



SANSA

MATJIESFONTEIN

SPECIFICATION FOR THE BACK-UP

POWER AND ELECTRICAL

INSTALLATIONS

CLOSING DATE:

NAME OF TENDERER :

ADDRESS :

TEL NO :

DATE :



CLAASSEN AURET (PTY) LTD
Consulting Engineers

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PART 1

PROJECT : Electrical Installation for SANSA Matjiesfontein

DATE : 2024/12/04

SCHEDULE : Electrical Installation

NOTES TO TENDERERS AND ENQUIRERS

It is intended this tender will be accepted by Archstone Construction when the Contractor is to be appointed.

Any conditions appended by the Tenderer, which are at variance with the conditions set out herein, may invalidate the Tender.

The lowest tender or any part thereof need not necessarily be accepted.

This Tender is to be submitted to CLAASSEN AURET, drawings@cai.co.za AND harry@cai.co.za e-mail to be titled as follows:

"SANSA MATJIESFONTEIN ELECTRICAL INSTALLATION"

Tender Briefing	No tender briefing	Time: 10:00
Closing of Tenders	Time: 12:00

Tenders will not be opened in public and tender results will not be declared.

The Tender shall remain in full legal force for a period of 60 calendar days from the Tender closing date.

On no account will Tenders received after the time and date for submission of Tenders be considered and Tenderers are advised that postal delays will not constitute a claim for recognition of such Tenders. The Tenders are to be retained by the Employer for evaluation.

TENDER SCHEDULE

1. CONTRACTING AND OTHER PARTIES

1.1 Contractor	:	
1.2 Employer	:	Attacq (Pty) Ltd
1.3 Architect	:	LYT Architects
1.4 Quantity Surveyor	:	Pentad
1.5 Consulting Civil/Structural Engineer	:	Pure Consulting (Pty) Ltd
1.6 Electrical Engineer	:	Glaassen Auret (Pty) Ltd.
		Tel No.: 011 496 3101
	

1.7 Mechanical Engineer : Adaptive Resources

2. SUB-CONTRACT DETAILS

2.1 Will be appointed in terms of the Principal Agreement as : [REDACTED] Selected Sub-Contractor

2.2 This Tender is for work to be carried out in accordance with the design and/or specification of a Consulting Engineer : Yes [REDACTED]

2.3 A The Principal Works : Will be updated

b Sub-Contract Works : Electrical Installation

c The Site : SANSA Matjiesfontein

2.4 Sub-Contract Guarantee : T.B.G

2.5 The latest day of the month for issue of interim payment certificate in terms of the Principal Agreement : T.B.G

2.6 Number of days within which interim payment certificates are to be paid in terms of the Principal Agreement : T.B.G

2.7 Latest day of the month for submission of payment application : T.B.G

2.8 Number of days after payment to Contractor for payment to Sub-Contractor : T.B.G

3. COMMENCEMENT, COMPLETION AND PENALTY PROVISIONS

3.1 The Sub-Contract period shall commence on : T.B.G

3.2 The intended date of practical Completion of the Sub-Contract Works is : T.B.G

Dates mentioned above serves as a rough guide only and exact dates are to be agreed with the Main Contractor prior to signing of the Sub-Contract.

The Sub-Contractor must however ensure that he can comply with the Main Contractor's program prior to submission of Tenders.

4. INSURANCES

4.1 Construction Risk to be effected by Contractor

a For a limit of : T.B.G

b With a deductible of : T.B.G

4.2 Public Liability to be effected by the Contractor

a For a limit of : T.B.G

b With a deductible : T.B.G

4.3 Support to be effected by the Contractor

a For a limit of : T.B.G

b With a deductible : T.B.G

5. PRICE ADJUSTMENT

5.1 a The adjustment of the Sub-Contract escalation shall be in terms of : Not applicable

b If CPAP the base month shall be : Not applicable

c The Work Group shall be : Not applicable

d If "OTHER" state method : Not applicable

6. MAIN CONTRACT DETAILS

6.1 COMMENCEMENT, COMPLETION AND PENALTY PROVISIONS

6.1.1 The date on which possession of the Site will be given will be once the tender is being adjudicated:

6.1.2 The intended date of practical completion and the penalty for each day of non-completion where sectional completion is not achieved shall be:

T.B.G

6.2 MAIN CONTRACT PRELIMINARIES

6.2.1 If required by the tenderers the full scope of the preliminaries for the main contract is available at the office of the Quantity Surveyors for perusal during normal office hours if it has not been included in this document.

7: DRAWING

- 7.1 The following drawings issued with this tender and is deemed to form part of these documents : Refer to latter parts of this document
-
-

KINDLY NOTE THE FOLLOWING DOCUMENTATION MUST BE INCLUDED IN ELECTRONIC FORMAT WITH TENDER SUBMISSION:

Covering Letter in MS Word
Bill of Quantities in Excel

NOTES TO TENDERERS

- ~~1.0 Tenderers are to note the **Total Price [which includes VAT]**, must be carried over to the final summary and all fixed amounts shown in the price schedule must be included therein. No adjustments will be made for any failure by Tenderers to include the fixed amounts in the **Total Price**.~~
- 2.0 All material covered by this specification shall, wherever possible, be of South African manufacture. In the adjudication of tenders, preference shall be given to South African materials or items manufactured in the RSA.
- 3.0 Should any tenderer offer products of South African manufacture as an alternative to imported products which may be specified, such offers shall receive full consideration, provided the alternative article complies with the technical requirements of the specification.
- 4.0 The pages of the sections of this document are numbered consecutively and the Tenderer's shall scrutinise the document to ascertain all pages are legible and have been included in the binding. If there are any discrepancies, the Tenderer's shall take immediate steps to obtain missing information in time for him to complete the document prior to tender closing time.
- 5.0 The Tenderer's attention is drawn to the following clauses, which will apply to this contract:

Works Drawings

Definition

The term "works drawings" shall mean drawings, diagrams, illustrations, schedules, performance charts, brochures, operating manuals and other data which are prepared by the Tenderer, manufacturer, supplier or distributor and which illustrate some portion of the Works.

General Responsibilities

The Tenderer shall provide a person or persons whose responsibility will be:

- [a] To familiarise himself with all drawings produced by the Engineer. This will involve a clear understanding of services and element co-ordination performed by the Engineer.
- [b] To provide the Engineer with comprehensive lists of works drawings to be prepared by the Tenderer.
- [c] To check all works drawings for sufficiency prior to submission to the Engineer. It is expected that such checking will include all co-ordination and pro-active resolution of any conflicting services and elements.
- [d] To update fortnightly the drawing Control Register in respect of works drawings.

Procedures

The Tenderer shall, at his own expense, prepare and submit two sets of drawings of the works of all fabricated work, working or setting out drawings, shop details and schedules to the Engineer for approval and such work shall not be performed by the Tenderer until such approval has been given.

The Tenderer shall present a complete schedule showing the sequence of submission of works drawings, including submission dates, for all trades and the scheduled dates for approval of all drawings. This schedule will take into account that the Engineer and the Employer each reserve a three-week check period from the date of the receipt of all works drawings and/or catalogue data.

All submissions shall be on dates as indicated in the above schedule and sufficiently in advance to permit the Tenderer to meet fabrication deadlines; no claim for extensions to the contract time will be granted to the Tenderer by reason of his failure in this respect.

The Tenderer shall submit one copy of catalogues and data for approval. The Tenderer shall check all

submissions for conformity with the contract drawings and specifications and correct any errors, omissions or deviations before their transmission to the Engineer. All submissions shall bear the Tenderer's dated stamp of approval as evidence that they have been so checked and corrected by the Tenderer. Any drawings, schedule or catalogue submitted without this stamp will not be considered by the Electrical Engineer and will be returned.

When the Engineer advises the Tenderer the working drawings have been approved, he shall immediately submit to the Engineer the original transparencies of such drawings so that the Engineer's stamp of approval may be appended thereto.

Thereafter the Tenderer shall furnish to the Engineer four prints of the approved works drawings, setting out drawings and schedules. The Tenderer shall also furnish to the Works as many prints of the approved works drawings and schedules as may be required. No work shall be performed from any works drawings and/or catalogues not stamped with the Engineer's approval.

The Tenderer shall be responsible for ensuring that all dimensions conform to the dimensions of built work.

The Engineer's approval of any document or drawing shall not in any way vary his contractual or delictual obligations and liabilities to the Employer or any other party, nor does it vary the contractual or delictual obligations and liabilities of the party submitting such document or drawing for approval.

If the submissions differ from the requirements of the contract, the Tenderer shall make specific mention of each difference in his letter of transmission with a request for substitution, together with his reasons for same, in order that, if acceptable, suitable action may be taken by the Engineer. Otherwise, the Tenderer will not be relieved of the responsibility for executing the work in accordance with the requirements of the contract.

Corrections of works drawings by the Engineer shall not change the scope of work. Should any such correction be considered to constitute a change of scope of work, the Tenderer shall notify the Engineer in writing within not more than seven calendar days of such change and shall not proceed with the fabrication until so authorised by the Engineer. Claims for change of scope made after performance of the work constituting the claimed change of scope will not be considered. Unless otherwise agreed with the Engineer, works drawings shall be prepared to show all details of installation (which has been excluded from this contract), including reticulation fixing, etc., of all components and assemblies, or if the Tenderer desires to deviate from the design and these drawings shall be all in accordance with the above procedures and at the Tenderer's expense.

7.0 **Tenderers Instructions**

[a] **Terms and Conditions**

This document is strictly confidential and shall not be communicated to any unauthorised personnel or company without the express permission of the author or an appropriate CAI senior manager/executive. All tenderer-specific information is understood to be proprietary in nature and will be held in strictest confidence.

The following instructions apply to all the **elements** in this Tender.

All tenderers are to advise Mr Harry Meyer at 0836000454 or Francois Louw at 0823706079 immediately of any, what they may regard, as proprietary equipment or standards, contained within this Tender for any of the elements. Any incidences must be clearly identified and comprehensively documented under each specific element category.

