10kV

5.14.3 PVC Insulated Cables:

5.14.4 A 2 000V merger shall be used to test the insulation between phases and phases and earth.

5.14.5 Tenderers must allow in their Tender prices for the provision of all test equipment, instruments and the supply of power for these tests. Copies of the test certificates shall be handed to the engineer.

5.14.6 Should any cable break down during these tests, it shall be replaced and/or the cable end or joint shall be redone.

5.14.7 The cost for such an action shall be for the account of the Contractor.

5.15 AS INSTALLED DRAWINGS

5.15.1 The following information shall be indicated on the "as installed drawings":

- The length of each run of the cable route, the lengths between joints, the position of each joint relative to a permanent reference points the cable drum number of each length of cable.
- The Engineer shall supply the plastic film, containing the site plan to the Contractor, who shall return the drawing (film) plus four paper copies to the Engineer within four weeks of completion of the Contract works. No final payment/s or releasing of retention money will be certified until the drawing/s has been returned.

5.16 Technical Schedule A and B

THIS SECTION MUST BE COMPLETED IN FULL

Schedule A: Purchaser's specific requirements

Schedule B: Particulars of equipment to be supplied (to be completed by Tenderer)

Detail provided in this schedule supersede any detail quoted in the specifications

NB: All Blanks in Part B to be filled in even if it confirms the specific requirements.

ITEM	DESCRIPTION		SCHEDULE A	SCHEDULE B
			Minimum Requirements	Equipment Details (To be completed by Tenderer)
1	Low voltage 4-core power cables (XLPE/PVS/SWA/PVC)			
1.1	Manufacturer's name			
1.2	Country of Origin			
1.3	Conductor size	mm ²	70	
1.4	Number of cores		4	
1.5	Cable type		SWA PVC SWA	
1.6	Conductor type		Copper	
1.7	Symmetrical fault level	kA (1 sec)	8.7	
1.8	Earth fault level	kA (1 sec)	7.4	
1.9	Marking requirements		Required	
1.10	Technical Catalogue to be provided with tender documentation		Required	
1.11	Certified copy of type test to be provided with tender documentation	SANS 1507	Required	

PART C: STANDARD SPECIFICATION FOR EARTHING

6 SECTION 6 – EARTHING

6.1 INTRODUCTION

This Technical Specification covers the standard requirements for the manufacture, works testing, supply, delivery, installation, site testing and commissioning of earthing installations.

6.2 NORMATIVE REFERENCE

The following documents contain provisions that, through reference in the text, constitute requirements of this Technical Specification. At the time of compilation, the edition indicated was valid. All controlled documents are subject to revision, and parties to agreements based on this Technical Specification. All parties are therefore encouraged to investigate the possibility of applying the most recent edition of the documents listed below.

SANS 1063:1998, Earth rods and couplers.

SANS 1411-7:2003, Materials of insulated cables and flexible cords – Part 7: Polyethylene (PE). SANS 10199:2004, The design and installation of earth electrodes.

SANS 10292:2001, Earthing of low-voltage (LV) distribution systems.

6.3 DEFINITIONS AND ABBREVIATIONS

6.3.1 Definitions

6.3.1.1 Ground

Terra Firma - The general Mass of the Earth.

6.3.1.2 Earth electrode

One or more conductive parts embedded in the ground for the purpose of making effective electrical contact with ground and to act as a path for the discharge of either lightning currents or fault currents.

6.3.1.3 Earthing system

A system intended to provide at all times, by means of one or more earth electrodes, a low impedance path for the immediate discharge of electricity energy, without danger into ground.

6.3.1.4 Earthed

So connected to ground as to ensure at all times an immediate discharge of electrical energy without danger.

6.3.1.5 Earth grid

An earth electrode consisting of a large rectangular arrangement of conductors buried in trenches and divided by longitudinal and transverse conductors into a number of smaller rectangles having mesh dimensions of the order of five meters or greater.

6.3.1.6 Earthing lead

A conductor including any clamp or terminal, by which connection of equipment's earth terminal or conductor to an earth electrode is made.