[b] **Publicity**

No publicity or any other information relating to this Tender or the project is to be released by the tenderer, or his sub-Tenderers and suppliers without the prior consent of CAI.

[c] **Tender Response Format**

Respondents to this Tender must adhere to the sequential format of the Tender document. All pages must be numbered, indexed elements and chapters separated by tabs.

All questions and requests should be included in the response and are to be comprehensively answered. Responses such as “Comply”, “Yes”, “No”, etc. will not be accepted.

Tenderers are to respond to all questions and requests, whether further amplification is given or not, with one of the responses in bold lettering: -

Explicit compliance

Partial compliance.

Non-compliance.

Tenderers will, wherever possible, provide quantitative/measurable criteria for system/ services functionality and derived benefits to facilitate CAI evaluation and subsequent tenderer/product comparison.

A summary of compliance matched to document headings is to be completed.

[d] **Documentation**

~~Tenderers are to provide one printed copy and one electronic copy of their final response.~~

~~A copy of the response to be on submitted on a compact disc. The document formats to be compiled using the Microsoft office suite, Word, Excel, MS project, etc.~~

Tenderers are encouraged to make use of colour graphics and diagrams where appropriate to emphasize and elaborate important criteria/information and for simplicity to facilitate easier assimilation.

The tender responses shall be completed in a manner whereby the response paragraphs are written directly below the questions and the background colour shaded to clearly identify tenderers response information.

[e] **Commercial conditions**

Tenderers must include all costs for a complete solution to satisfy the requirements given in this Tender.

[f] **Bid price**

Tenderers must provide detailed costs for the outright purchase of the different solution elements in the formats shown in the Bills of Quantities. The bid price must be in South African Rand and exclusive of VAT, stating the exchange rate, including the landed cost of all elements necessary to meet the full system requirements as detailed in each element section. Claassen Aurret (Pty) Ltd. will confirm a rate of exchange against which all tenders shall be submitted in order for the submissions to be compared on an equal basis. All tenderers shall take preferably secure forward cover from an authorised banking institution once advised their bid was successful.

The bid price shall include full user documentation, including all necessary user guides.

The following spot rates shall be used in the pricing of the submissions if a fixed price has not been offered:

1\$	R18-86
1EUR	R20-68
1GBP	R21-14

The bid price shall include full system documentation for each element.

Forward cover for all orders placed will be discussed and agree between the appointed main Contractor and the successful Tenderer. It will be expected from the Tenderer forward cover is taken as soon as the contract has been secured but is to be confirmed by the tenderer with the appointed Main Contractor once the order has been issued or a Letter of Intent.

[g] **Standard terms and conditions**

No standard terms and conditions will be accepted for any of the tenderers. The Conditions of Contract as included in the tender will apply to this contract.

[h] **Price variation**

The price will be adjusted using the rates in the Bills of Quantities.

[i] **Penalties and Rewards**

~~A penalty will be confirmed of the total contract price will be levied for each day or part thereof, that the agreed completion dates are over extended as a direct result of the successful tenderer causing the delay.~~

~~The Tenderer will be deemed responsible for any delays caused by entities which Archstone Construction (Pty) Ltd considered under their direct control, including the equipment manufacturer, sub-Tenderers, agents and/or any other entity who the Tenderer has entered into agreements within order to fulfil the terms of their offering.~~

[j] **Project Time Scales**

~~Over and above to what has been detailed on the programme, tenderers will have to once been awarded the contract provide a project program for the supply of the machines.~~

[k] **ISO Certification**

Tenderers are to document their ISO qualification and compliance and the system elements offered by the Tenderers.

8.0 **Project Strategy**

The following is envisaged as the project strategy if applicable to this contract subject to confirmation once Tenders have been received. This may be altered once the submissions have been received:

- Evaluate tenders
- Award of the tender

9.0 **Bills of Quantities**

Provisional Bills of Quantities shall be read and priced in conjunction with the specification.

All rates quoted for in the Bills of Quantities shall include the design, materials, profit and delivery to site.

10.0 **Service Conditions**

All equipment shall be suitable for the following site conditions:

Ambient temperature 40°C maximum, -5°C minimum



Altitude	Approximately 1600 m
Lightning	Severe
Dust	Severe
Relative Humidity	40% at 27°C
Nominal LV Supply	400/231 (no load) 4 wire, 3 phase system with earthed neutral
Nominal HV Supply	11000V 3-wire system
Frequency	50 Hz
Fault Level	350 MVA at 11 000 Volts

11.0 **Details to be submitted with tenders**

The attention of the Tenderers is drawn to the fact the tender is subject to disqualification if all the information called for is not submitted with the Tender.

Should the Tenderer in any way differ from the specification such differences shall be explained in detail. This information shall be submitted in a covering letter accompanying the Tender document, stating the paragraph of the specification where the requirements of the specification are deviated from. Should this not be done, it will be assumed that the document meets the specification in all respects and no claims for additional cost will be considered. Such deviations shall be provided in the form of alternative offers, but the main offer must be in accordance with this document.

It should be noted information entered in the schedules will not relieve the Tenderer of his obligations to comply with the specification.

~~Tenderers are to submit a copy of their BEE certificates as this will form part of the adjudication~~

12.0 **Validity of Tender Responses**

~~The tender response shall be valid, for a minimum period of sixty days [60], from date of submission.~~

13.0 **Site Inspection**

~~A site meeting will be called with all tenderers.~~

~~A site briefing at the consulting engineer offices will be held to explain the contents of the Bill of Quantities and answer questions.~~

The Tenderer shall view the site and any existing structures, if any, thereon and make himself thoroughly acquainted with the conditions under which the works are to be done, the means of access to the works, the condition of the roads, the nature of the site, and generally with all matters which may influence the Contract and any restrictions or conditions which may be imposed by the Local Authority. No claim for any extras in connection with the position, conditions or circumstances of the work or siting of buildings, will be entertained.

The contractor must also acquaint himself on site with all factors, which might influence the cost, as no extras for height, unknown information, etc. will be entertained.

Name of Tenderer: _____

Address: _____



Date:

SIGNATURE OF TENDERER

PART 2

SANSA MATJIESFONTEIN

FORM OF TENDER

GENERAL ELECTRICAL INSTALLATION SPECIFICATION



PART 2

SANSA MATJIESFONTEIN

FORM OF TENDER

Notes:

The tender will not be considered unless this form has been completed correctly and it must be signed.

I/We hereby agree to carry out the whole of the work specified herein, in strict accordance with the specification in the total fixed sum, **excluding VAT**, for,

- | | |
|---|---------------|
| • Preliminaries | R..... |
| • Medium Voltage Installation carried over from Bill | R..... |
| • Low Voltage installation carried over from bill | R..... |
| • Sub- Total | R..... |
| • Cost to fix the tender | R..... |
| • Sub-Total | R..... |
| • VAT 15% | R..... |
| • Total carried to Form of tender inclusive of VAT | R..... |

In words

.....

I/We, hereby agree and undertake this tender shall not be withdrawn or amended as to the whole or any part thereof but shall remain in force for a period of sixty [60] days from the date of the closing of the tender and may be accepted at any time during the aforesaid period or within such extended period as the parties may agree.

In the event of this tender being accepted, I/We, will undertake to enter into a supply and install agreement with Main Contractor

Tenderers should note that the only, lowest or any tender may not necessarily be accepted by the Client.

.....
NAME OF TENDERER

.....
SIGNATURE

PART 3

SANSA MATJIESFONTEIN

MINIATURE SUBSTATIONS

GENERAL TECHNICAL SPECIFICATION

This index refers to the Part numbers [Part 4.1] as per the CAI standard document.

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PART 3

MATJIESFONTEIN

MINIATURE SUBSTATIONS

GENERAL TECHNICAL SPECIFICATION

3.1 REGULATIONS

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

MOSA The Machineries and Occupational Safety Act.

The regulations of the local Gas Board.

SANS

The SANS Code for the Wiring of Premises - SANS 10142

The local Municipal bylaws and regulations as well as the regulations of the Local Supply Authority.

Code of Practice for Engineering Drawing (Metric Units).

BS 308
(Including
Supplement No 1)

Engineering Drawing Practice.

ISO
Recommendation
R370

Conversion of Tolerance Dimensions.

BS 3939

Recommended Graphical Symbols.

BS5486
Part 1

Factory built assemblies of Switchgear and Control gear for voltages up to and including 1000V AC and 1200V DC.

BS5419

Air Break switches, Air Break disconnectors.

IEC 148

Air break switch disconnectors and fuse combination units for voltages up to and including 1000V AC and 1200V DC.

BS 5424
Part
IEC 158.1

Control gear for voltages up to and including 1000V AC and 1200V DC.

IEC 144

Degrees of Protection of Enclosures for low voltage switchgear.

IEC Technical
Subcommittee

Draft Guiding principles in the preparation of Circuit Diagrams

BS4752 Part 1

Circuit breakers of rated voltage up to and including 1000V AC and 1200V DC.

BS 142	Electrical protective relays.
BS89 IEC 51	Direct Acting Electrical Indicating Instruments.
BS 3693 Part 1	Instruments of bold presentation and for rapid reading.
BS3938	Current Transformers.
BS3941	Voltage Transformers.
BS 3535	Safety isolating transformers for domestic and industrial purposes.
DIN 43620	Low Voltage High Current Fuses 500V with contact blades - NH fuse cartridges.
VDE 0660 Part 4	Regulations for low voltage power fuses (NH Fuses) with rated voltages up to 1000V AC and up to 3000V DC.
IEC 269-1/-2	Low Voltage Fuses.
BS 158	Marking and arrangement of switchgear busbars, main connections and small wiring.
BS 159	Busbars and Busbar connections.
BS 1433	Copper for Electrical purposes.
BS 1706	Electroplated coatings of Cadmium and zinc on iron and steel.
BS 5472	Specification for low voltage switchgear and control gear for industrial use, terminal marking and distinctive number (General rules).
BS 4794 Part 1 & Part 2	Control switches, switching devices including contactor relays for control and auxiliary circuits up to, and including 1000V AC and 1200V DC.
SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods.
SANS 1091	National Color Standards for Paint.
SABS 135 & Amendment 1	ISO Metric Black Bolts, Screws and Nuts.

- 3.1.2 It shall be assumed that the Sub-Contractor is conversant with the above-mentioned regulations. Should any requirements, bylaws or regulations, contradict the requirements of this document, apply or become applicable during erection of the installation, such requirements, bylaws or regulations shall overrule this document and the Sub-Contractor shall immediately inform the Engineer of such a contradiction.

3.2 **OPERATOR TRAINING**

On completion of all tests, the Sub-Contractor shall continue to be responsible for the complete operation and maintenance of the works until the completion date, during which period instructions shall be given to the *Employer's* staff for the proper operation and maintenance of the equipment.

The operation and maintenance of the works, for the duration of the instruction period, shall not in any way relieve the Sub-Contractor of their responsibilities under the terms of the Contract.

3.3 LOCATION OF EQUIPMENT

The Sub-Contractor shall check on doorways, passages, openings, lifts, etc., provided and shall ensure all equipment offered can be installed in its final position. If necessary, equipment shall be ordered in a partially dismantled condition so that it is suitable for moving through the restricted openings or areas of restricted height or areas of restricted load.

3.4 CONTRACTORS WORK

The Sub-Contractor Services shall, within 30 days, or any shorter period which may be necessitated by the construction program, submit drawings showing all building work which will be obtained from the Medium Voltage Equipment Supplier

The drawings shall provide the Engineer with all the dimensions, details, etc., for the work to be carried out correctly.

The Electrical Engineer will scrutinize the drawings and request changes and adjustments as required. After such changes are satisfactorily made the drawings will be approved.

The Sub-Contractor shall provide five copies of the drawings to Electrical Engineer for issue to all parties.

It is the responsibility of the Sub-Contractor and the Electrical Engineer to check the work as it is completed to ensure that the work has been correctly carried out in accordance with the drawings. The Sub-Contractor shall point out any problem areas as soon as possible so that they can be rectified. No claims will be considered for delays or other additional costs which arise out of the Subcontractor failure to check the Medium Voltage Switchgear in good time.

The drawings shall be fully dimensioned and shall include the following:

- Details of all bases that are required.
- Details of all openings in walls and concrete work.
- Details of ventilation.
- Details and positions of all equipment to be built into walls.
- Any other work required.

3.5 DRAWINGS

The drawings for the contract shall be those issued after contract award and marked for construction.

As part of this Contract, the Sub-Contractor shall provide the following drawings:

- Manufacturing and Installation drawings
The manufacturing and installation drawings ("shop drawings") shall provide all details of the components necessary, if any, for the manufacture and installation of the system in accordance with the Specification.
- Wiring Diagrams
The wiring diagrams shall provide details of all the wiring associated with the installation over and above to what has already been issued to the Engineer. The same drawing symbols and system shall be used, as used on the drawings issued to the Contractor by Claassen Auret.
- Contractors Work Drawings
All necessary *Contractors* work drawings, as described elsewhere in this Specification, shall be provided as part of this Contract.
- As-built Drawings
On completion of the works, the Contractor shall provide a complete set of drawings showing the as-built confirmation of the works.

3.6 MAINTENANCE AND GUARANTEE

Maintenance

The Contractor shall maintain the works as described in the Specification for a period of 52 weeks from the completion date.

Maintenance visits shall be carried out at regular monthly intervals. The maintenance shall cover all items of the works and shall include replacement of expendable items. In addition to the monthly maintenance visit, the Contractor shall carry out all necessary visits to attend to all complaints by the Employer and to make adjustments on equipment if so required.

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

At each maintenance visit, the Contractor shall check the function of each item and shall ensure the system is performing to specification. All automatic controls and safety devices shall be checked. All electrical control gear, lamps, etc., shall be checked and adjusted or replaced as necessary.

The equipment and plant rooms shall be cleaned at each scheduled visit.

The Employer may at his discretion, allow the maintenance period to commence on any item of equipment or section of the installation at a date prior to the completion date, if it is put into operation for beneficial use of the Employer prior to the completion date. This will not be permitted in cases where the completion date is delayed due to the Contractor not completing the works in accordance with the program.

It will also be expected of the tenderers to price the maintenance of the works for a period of 12 months after the free maintenance period. Should the tender be submitted without this information it will be considered as a qualified tender and subject to disqualification. The maintenance of the installation for this period will form part of the adjudication process and it will not be possible to evaluate the tender without this information.

The maintenance will be priced against the specification included under the schedules. If accepted by the Employer a separate contract will be signed with the successful tenderer.

3.7 GUARANTEE

The Contractor shall and does hereby, in favor of the contract works and the Employer, guarantee and warrant the entire installation as described in this specification for twelve [12] months from the completion date.

The guarantee shall provide all parts, spares and equipment that becomes defective during the guarantee period shall be replaced free of charge. The guarantee shall cover all costs including material, labor, overheads, travelling, etc.

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

The guarantee shall cover all materials, plant and equipment whether or not it is covered by a manufacturer's guarantee. The twelve [12] month guarantee, in terms of this subcontract, on the works shall not be affected by the prior expiry of any guarantee provided by the manufacturer of any items of the works.

The Contractor shall cede to the Employer the remainder of any equipment guarantee received from Manufacturers that extend beyond the twelve [12] month period. It shall be the responsibility of the Subcontractor to ensure that each such equipment guarantee is transferable.

The Employer may, at his discretion, allow the guarantee period on any item of equipment of section of the works start at a date prior to the completion date if it is put into operation for beneficial use of the Employer. This will not be permitted in cases where the completion date is delayed due to the Contractor not completing the works as per the program.

It shall be required for extended guarantees to be provided as the miniature substations will be commissioned

and energized as and when installed.

3.8 OPERATING AND MAINTENANCE MANUALS

The Contractor shall provide three [3] hard and two [2] Compact Disc electronic copies of the Operating and Maintenance Manuals.

The Contractor shall submit four weeks prior to the completion date two draft copies of the Maintenance and Operating Manuals for the works to Claassen Auret for approval.

Claassen Auret will return these to the Contractor within ten [10] working days of receipt marked with all changes which are necessary.

The Contractor shall modify the manuals as required and re-submit to the Engineer, within ten working days, the revised copies of the manuals. Four [4] weeks after completion date the Contractor shall provide three copies of the Final Operating and Maintenance Manuals for the system supplied. The manuals shall be bound in book form with hard plastic covers to withstand constant use.

A soft copy is also to be provided separately to the Engineer with a copy of all the information in PDF format. It will also be expected and that will apply to the entire contract if there is any software required to program the equipment the software will be supplied to the client and the cost shall be included in the Bill of Quantities.

The manuals shall be properly indexed to facilitate ease of reference.

THE MANUALS SHALL INCLUDE:

- A list of spares to be supplied by the Contractor to cover the period of maintenance. This list shall cover all spares to be held in stock by the Contractor for this project and shall not in any way relieve the Subcontractor of the obligation to provide any and all spares required during the maintenance period.
- A list giving the name and address of the local agent for each item of equipment.
- A list giving the name and address of the manufacturer of each item of equipment.
- A copy of all test certificates obtained with the system.
- A preventative maintenance program for all equipment.
- Operating instructions for each item of equipment.
- Complete "As Built" drawings of the installation and wiring and schematic diagrams.
- Detailed operating instructions for all the modes of operation of the system [Firemen's service, Standby power service, etc.]
- Certificates of Compliance as required.
- Proof of qualification/certification of person responsible for testing and issuing of reports/documents.

3.9 GENERAL INFORMATION

The general technical requirements cover the delivery, installation, testing, commissioning and maintenance of the miniature substation installation.

The complete miniature substation installation shall comply with the requirements of this specification. Should any discrepancies or contradictions arise between this part of the Specification and the Detailed Technical Specification then the latter shall take preference. Should any discrepancies appear between the written specifications, Bills of Quantities and the drawings, Tenderers shall ascertain the position before tender closing date, otherwise the decision by the Engineer will be final.

This specification is of simplified form and includes abbreviated sentences. The omission of words or phrases shall be implied by inference. Unless clarified by the Contractor prior to submitting the tender interpretation of clauses, words and phrases shall be as determined by the Engineer.

The Contractor is required to provide all material, equipment, labor and services and to perform all operations required for the installation to be complete and operative.

"Document" shall mean the complete set of contract documents including all drawings, variation orders and Engineer's instructions issued in terms of the contract.

The Engineer will inspect the installation from time to time during the progress of the work. Discrepancies will be pointed out to the Contractor and these shall be remedied at the Contractor's expense.

Under no circumstances shall the abovementioned inspections relieve the Contractor of his obligations in terms of these Documents. It is the responsibility of the Contractor to ensure that the materials supplied and the installation conforms fully to this specification.

The Contractor shall notify the Engineer timeously when the installation reaches important stages of completion (e.g., equipment installation, pressure testing, etc.) so that the Engineer's representative may schedule his site inspections in the best interests of all concerned. Work shall not be unduly closed up prior to inspection.

Unless it is explicitly stated to the contrary the words "Subcontractor" and "Contractor" shall refer to the successful Tenderer for the Miniature Substation Installation.

3.10 SITE CONDITIONS

Tenderers are advised to visit the site and acquaint themselves with all local conditions pertaining to the execution of the installation before tender closing date. No claims from the Contractor which may arise from insufficient knowledge of site access, type of site, labor conditions, establishment space, transport and loading/unloading facilities, power and water supply, etc., will be considered after submission of tenders.

For facilities where prior permission is required before Contractors can visit the site, a visit will be arranged for all interested parties.

3.11 ARRANGEMENTS WITH SUPPLY AUTHORITY

The Contractor shall give all notices required and pay all necessary fees, including any inspection fees, which may be required by the Local Supply Authority unless otherwise specified.

It shall be the responsibility of the Contractor to make the necessary arrangements at his own cost with the local Supply Authority and to supply the labor, equipment and means to inspect, test and commission the installation to the requirement of the Local and Supply Authorities. The Contractor shall supply and install all notices and warning signs that are required by the appropriate laws, regulations and/or the documents.