6.3.1.7 Earth resistance

The resistance of the electrode and surrounding earth as measured between the earthing lead and ground.

6.3.1.8 Grid resistance

Earth resistance of the earth grid.

6.3.1.9 Grid current

The magnitude of the current injected into the soil by the earthing system. In the extreme the grid current equals the fault level.

6.3.1.10 Soil resistivity

The resistance between the opposite faces of a cube of soil having sides of length, 1 m. This value is expressed in ohm meter.

6.16.2 Abbreviations

Not applicable.

6.17 STATUTORY REQUIREMENTS

6.17.1 The requirements of the Occupational Health and Safety Act, Act 85 of

1993, (OHS Act) and all subsequent amendments and regulations shall be observed and adhered to except where exemption has been obtained from the Chief Factories Inspector.

6.18 TECHNICAL REQUIREMENTS

6.18.1 General

- 6.18.1.1 The earthing philosophy used for the medium-voltage cable system is in accordance with the principles and design criteria of SANS 10200.
- 6.18.1.2 The earthing philosophy used for the low-voltage cable system is in accordance with the requirements and recommendations of SANS 10292.
- 6.18.1.3 Earth fault indicators (EFIs) shall be supplied with all new equipment incorporating compact secondary switchgear (i.e., Type B mini-sub and free-standing RMUs).
- 6.18.1.4 Earth resistance tests at sub-switching stations and mini substations shall be carried out.
- 6.18.1.5 A soil resistivity survey form and commissioning sheet shall be completed by the contractor for each medium-voltage equipment (i.e., mini sub and free-standing ring main unit) and low voltage distribution kiosk installation.

6.18.2 MV earthing and general requirements

The following shall cover the general requirements and in no way shall be seen to specify the full extent of the work to be carried out.

- 6.18.2.1 The connection of the earthing conductor to the cable armouring within a cable accessory (for example joint or termination) shall be by a type tested mechanical arrangement.
- 6.18.2.2 The armouring of the cable shall be continuous back to the substation and shall be used as an earth continuity conductor (ECC),
- 6.18.2.3 The cable armouring of all primary and secondary feeders within a switching station shall be bonded to the earthing bar of the metal clad switchgear. The earthing bar of all metal clad switchgear panels shall be interconnected and bonded to the switching station earth electrode.

6.18.2.4 The bonding and earthing at mini substations shall comply with the following requirements:

- (a) if there is a continuous earth continuity conductor (ECC) from the mini-substation back to the step- down station earth (through the armouring and lead sheath (if applicable) of the supply cable) an earth electrode shall be installed below the operator's feet, that ensures safe touch potentials under MV earth fault conditions. In this case the LV neutral busbar of the mini substation shall be bonded to the mini- substation earth bar, and

NOTE: If mini substations are supplied with a 70mm² copper links in parallel with a surge arrester that is connected between the LV neutral busbar and the mini substation earth bar. In this case the copper link and surge arrester arrangement should be left as supplied.

- (b) if no ECC exists then an earth electrode shall be installed below the operator's feet that ensure safe touch potentials under earth fault conditions. In addition to this an MV and an LV earth electrode shall be installed that ensures that the earth fault protection relay at the step-down or switching station will operate in the event of an MV earth fault at the mini substation. A surge arrester shall be installed between the LV neutral busbar and the mini substation earth bar.

NOTE: If mini substations are supplied with a 70mm² copper links in parallel with a surge arrester that is connected between the LV neutral busbar and the mini substation earth bar. In this case the copper link should be removed.

6.18.3 LV earthing general requirements

The following shall cover the general requirements and in no way shall be seen to specify the full extent of the work to be carried out.

- 6.18.3.1 The TN-C-S system earthing philosophy (see SANS10292) shall be used for all LV underground cable networks.
- 6.18.3.2 The cable armouring shall be bonded to the earth bar or earth stud by:
 - (a) Mechanical glands, with the gland plate bonded to the earth bar,

or

- (b) Lugging all of the armour wires and connecting them to the earth bar or earth stud (only applicable to existing installed equipment: all new equipment is fitted with gland plates which shall be utilized);

6.18.3.3 The minimum size of an earthing conductor to be used shall be governed by the maximum allowable temperature rise during current flow and practical considerations.