3.12 MATERIAL, EQUIPMENT AND WORKMANSHIP

All material shall conform in respect of quality, manufacture, tests and performance, with the requirements of the South African Bureau of Standards or where no such standards exist, with the appropriate current specification of the British Standards Institution.

All material shall be new and in accordance with the specifications, and suitable for the conditions on site. These conditions shall include weather conditions as well as conditions under which materials are installed, stored or used. Should the materials not be suitable for use under temporary site conditions then the Contractor shall at his own cost provide suitable protection until these unfavorable site conditions cease to exist.

The Contractor shall, where requested to do so, submit samples of equipment and materials to the Engineer for his approval prior to installation. Samples may be retained in the Engineer's possession until the contract is completed after which they will be returned.

Locally manufactured equipment shall be used where possible and practical in preference to imported equipment. The Owner in no way binds himself to assist the Contractor in obtaining import permits for imported equipment.

The works shall be so installed as to provide ease of inspection, cleaning and maintenance.

All artisans employed on site shall be competent in terms of the Regulations and Acts. All installations shall be carried out by qualified artisans or under the direct supervision of qualified artisans. Installations (or part

thereof) carried out by unskilled persons will be rejected.

The contract shall be executed to an acceptable standard and to the satisfaction of the Engineer. Should any workmanship, equipment or material not be to the satisfaction of the Engineer, it shall be rectified at the cost of the Contractor and all rejected materials shall be removed from site.

If, in the opinion of the Engineer, any member of the Contractor's staff is not competent to carry out the work to the required standard, then that person shall be removed from the project if so instructed by the Engineer.

3.13 PROGRAMME AND PROGRESS

The program for carrying out the works shall be submitted in detailed form covering all significant operations and shall be in the form of a bar chart. In addition, should the information be required in a particular format to suit project management requirements then such information shall be provided as part of this contract.

The Contractor shall liaise with all necessary parties (other Contractors, Sub-Contractors, Consultants, equipment suppliers, etc.) to ensure that the program is as accurate and as realistic as possible.

The Contractor shall submit the programme as soon as possible after award of the contract but at the latest fourteen days after award of the contract.

The programme shall list each scheduled item of equipment in the contract and shall indicate periods for:

- Preparation, approval and finalization of manufacturing drawings.
- Ordering.
- Manufacturing.
- Inspection and testing during manufacture.
- Delivery.
- Installation.
- Testing.
- Commissioning.

The Contractor shall allow in the programme a period of two weeks for approval of drawings by the Engineer.

The Contractor shall allocate to a senior member of his staff, the duties of studying and evaluating the works in relation to the approved programme, of devising methods to overcome or prevent delays and of co-operating with the Engineer and other Contractors working on site. He shall report to the Engineer and draw his attention timeously to anything, which may cause a delay in the execution of the works.

The programme shall be updated as and when necessary to take account of changed circumstances.

3.14 BUILDER'S WORK

The successful Tenderer shall, within 30 days, or any shorter period, which may be necessitated by the construction programme, submit two copies of all drawings showing all builders' work required for the project over and above to what has already been provided.

The drawings shall provide the builder with all the dimensions, details, etc., for the work to be carried out correctly.

The Engineer will scrutinize the drawings and request changes and adjustments as required. After such changes are satisfactorily made the Engineer will fix his stamp of approval to the drawings.

The successful Tenderer shall provide all the necessary copies of the drawings to the Engineer for issue to all parties.

It is the responsibility of the Contractor to check the builder's work as it is completed to ensure that the work has been correctly carried out in accordance with the drawings. The Contractor shall point out any problem areas as soon as possible to the builder so that they can be rectified. No claims will be considered for delays or other additional costs which arise out of the Contractor's failure to check the builder's work in good time.

The builder's work drawings shall be fully dimensioned and shall include the following:

- Details of all openings in walls and concrete work required.
- Details and positions of all equipment to be built into walls, columns or other structural elements.
- Any other work required.

All areas where the installation pierces waterproofing shall be carefully detailed by the Contractor and builder to the approval of the Engineer and Architect. All necessary sleeves, caulking and flashing as required to make the installation waterproof shall be provided as part of this contract.

3.15 SUPERVISION AND SITE ORGANISATION

For the full duration of this contract, the Contractor shall employ at least one good and competent Supervisor, skilled in all aspects of the trades and skills required by the contract. This supervisor shall be on site whenever work, associated with this contract, is being carried out and shall at all times be available to attend to queries by the Principal Contractor or Engineer.

The supervisor shall be the Contractor's authorized representative for the project and shall be available to attend progress meetings when called upon to do so by the Principal Contractor, Engineer or Architect whether or not these take place prior to work actually starting on site.

The supervisor shall be empowered to make all decisions necessary for the execution of the contract.

The supervisor shall not be transferred from his position without approval of the Engineer.

The Contractor shall at all times have on site copies of all relevant drawings as well as a copy of the specification. The Contractor shall institute the necessary procedures to ensure that the drawings on site are the latest drawings and that all superseded drawings are removed from site.

3.16 APPROVAL OF DRAWINGS

The Contractor shall submit, for approval, copies of all abovementioned drawings prior to starting work or issue to other parties. Any work started (off site or on site) prior to receiving the Engineer's approval of drawings shall be at the Contractor's own risk.

The Engineer may require from the Contractor further detailed drawings and/or calculations which clarify features not adequately shown on the layout drawings. The request for additional details shall not be construed as extending the scope of this contract or altering the programme.

The Contractor shall submit two copies of each drawing to the Engineer for approval.

The Engineer will return to the Contractor, within two weeks of their receipt by him one copy of each drawing marked 'APPROVED IN PRINCIPLE' or marked with any changes, which are necessary. The Contractor shall modify the details and drawings as required by the Engineer. The nature and date of each modification and a distinguishing symbol shall be added and the drawings shall be submitted again for approval.

Alterations to drawings, by the Engineer, are not intended to change the scope of work unless explicitly stated as doing so. Should any alterations, in the opinion of the Contractor, change the scope of work the Contractor shall notify the Engineer immediately of receipt of the altered drawings before any further drawing work or fabrication is carried out. Claims for a change of scope, made after performance of the work constituting the claimed change of scope of work will not be considered.

The "Approval in Principle" of drawings by the Engineer shall not relieve the Contractor of any responsibility in terms of the contract. The Engineer will check the drawings for design only and approval of the drawings, schedules and catalogues shall not be construed as a complete check.

The Contractor shall be responsible for any discrepancies, errors or omissions in the drawings and other

particulars supplied by him whether such drawings or particulars have been approved by the Engineer or not, provided that such discrepancies, errors or omissions are not due to inaccurate information or particulars furnished in writing to the Contractor.

The Contractor shall provide, at his own expense, all copies of drawings required by him in the execution of the work and shall also, at his own expense, supply to the Engineer such drawings and copies thereof as are provided for in the specification.

On completion of the installation, but before final handover, the Contractor shall provide two high quality paper prints of each of the drawings listed below showing the system as fixed:

- Complete 1:100 scale drawings of the whole installation
- Detailed drawings of all elements of the miniature substation
- Details of any other items requested by the Engineer

The drawings shall be sufficient in detail to enable the Employers' staff to maintain, dismantle, reassemble and adjust any part of the works.

3.17 MINIATURE SUBSTATIONS

3.17.1 General

This specification covers the manufacture and supply of various sizes of miniature substations as per the Bills of Quantities suitable for use up to 11kV (3 phase) and 400V (3 phase neutral), 50 Hz systems.

The substation shall comply with the requirements of SANS 1029 and 1030 unless otherwise specified.

In addition, the following requirements shall be complied with:

Construction requirements

Sheet Steel Housings:

The housing shall be manufactured and painted in accordance with SANS 1029 and SANS 780.

The sheet steel construction shall comply with the minimum strength requirements of Clause 3.4 of SANS 1029 and painted in accordance with SANS 780 Clause 3.23.

The colour of the outer coat of paint on the outer surfaces of substation shall be to colour C37 "Light Stone" of SANS 1091. A tin of matching touch up paint (not smaller than 500ml) shall be provided with each mini-substation.

3.17.2 Concrete Plinth

The mini-substations shall be mounted on concrete plinths and shall be allowed for in the price of the minisubs. The Contractor shall provide the Engineer with a detailed plinth drawing suitable for each type of mini-substation supplied. The Contractor shall be responsible to see that the plinth is built in accordance with the detailed plinth drawings with special reference to the provisions for cable terminations.

3.17.3 Base

Steel cases shall be hot dip galvanizing and shall be coated with black epoxy tar paint.

3.17.4 Doors

Long pedestal type hinges with at least two fixing bolts per hinge or similar hinges shall be used to hang the doors. The pedestal hinges shall be arranged in opposed fashion so that doors cannot be lifted off. Piano hinges are not acceptable. The hinges shall be of brass or other corrosion resistant materials. Nylon or aluminum hinges are not acceptable.

At least three hinges shall be provided on doors higher than 1.2m.

Door restraints shall be provided. Cloth or canvas straps are not acceptable. The fixing points of the restraints at both the door and door frame shall be reinforced.

Doors shall be fitted with brass or stainless steel lever locks equal or similar to the "BARKER & NELSON" type with a 180° movement. The locking mechanism shall have a catch on the rear, which catches behind the frame or door entry surround. The locking mechanism as well as the catch support area shall be backed with brass or galvanized steel plates. The locking mechanism shall be padlock able. Padlocks will be provided by the Owner.

3.17.5 High Voltage Compartment

The high voltage compartment shall be equipped with an SF6 ring main unit with a fused tee-off. **No oil switchgear will be accepted.**

The minimum clearances between connecting cables and jumpers and any sharp earthed metal edges or protrusion shall be at least 150mm.

"DELARON" or "THIOLITE" resin bound synthetic wood or similar dielectric material shall be used to maintain the phase-to-phase and phase-to-earth spacing of the cables and jumpers. The surfaces of these spacers shall be treated to prevent surface tracking.

Only stranded annealed copper conductors shall be used for jumper cables.

All terminals shall be shrouded with "RAYCHEM" or similar heat shrinkable shrouds. Taping is not acceptable.

3.18 **TRANSFORMER COMPARTMENT**

The transformer compartment shall be equipped with a low loss transformer as specified and in accordance with this specification and the requirements of SANS 1029. The Contractor shall advise if the miniature substation can be equipped with silicon oil.

3.19 **LOW VOLTAGE COMPARTMENT**

3.19.1 Equipment

The specified equipment shall be in accordance with this specification.

The low voltage compartment shall provide space for future requirements as specified.

3.19.2 Equipment Support Frame and Gland Plates

An angle iron or similar type rigid support framework shall be provided.

The frame shall be bolted down on the base with at least four M16 high tensile steel bolts.

A cable gland plate shall be provided at the bottom of the frame across the full width of the compartment. The gland plate shall be at least 100mm above the plinth height. A minimum distance as required by the bending radius of the cores of the outgoing cable shall be provided between the lowest terminals of major equipment and the gland plate. The gland plate shall be suitably punched to accept the number and size of cables specified as well as future cables.

All steelwork shall be hot dipped galvanized in accordance with SANS 763.

A "DELARON" or "THIOLITE" resin bound synthetic wood or similar dielectric material shall be provided for the mounting of all equipment and busbars. Impregnated hardboard, other treated or untreated wood products are not acceptable.

3.19.3 Application

Unless specified to the contrary, busbars shall be manufactured of solid drawn high conductivity copper with a rectangular cross-section in accordance with SANS 784 and 1195 and BS 159 and 1433, where applicable.

3.19.4 Earthing of Metal Parts

All non-current carrying metal parts of the mini-substation, e.g., framework, panels, base, steel housing, transformers, MV switches etc., shall be bonded to the earth busbar. Also refer to the relevant sections of this specification.

3.19.5 Load End Connections

The supply end connections to equipment shall be at the top and the load end connections at the bottom.

3.19.6 Conductor Terminations

All conductors terminating on equipment with screwed terminals shall be fitted with lugs. The lugs shall be soldered or crimped to the end of the conductor with the correct amount of insulation removed from the end to fit into the lug. Strands may not be cut from the end of the conductor.

Connections to circuit breakers, isolators or contactors shall be installed by one of the following methods:

- A ferrule of the correct size.
- Soldering the end of the conductors.

3.19.7 Identification

The colour of the conductors for all 230V circuits shall correspond to the colour of the supply phase for that circuit. Neutral conductors shall be black. All other conductors supplying control circuits, etc., shall be coded in colours other than those specified above. The devised colour codes shall be shown on a wiring diagram. Colored PVC or other tape will not be acceptable for colour coding.

3.19.8 Mounting of Equipment

The mounting of equipment shall conform to SANS 1180 where applicable. Equipment shall be fixed to the support panel with bolts, nuts, washers and spring washers. Self-tapping screws will not be accepted.

Equipment shall be arranged and grouped in a logical fashion.

All equipment shall be mounted flush behind panels with only circuit breaker and isolator toggles and meter faces protruding. The front panels shall be secured in position with 6mm studs and hexagonal chromed brass dome nuts and washers or hank nuts or "DZUS" or "CAMLOC" fasteners.

Self-tapping screws are not acceptable.

Blanking plates shall be fitted over the slots intended for future equipment.

These plates shall be fixed so that fixing holes need not be drilled through from the panel.

3.19.9 Access

All equipment, busbars and wiring shall be completely accessible with the front flush mounting panel removed.

3.19.10 Wiring and Cabling

Incoming and outgoing cables shall be terminated on the gland plate. Cable tails with sizes up to 70mm² may terminate on clamp type terminals where the clamping screws are not in direct contact with the conductor. All cable sizes larger than 70mm² shall terminate on busbar stubs, which are connected directly to the equipment.

Parallel connected cables shall be connected to a collector busbar without crossing the conductors. Cable connections to busbars shall be by means of crimped lugs and bolted fixing only.

3.19.11 Current Ratings

The current rating of conductors for the internal wiring shall be sufficient to carry the maximum continuous current that can occur in the circuit. This value shall be determined from the circuit breaker or fuse protection of the circuit. (Refer to Table 41.2 in VDE 0100) The smallest conductor size to be used for power wiring shall be 2.5mm².

The following table shall be applied for ambient temperatures up to 40°C. For higher ambient temperatures the values shall be derated as prescribed by SANS 1

Nominal Cross Section mm ²	CONDUCTOR RATING (A)				
	1	2 – 3	4 - 5	6 - 9	10 and more
2.5	26	23	21	18	16
4	38	34	30	27	23
6	47	42	38	33	28
10	60	54	48	42	36
16	75	68	60	52	45
25	94	85	75	66	56
35	120	108	96	84	72
50	150	135	120	105	90
70	187	168	150	130	112

3.19.12 Internal Wiring

Standard 600V Grade PVC insulated stranded annealed copper conductors to SANS 150 shall be used for the internal wiring.

Wiring shall be installed away from terminals, clamps or other current carrying parts. Wiring shall also be kept away from exposed metal edges or shall be protected where the cross metal edges.

No joints will be allowed.

3.19.13 Labelling

All equipment shall be fully labelled and accurate descriptions shall be given.

Engraved plastic or ivory sandwiched strips shall be used for labels. The labels shall bear white lettering on a black background. Painted or printed labels are not acceptable.

The following labels shall be supplied as a minimum requirement:

- Designation of Mini-substation

Lettering - at least 40mm high. Label on the outside in a prominent position on both the front and back of the substation.

- Designation of circuits i.e., circuit breaker, isolator, meter, etc.
e.g. HOUSE 473

PUMP SUPPLY

Lettering - at least 5mm high. One label installed directly below each item of equipment pertaining to the particular circuit shall be provided.

- The function and circuits of all other equipment shall be clearly identified. Flush mounted equipment within the front panel shall be identified with labels fixed to the front panel. The labels for all equipment installed behind panels shall be fixed to the support panel close to the equipment.
- The labels shall be secured by means of brass nuts and bolts, self-tapping screws, pop rivets or slotted label holders. Engraved labels shall be secured to facilitate a neat alteration of the destination of the labels. *Labels shall not be glued to their mounting positions.* Sufficient fixing points shall be provided to prevent labels from warping.
- All label designations shall be confirmed with the Engineer before manufacture.

3.20 Notices

The notices in terms of Clause C52 of the Factories, Machinery and Building Works Act, 1941 and labels as required on the outside of the mini-sub shall be riveted to the steel door or panelling so that they cannot easily be removed. Brass rivets shall be used. In the case of fibreglass kiosks, the notices shall be laminated into the fibreglass except for the designation label.

3.21 Inspection

The Engineer shall be notified at least two weeks in advance of the completion of the mini-substations in order that an inspection may be carried out before delivery.

3.22 Drawings

3.22.1 Drawings for Approval

A set of two prints of the shop drawings of the mini-substations shall be submitted to the Engineer for approval before manufacture commences.

The following information shall be presented:

- Schematic and wiring diagrams.
- A complete layout of the internal arrangement of the mini-substations showing all equipment dimensions and constructional details. The positions and method of fixing of busbars shall be shown.
- All labelling information in both official languages on a separate sheet.
- The makes, catalogue numbers and capacities of all equipment schedules on a separate sheet.
- A detail drawing of the concrete plinth showing concrete mixes, dimensions, opening sizes, steel reinforcing details and holding down bolts fixing details. These drawings shall be submitted immediately after the award of the contract for pre-installation purposes.

The approval of drawings shall not relieve the Contractor of his responsibility to the Engineer to supply the mini-substations according to the requirements of this specification.

3.22.2 Final Drawings

A complete set of "as-built" drawings of the mini-substations shall be submitted to the Engineer within two weeks after delivery.

3.22.3 Completion

The contract shall be regarded as incomplete unless all drawings have been handed to the Engineer.

PART 3T

SANSA MATJIESFONTEIN

MINIATURE SUBSTATIONS

DETAILED TECHNICAL SPECIFICATION FOR MINIATURE

This index refers to the Part numbers [Part 3T] as per the CAI standard document.

PART 3.1	LOCAL SUPPLY AUTHORITIES
PART 3.2	SERVICE CONDITIONS
PART 3.3	INSPECTION OF SITE
PART 3.4	INSURANCE
PART 3.5	REGULATIONS
PART 3.6	DOCUMENTATION
PART 3.7	DETAILS TO BE SUBMITTED WITH TENDERS
PART 3.8	MAINTENANCE AND GUARANTEE
PART 3.9	TIME PROGRAMME
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PART 3.11	DESCRIPTION OF THE MINIATURE SUBSTATION
PART 3.12	PLINTH

PART 3T

DETAILED TECHNICAL SPECIFICATION FOR MINIATURE SUBSTATION

This specification covers the supply, delivery, installation, commissioning and free maintenance during the guarantee period of the Miniature Substation installation.

A summary of the work involved and for which the Tenderer must allow is as follows:

Supply and delivery of miniature substations, complete with own plinths.

The miniature substations shall comply with the latest edition of SANS 780 and its subsequent amendments and all Standard referred therein. It shall bear the SANS mark.

Rated Power	:	As per BoQ
Number of phases	:	3
Rated frequency	:	50Hz
Rated voltage ratio	:	11 000/400
Vector group	:	Dyn 11
Outdoor type	:	Yes
Hermetically sealed	:	Yes
Cooling	:	ONAN
Winding	:	Double wound, copper or aluminum
Losses	:	Low loss type
Neutral terminal	:	on the LV side
Earthing terminal	:	Yes
Tapping	:	± 2,5% and ± 5% of the rated voltage on the MV side, with externally operated off-load tap-changing switch.
Core Steel	:	Hot rolled or cold rolled low loss steel
Terminal arrangements	:	bushing on both MV and LV side
Other constructional details And fittings	:	Rating and diagram plates lifting lugs

3.1 LOCAL AND SUPPLY AUTHORITIES

The Supply Authority will eventually be Eskom. The successful Tenderer shall ensure that he is fully conversant with all by-laws of the authorities.