6.18.3.4 Continuity of the cable armouring shall be maintained at all cable joints by using ferrules to join all the armour wires;

6.18.3.5 All exposed conductive parts of a consumer's installation shall be connected to the protective conductor through the supply earth terminal and the service connection.

6.18.4 Earth electrodes

6.18.4.1 Earth electrode selection and installation procedure

The following procedures shall be followed when establishing a main earth electrode installation:

- (a) A soil resistivity survey shall be undertaken to establish suitable electrodes sites.
- (b) An electrode type appropriate for the soil conditions shall be selected, and
- (c) The electrode shall be installed.

6.18.4.2 Soil resistivity survey

The resistance to earth of an electrode is influenced by the resistivity of the surrounding soil. The measurement of soil resistivity is therefore an extremely important function and shall form an integral part of the overall earthing process. A soil resistivity survey shall be implemented as follows:

- (a) The soil resistivity survey shall be performed using the Wenner Method.
- (b) The soil resistivity value measured in ohm meters (Ωm) at a depth of 0,5m to 1,5m below ground level is used for the selection of an appropriate earth electrode. This depth range is important as the soil that is close to the electrode has the greatest positive effect on its final resistance value.

6.18.4.3 Earth electrode selection

A standard earth electrode type is selected on the basis of the required resistance value and the result of the apparent soil resistivity measurement (taken at 0,5m to 1,5m below ground level). A three point star electrode configuration is referred.

Where the measured resistivity value does not correspond to one of the four "standard" values, 300Ωm, 600Ωm, 900Ωm and 1 500Ωm, an electrode designed for the next highest standard resistivity value should be selected. For example, if the soil resistivity survey yielded a result of 400Ωm, a standard electrode designed for 600Ωm should be selected.

6.18.4.4 Installation of an earth electrode

Earth electrode components are installed as follows:

(a) Horizontal conductors.

Horizontal conductors are buried in trenches no less than 500mm below ground level.

(b) Single earth rods

Each earth rod shall be driven into undisturbed soil. The general rule is that if a foundation hole can be excavated by mechanical means, then it will be reasonably easy to drive in an earth rod,

Earth rods shall be driven a minimum of 1 000mm from the structure and the rod top shall be not less than 500mm below ground level.

6.18.4.5 Connection to earth electrodes

Connection to earth electrodes shall comply with the following:

(a) All normally accessible earthing terminations to equipment shall be made with compression lugs or bolted clamps.

(b) All earthing connections to equipment shall be so arranged that they can be removed, permanently or temporarily, independently or any other earth; and

(c) The number of connections to earth conductor shall be kept to a minimum.

6.18.4.6 Material for earthing applications

(a) The conductor used for earthing leads and earth bonding

conductor shall be annealed stranded or solid copper conductor. A minimum cross-sectional area of 16mm² stranded copper or 12mm² solid copper shall be used.

- (b) The earth leads used to obtain the separation between the MV and LV electrodes at transformer installations shall be insulated with a black, 1000V, ultra-violet stabilized, PVC covering. The PVC covering and copper shall comply with SABS 1411-7.
- (c) It is preferred that all bonds within an earthing system be made via a crimped, bolted or exothermic welded connection. The following connectors are suitable for use on both copper and copper-clad steel conductors:

- (i) Connections to earth rods

- Conductor to rod crimped connection (preferred)
Suitable for use with one 16mm² conductor and a 16mm diameter earth rod.
 - Exothermic welded connection.
 - Conductor to rod clamp
Suitable for use with conductor or maximum cross-sectional area of 70mm² and a 16mm diameter earth rod. The clamp bolt shall be tightened onto the earth rod, not the copper lead.

- (ii) Connections for conductors

- Crimped ferrule (preferred)
To be used with four off 16mm² conductors. The ferrule is crimped using a 14.5 HEX across flats die and a half-ton hydraulic crimping tool (the same as is used for ABC joints and terminations),
 - Line tap
To be used with connection of stranded conductor of diameters up to 9mm.