3.2 SERVICE CONDITIONS

All equipment shall be suitable for the following site conditions:

Ambient Temperature	-5°C to +40°C	24 hour average not exceeding 35°C
Humidity	5% to 95% RH (non-condensing)	
Altitude	Approximately 1750 m	
Lightning	Severe	
Dust	Severe	
Nominal LV Supply	400/230V (no load), 4 wire 3-phase system with earthed neutral \pm 5%	
Fault Level	350 MVA (To be Confirmed)	

Tenderers are advised to visit the site and thoroughly acquaint themselves with the nature and extent of the site conditions, availability of labour and storage of material.

Tenderers are to make allowance for items obviously intended and necessary for the proper completion of the work, although not specifically specified.

3.3 INSPECTION OF SITE

No site visit will be arranged.

3.4 INSURANCE

Tenderers shall ensure their insurance policies provide adequate cover for the installation activities as the construction work progresses. Documentary proof shall be presented with the tender. Should insurances have to be extended to cover eventualities that may arise from construction activities, these additional premiums shall be deemed to be included in the tender price. Tenderers shall refer to the Contract Preliminaries and ensure that their insurance policies comply with the requirements of the Contract Preliminaries.

3.5 REGULATIONS

The total installation shall conform to relevant SANS codes as well as all the regulations and by-laws of the Local Authorities.

3.6 DOCUMENTATION

The Transformer/Miniature Substation Installation shall comply in all respects with the conditions of this document and the drawings, which form part of this specification. In the event of contradictions between Part 2 and Part 3 of the specification, Part 3 shall take preference.

3.7 DETAILS TO BE SUBMITTED WITH TENDERS

The attention of the Tenderer is drawn to the fact that a tender is subject to disqualification if all the information called for is not submitted with the tender.

Should the Tenderer in any way differ from the specification, he shall explicitly state such differences in detail. This information shall be submitted in a covering letter accompanying the tender, stating the paragraph of the specification where the requirements of the specification are deviated from.

It should be noted that information entered in the schedules would not relieve the Tenderer of his obligations to comply with the specification.

3.8 **MAINTENANCE AND GUARANTEE**

The installation and equipment supplied under this contract shall be guaranteed and maintained for a period of twelve [12] months, from date of acceptance by the Engineer, in all respect and commissioned for continuous service. The tender price shall include the above.

3.9 **TIME PROGRAMME**

Tenderers are advised that it will be required of the successful tenderer to commence work on site as per the programme.

3.10 **TESTS**

Standard routine group III tests and test certificates are required, in accordance with SANS 780. Neither group I nor group II tests will be required if type test certificates are available.

3.11 **DESCRIPTION OF THE MINIATURE SUBSTATION**

13.11.1 Standards

The mini-substations shall comply with the latest edition of SANS 1029 and SANS 1030.

13.11.2 General construction

Each unit shall consist of a sheet steel, weatherproof case divided into three compartments:

- MV compartment
- Transformer compartment
- LV compartment

Access to the various compartments shall be by hinged doors fitted with suitable locks.

The transformer shall be completely removable, without disturbing the MV and LV compartments.

13.11.3 MV compartment

The MV compartment of each miniature substation shall incorporate:

- One 11kV, 3-phase, cable boxes suitable for connection of a 70mm², 11kV cross linked polyethylene insulated, armored cable.
- One 3-pole, 11kV, 400A, dry type, manually operated, spring assisted, on-load isolator, with a suitable short circuit protection for the transformer.

Making capacity : 30kA

Short time current – 1 sec : 14kA

Mechanical withstand peak current : 30kA

- Busbars of epoxy resin insulated, hard drawn high conductivity copper, rated 200A.
- Ring main unit to SF6 type. Alternative offer shall be provided for oil type.

13.11.4 LV compartment

The LV compartment shall be equipped as per single line diagrams. ~~Note that load breakers have to be accommodated as national tenants as well as the main LV Board will be supplied from the LV Compartment.~~

Metering with associated current transformers and ammeters rated at 5 Ampere (1500:5 ratio CT).

Space must be left for future extensions.

All connections shall be brought to terminals mounted near the bottom of the cubicle.

Each mini-sub shall be suitable for the termination of 3 off 185mm² cables.

A cable gland tray shall be supplied.

All cables to be in a trefoil configuration.

13.11.5 Corrosion protection

All steel shall be dressed to have a weld spatter and burr removed. Base frames and structural steel components, if and where used, shall be galvanized to SANS 763. Note that no drilling, cutting or machining will be permitted after galvanizing. All other steel shall be painted.

Galvanized sheet where used:

- Clean off all contaminants and passivating films with an approved proprietary compound i.e. galvalume.
- Paint with an alkyd system consisting of an approved primer for galvanizing, an intermediate coat of universal undercoat followed by two coats of enamel, the final colour being Avocado (SANS 1091 colour no C12). The total dry film thickness shall not be less than 150 micro meters.
Or
Coat with a polyester powder coat to the same thickness and colour.

Other sheet steel, where used:

- Clean off all rust and mill scale, either by pickling for thickness under 4mm or abrasive blasting to SA 2½ for 4mm and thicker material.
- Coat as for galvanized sheeting, but using an appropriate primer i.e. Zinc Chromate.

13.12 PLINTH

Miniature sub-station concrete plinth to be supplied with the miniature substation.

13.12.1 TEST AND INSPECTIONS

The Electrical Engineer shall be informed:

- When the manufacture of the transformer has been completed, so that tests on it may be witnessed if required.
- When the equipment is “ready for dispatch” so that an additional inspection can be carried out.

13.12.2 “AS-BUILT” DRAWINGS

The following drawings shall be submitted with the tender:

Transformer

- Out-line and general arrangement
- General arrangement of core and windings
- MV and LV terminal arrangement
- General arrangement of off-load tap switch

Miniature Substation

- General arrangement of MV switchgear and cable boxes
- General arrangement of LV switchgear
- General design of whole substation showing the position of transformer, MV and LV, switchgear, LV busbar arrangement and inter-connections and overall dimensions

The successful Tenderer will be responsible for the compilation of "As Built" drawings showing the exact location of all the conductors and connections installed as part of the contract, as well as all readings taken during testing.

The drawings shall show the exact, dimensioned location of conductors and connections.

13.12.3 OPERATING AND MAINTENANCE MANUALS

The Contractor shall provide three [3] hard and two [2] electronic copies of Operating and Maintenance Manuals, which shall contain the following:

- A list giving the name and address of the Manufacturer of each item of equipment.
- A preventative maintenance programme for all equipment.
- Operating instructions for each item of equipment.

NOTE:

The installation will not be considered complete until the above drawings and schedules have been issued.

13.12.4 DELIVERY

The delivery period from date of appointment shall be clearly specified; preference may be given to tenders offering short delivery times.

MEDIUM VOLTAGE SWITCHGEAR

SCHEDULE OF EQUIPMENT OFFERED

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	EQUIPMENT GUARANTEES AND TECHNICAL PARTICULARS
A	TRANSFORMERS			
1	Country of manufacture			
2	Manufacture			
3	Does transformer comply with SANS 780, low loss?		YES	
4	Has the transformer the SANS mark		YES	
5	Rated output	kVA	500	
6	Rated voltage ratio	kV	22/0.4	
7	Voltage tapping on MV	%	± 2,5 and 5	
8	Rated frequency	Hz	50	
9	Hot rolled or cold rolled steel			
10	Copper or aluminum winding			
11	Class of oil			
12	Total oil quantity	1		
13	Overall dimensions			
13.1	Height	mm		
13.2	Length	mm		
13.3	Width			
14	Thickness of materials			
14.1	Sides	mm		
14.2	Bottom	mm		
14.3	Top	mm		
14.4	Cooler tubes	mm		
15	Guarantee on principal tapping			
15.1	No load loss	W		
15.2	Magnetizing current	A		
15.3	Load loss (U^2R + stay) at 75°C	W		
16	Maximum flux density			
16.1	Core	T		
16.2	Yoke	T		
17	Maximum current density in wining			
17.1	MV	A/mm ²		
17.2	LV	A/mm ²		
B	MINIATURE SUBSTATION UNIT			
1	Country of manufacture			
2	Manufacturer			
3	Overall dimensions			
3.1	Height	mm		
3.2	Length	mm		
3.3	Width	mm		
4	Dimensions of base			
4.1	Length	mm		
4.2	Width	mm		

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	EQUIPMENT GUARANTEES AND TECHNICAL PARTICULARS
5	Thickness of case	mm		
6	Total mass of complete substation including all fittings and first filling of oil			
C	MV SWITCHGEAR			
1	Country of manufacture			
2	Manufacturer			
3	Type			
4	Rated normal current	A	400	
5	Rated voltage	kV	22	
D	LV SWITCHGEAR			
1	Country of manufacture			
2	Manufacturer			
3	Type			
4	Rated normal current	A	400	
5	Rated voltage	V	400/230	

PART 4

SANSA MATJIESFONTEIN

GENERAL TECHNICAL SPECIFICATION

ELECTRICAL INSTALLATION

This index refers to the Part numbers [Part 4.1] as per the CAI standard document.

PART 4.1	GENERAL INFORMATION
PART 4.2	CONDUIT SYSTEMS AND ACCESSORIES
PART 4.3	WIRING AND WIRING SYSTEM ACCESSORIES
PART 4.4	EARTHING
PART 4.5	LIGHT FITTINGS AND INSTALLATION REQUIREMENTS
PART 4.6	MOTORS, STARTERS AND MOTOR PROTECTION SYSTEMS
PART 4.7	DISTRIBUTION BOARDS AND DISTRIBUTION BOARD EQUIPMENT
PART 4.8	CABLE INSTALLATION AND ACCESSORIES
PART 4.9	LIGHT SWITCHES AND SOCKET OUTLETS
PART 4.10	CONNECTIONS TO EQUIPMENT
PART 4.11	FIXING MATERIALS
PART 4.12	SUBSTATIONS FOR PLANT ROOMS
PART 4.13	PROVISION FOR TELEPHONE INSTALLATIONS
PART 4.14	OVERHEAD TRANSMISSION LINES UP TO 22kV
PART 4.15	BUSBAR SYSTEMS (UP TO 1000 V)
PART 4.16	HIGH VOLTAGE SWITCHGEAR AND ASSOCIATED EQUIPMENT
PART 4.17	LOW VOLTAGE DISTRIBUTION CUBICLES (KIOSKS)
PART 4.18	MINIATURE SUBSTATIONS
PART 4.19	DISTRIBUTION TRANSFORMERS
PART 4.20	HOT WATER CYLINDERS
PART 4.21	POWER FACTOR CORRECTION EQUIPMENT

4.1 GENERAL INFORMATION

The general technical requirements cover the supply and delivery, installation, testing, commissioning and maintenance of the Electrical Installation as described in the Specification.

The works shall comply with the requirements of the Specification.

The Subcontractor is required to provide all material, equipment, labour and services, and to perform all operations required for the installation to be complete and operative.

The Engineer will inspect the installation from time to time during the progress of the work. Discrepancies will be pointed out to the Sub-contractor and these shall be remedied at the Subcontractor's expense.

The Subcontractor shall notify the Engineer timeously when the installation reaches important stages of completion so that the Engineer may schedule site inspections in the best interests of all concerned. Work shall not be unduly closed up prior to inspection.

4.2 REGULATIONS

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

MOSA	The Machineries and Occupational Safety Act.
	The regulations of the local Gas Board.
SABS	The SANS Code for the Wiring of Premises - SANS 0142 as well as SANS 0180 as amended.

The local Municipal bylaws and regulations as well as the regulations of the Local Supply Authority.

Code of Practice for Engineering Drawing (Metric Units).

BS 308 (Including Supplement No 1) Engineering Drawing Practice.

ISO Recommendation R370	Conversion of Tolerance Dimensions.
BS 3939	Recommended Graphical Symbols.
BS5486 Part 1	Factory built assemblies of Switchgear and Control gear for voltages up to and including 1000V AC and 1200V DC.
BS5419	Air Break switches, Air Break disconnectors.
IEC 148	Air break switch disconnectors and fuse combination units for voltages up to and including 1000V AC and 1200V DC.
BS 5424 Part IEC 158.1	Control gear for voltages up to and including 1000V AC and 1200V DC.
IEC 144	Degrees of Protection of Enclosures for low voltage Switchgear.
IEC Technical Sub-Committee	Draft Guiding principles in the preparation of Circuit Diagrams
BS4752 Part 1	Circuit breakers of rated voltage up to and including 1000V AC and 1200V DC.
BS 142	Electrical protective relays.

BS89 IEC 51	Direct Acting Electrical Indicating Instruments.
BS 3693 Part 1	Instruments of bold presentation and for rapid reading.
BS3938	Current Transformers.
BS3941	Voltage Transformers.
BS 3535	Safety isolating transformers for domestic and industrial purposes.
DIN 43620 cartridges.	Low Voltage High Current Fuses 500V with contact blades - NH fuse
VDE 0660 Part 4	Regulations for low voltage power fuses (NH Fuses) with rated voltages up to 1000V AC and up to 3000V DC.
IEC 269-1/-2	Low Voltage Fuses.
BS 158	Marking and arrangement of switchgear busbars, main connections and small wiring.
BS 159	Busbars and Busbar connections.
BS 1433	Copper for Electrical purposes.
BS 1706	Electroplated coatings of Cadmium and zinc on iron and steel.
BS 5472	Specification for low voltage switchgear and control gear for industrial use, terminal marking and distinctive number (General rules).
BS 4794 Part 1 & Part 2	Control switches, switching devices including contactor relays for control and auxiliary circuits up to, and including 1000V AC and 1200V DC.
SABS 763	Hot dip (Galvanised) Zinc coatings other than continuously coated steel sheet and wire.
SABS 1091	National Colour Standards for Paint.
SABS 135 & Amendment 1	ISO Metric Black Bolts, Screws and Nuts.

It shall be assumed the Subcontractor is conversant with the abovementioned regulations. Should any requirements, bylaws or regulations, contradict the requirements of this document, apply or become applicable during erection of the installation, such requirements, bylaws or regulations shall overrule this document and the Subcontractor shall immediately inform the *Engineer* of such a contradiction.

4.3 ARRANGEMENTS WITH THE SUPPLY AUTHORITY

The Subcontractor shall supply and install all notices and warning signs required by the appropriate laws, regulations and/or the Specification.

4.4 MATERIAL, EQUIPMENT AND WORKMANSHIP

All material shall conform in respect of quality, manufacture, tests and performance, with the requirements of the South African Bureau of Standards, or where no such standards exist, with the appropriate current specification of the British Standards Institution.

All material shall be new and of acceptable quality and where not covered by standards be, suitable for conditions on site. These conditions shall include weather conditions as well as conditions under which materials are installed, stored or used. Should the materials not be suitable for use under temporary site conditions, then the Subcontractor shall, at

his own cost, provide suitable protection until these unfavourable site conditions cease to exist.

The Subcontractor shall, where requested to do so, submit samples of equipment and materials for approval prior to installation. Samples may be retained until the contract is completed after which they will be returned.

Locally manufactured equipment shall be used where possible and practical, in preference to imported equipment. The Engineer in no way binds himself to assist the Subcontractor in obtaining import permits for imported equipment.

The works shall be so installed as to provide ease of inspection, cleaning and maintenance.

All artisans employed on site shall be competent in terms of the Regulations and Acts.

Should any workmanship, equipment or material not be to the satisfaction of the Engineer at any stage of the Subcontract it shall be rectified at the cost of the Subcontractor and all rejected materials shall be removed from site.

4.5 OPERATOR TRAINING

On completion of all tests, the Subcontractor shall continue to be responsible for the complete operation and maintenance of the works until the completion date, during which period instructions shall be given to the *Employer's* staff for the proper operation and maintenance of the equipment.

The operation and maintenance of the works, for the duration of the instruction period, shall not in any way relieve the Subcontractor of his responsibility under the terms of the Subcontract.

4.6 STORAGE OF EQUIPMENT AND MATERIALS

The Subcontractor shall ensure that all stored materials and equipment are safely stacked and that stacking does not damage them.

The Subcontractor shall ensure stored materials and equipment do not overload the structure or floor construction. The Subcontractor is to take note of the design loads for the floor systems in terms of the final and temporary position of equipment.

The storage of combustible materials on site shall be kept to a minimum. The Subcontractor shall be responsible for ensuring that such combustible materials are safely stored. Suitable firefighting equipment shall be provided by the Subcontractor, who shall further ensure that staff capable of using the equipment is at hand.

4.7 LOCATION OF EQUIPMENT

The Subcontractor shall check on doorways, passages, openings, lifts, etc., provided and shall ensure that all equipment offered can be installed in its final position. If necessary, equipment shall be ordered in a partially dismantled condition so that it is suitable for moving through the restricted openings or areas of restricted height or areas of restricted load.

4.8 CO-OPERATION WITH OTHER TRADES

The Subcontractor shall ascertain the extent of the work of other trades on site.

The Subcontractor shall give all necessary assistance to other trades to ensure that the work of all trades can be installed satisfactorily and without delay.

The Subcontractor shall liaise with other trades working in close proximity to the work covered by the Specification and shall assist in planning equipment and material positions to ensure that all trades can complete their work satisfactorily.

4.9 SUBCONTRACTORS WORK

The Subcontractor shall, within 30 days, or any shorter period which may be necessitated by the construction programme, submit three copies of all drawings showing all building work that would be required to facilitate the installation of electrical equipment.

The drawings shall be complete with all the dimensions, details, etc., for the work to be conducted correctly.

The Engineer will scrutinise the drawings and request changes and adjustments as required. After such changes are satisfactorily made the drawings will be approved.

It is the responsibility of the Subcontractor to check the works to ensure that the work has been correctly conducted in accordance with the drawings. The Subcontractor shall point out any problem areas as soon as possible to the Engineer so that they can be rectified. No claims will be considered for delays or other additional costs which arise out of the Subcontractor's failure to check the works in good time.

The drawings shall be fully dimensioned and shall include the following:

- Details of all bases that is required.
- Details of all openings in walls and concrete work.
- Details of ventilation.
- Details and positions of all equipment to be built into walls.
- Any other work required.

4.10 SUPERVISION AND SITE ORGANISATION

The Subcontractor shall always have copies on site of all relevant drawings as well as a copy of the Specification. The Subcontractor shall institute the necessary procedures to ensure that the drawings on site are the latest drawings and that all superseded drawings are removed from site.

4.11 DRAWINGS

The drawings for the subcontract shall be those issued after subcontract award and marked for construction.

As part of this contract, the Subcontractor shall provide the following drawings:

- **Manufacturing and Installation drawings**
The manufacturing and installation drawings ("shop drawings") shall provide all details of the components necessary, if any, for the manufacture and installation of the system in accordance with the Specification.
- **Wiring Diagrams**
The wiring diagrams shall provide details of all the wiring associated with the installation over and above to what has already been issued to the Subcontractor. The same drawing symbols and system shall be used, as used on the drawings issued to the Subcontractor.
- **Subcontractor's Work Drawings**
All necessary Subcontractors' work drawings, as described elsewhere in this Specification, shall be provided as part of this subcontract.
- **As-built Drawings**
Four weeks after completion of the works, the Subcontractor shall provide a complete set of drawings showing the completed works.

4.12 MAINTENANCE AND GUARANTEE

Maintenance

The Subcontractor shall maintain the works as described in the Specification for a period of 52 weeks from the completion date.

Maintenance visits shall be conducted at regular monthly intervals. The maintenance shall cover all items of the works and shall include replacement of expendable items. In addition to the monthly maintenance visit, the Subcontractor shall conduct all necessary visits to attend to all complaints as identified by the Client.

The Subcontractor shall report to the Client's nominated representative both on arriving and leaving the site. The

Subcontractor shall provide the Client with a Service Report for each visit whether scheduled or breakdown.

At each maintenance visit, the Subcontractor shall check the function of each item and shall ensure that the system is performing to specification. All automatic controls and safety devices shall be checked. All electrical control gear, lamps, etc., shall be checked and adjusted or replaced as necessary.

The equipment and plant rooms shall be cleaned at each scheduled visit.

The Subcontractor may at his discretion, allow the maintenance period to commence on any item of equipment or section of the installation at a date prior to the completion date, if it is put into operation for beneficial use of the *Employer* prior to the completion date. This will not be permitted in cases where the completion date is delayed due to the Subcontractor not completing the works in accordance with the programme.

The maintenance will be priced against the specification included under the schedules. If accepted by the *Employer* a separate contract will be signed with the successful tenderer.

4.13 GUARANTEE

The Subcontractor shall and does hereby, in favour of the subcontract works and the *Employer*, guarantee and warrant the entire installation as described in this specification for twelve [12] months from the completion date.

The guarantee shall include all parts, spares and equipment that becomes defective during the guarantee period shall be replaced free of charge. The guarantee shall cover all costs including material, labour, overheads, travelling, etc.

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

The guarantee shall cover all materials, plant and equipment whether or not it is covered by a manufacturer's guarantee. The twelve [12] month guarantee, in terms of this subcontract, on the works shall not be affected by the prior expiry of any guarantee provided by the manufacturer of any items of the works.

The Subcontractor shall cede to the *Employer* the remainder of any equipment guarantee received from Manufacturers that extend beyond the twelve [12] month period. It shall be the responsibility of the Subcontractor to ensure that each such equipment guarantee is transferable.

The Project Manager may, at his discretion, allow the guarantee period on any item of equipment of section of the works start at a date prior to the completion date if it is put into operation for beneficial use of the Client. This will not be permitted in cases where the completion date is delayed due to the Subcontractor not completing the works as per the programme.

4.14 OPERATING AND MAINTENANCE MANUALS

The Subcontractor shall provide three [3] hard and two [2] electronic copies of the Operating and Maintenance Manuals.

The Subcontractor shall submit four weeks prior to the completion date two-draft copies of the Maintenance and Operating Manuals for the works to the Engineer for approval.

The Engineer will return these to the Subcontractor within ten working days of receipt marked with all changes, which are necessary.

The Subcontractor shall modify the manuals, as required and re-submit to the Engineer, within ten working days, revised copies of the manuals. Four weeks after completion date the Subcontractor shall provide three copies of the Final Operating and Maintenance Manuals for the system supplied. The manuals shall be bound in book form with hard plastic covers to withstand constant use.

The manuals shall be properly indexed to facilitate ease of reference.

The manuals shall include:

- A list of spares to be supplied by the Subcontractor to cover the period of maintenance. This list shall cover all spares to be held in stock by the Subcontractor for this project and shall not in any way relieve the

- Subcontractor of the obligation to provide any and all spares required during the maintenance period.
- A list giving the name and address of the local agent for each item of equipment.
- A list giving the name and address of the manufacturer of each item of equipment.
- A copy of all test certificates obtained with the system.
- A preventative maintenance programme for all equipment.
- Operating instructions for each item of equipment.
- Complete "As Built" drawings of the installation and wiring and schematic diagrams.
- Detailed operating instructions for all the modes of operation of the system [Firemen's service, Standby power service, etc.]
- Certificates of Compliance as required.

4.15 GENERAL REQUIREMENTS

These rules will be applicable to all Subcontractors entering the site location for Matjiesfontein

Whilst these rules will apply to all Subcontractors, it is appreciated that in certain instances the size of the contracting company or the nature of the contract in question will render some of the rules inapplicable. However, in such instances any subsequent exceptions or exemptions will only be enforceable if so agreed to in writing by the Principal Agent. The onus is upon the Subcontractor to apply for any such exception or exemptions.

4.15.1. Definitions

The Act

The "Act" refers to the Occupational Health and Safety Act, and any Regulation made under the Act.

Management

"Management" mean those persons to whom duties have been assigned in terms of Section 16(2) of the Occupational Health and Safety Act.

Project Engineer

This shall refer to a qualified Engineer.

Representative

This shall refer to the Project Manager assigned to co-ordinate the project.

Subcontractor

The term "Subcontractor" shall refer to the successful Tenderer or any other employer appointed to perform any service for the Main Contractor.

Tools and/or Equipment

"Tools and/or equipment" shall mean any work article, substance, plant or machine in the context of the Occupational Health and Safety Act, and any Regulation incorporated under the Act.

SABS

South African Bureau of Standards.

NOSA

National Occupational Safety Association.

SANS

SANSA Matjiesfontein

Electrical Specification

February 2025

Rev 3

South African National Standards.

4.15.2. Introduction

Apart from human considerations, the observance of these safety and health rules will assist in complying with legal requirements and more specifically but not limited to the requirements of the Act.

These rules are not intended to restrict the duties of the Subcontractor or to relieve him of his legal obligations to ensure safe working conditions and methods but must be viewed as arrangements and procedures in terms of section 37 (2) of the Act.

The Subcontractor shall bring the contents of this document to the attention of each and every staff member and shall ensure their compliance.

4.15.3. Statutory obligations and regulations

The Subcontractor will ensure that all work is executed in accordance with the law, in particular:

Occupational Health and Safety Act.

Compensation of Occupational Injuries and Diseases Act.

Standards Act applicable to peri-urban by-laws, and any amendments to our subsequent replacements of these acts.

The Subcontractor will ensure that work is executed in accordance with the following environmental legislation:

Environment Conservation Act.

National Environmental Management Act.

Hazardous Substances Act.

National Water Act.

Petroleum Products Act.

Atmospheric Pollution Prevention Act.

Local (OFS) by-law for the Prevention of Water Pollution (Local Authority Notice) and amendments to or subsequent replacements of this legislation.

All work shall be done in a substantial, permanent, professional and neat manner by competent tradesmen, incorporating the best methods and common practices and shall conform with:

General Conditions of Contract, for use in connection with Electrical and Mechanical Engineering Works.

Code of Practice for the Electrical Wiring of Premises, SANS 0142, as amended.

Fire Protection for Installations, SABS 0400, subject to the final approval of the Safety, Health and Department.

Specifically, the acceptance of these rules implies that the Subcontractor guarantees that the Client has no liability in terms of the requirements of the Compensation of Occupational Injuries and Diseases Act.

The Subcontractor shall submit to the Main Contractor a certificate of good standing with the Workmen's Compensation Commissioner.

4.15.4. Entry into Works

On arrival at the works, the Subcontractor shall report to the Main Contractor site office.

4.16 ELECTRICAL SPECIFICATION

14.16.1 General procedure for electrical works by subcontractors

The Subcontractor shall be registered with the Electrical Contracting Board of South Africa (ECB), the Electrical Subcontractors association (ECA) and the department of Manpower as an electrical Subcontractor. Also refer an earlier clause pertaining to registration and documentary proof required of registration.

It is at all times the Subcontractor's responsibility to ensure that his work complies with the SANS Codes of Practise.

The Subcontractor shall submit a "Certificate of Compliance" upon completion of the works.

14.16.2 General requirements

The tenderer shall deem to have examined carefully the tender documents (Specifications, schedules, conditions, and drawings) to submit an accurate tender. The tenderer must submit to the engineer in writing any queries regarding unclear information so that it can be resolved before the tender closes.

Tenderers are advised equipment specified refers to the type and manufacturer specifically and that if it is anticipated to use substitutes, the onus is on the electrical Subcontractor to prove that such substitutes are similar and equal to the article specified and meets with the engineers' approval.

The decision whether the specified articles are to be used and installed or whether alternatives offered are acceptable shall rest solely with the Electrical Engineer whose decision shall be final.

The Electrical Engineer may request the Subcontractor to install exact articles specified and no alteration to the tender price shall then be permissible.

All queries and requests regarding substitutes or alternatives must be submitted in writing to the Electrical Engineer who will submit his/her decision in writing to the Subcontractor. The installation of such equipment or material may only commence upon such approval.

No telephonic enquiries shall be entertained. All queries shall be e-mailed to harry@cai.co.za in all correspondence.

14.16.3 Compliance with regulations

The installation shall be executed in accordance with the latest revision and amendments of the relevant Codes of Practise as listed elsewhere in this document.

No claims for extra work in respect of failure by the Electrical Subcontractor to comply with any of the regulations will be considered.

Where conflict exists between any of the regulations and the tender specifications, the said conflict must be referred to the Electrical Engineer in writing for his written ruling.

14.16.4 Drawings

The Electrical Subcontractor must refer to the Architect's-, Civil- and Other services drawings for detail information on various parts of the electrical installation.

The Electrical Subcontractor must submit to the Electrical Engineer, shop drawings, diagrams, schedules, brochures and samples for any design of equipment (e.g. Distribution Boards), required on the part of the Electrical Subcontractor, for approval.

Approval by the Electrical Engineer of such drawings and samples shall not relieve the Subcontractor of responsibility for errors or omissions of and deviations from these drawing or samples.

A complete set of drawings will be issued to the Electrical Subcontractor to be marked up to indicate the "As-Built" installation and to include all additional work or omissions. This is a prerequisite to the completion of the installation.

14.16.5 Material

Materials and equipment used in this contract must, where possible be of South African manufacture and shall comply with this specification and the relevant SABS specifications and shall be approved and installed to the satisfaction of the Electrical Engineer.

The Electrical Subcontractor must submit samples of material and equipment to the Electrical Engineer if requested and such samples will be returned upon completion of the contract.

BUILDERS WORK

Immediately after the acceptance of the tender the Electrical Subcontractor shall inform the Building Contractor of the requirements for all the chases, openings in building work, casting in of sleeve pipes and boxes in concrete and installation of pipes and boxes in partitioning and at regular intervals thereafter to enable the builder to be well informed in advance of all structural electrical requirements.

The Electrical Subcontractor shall ensure that all such equipment is firmly fixed in position before casting or closing of brickwork or partitioning commences.

The Building Subcontractor is responsible for the making good of all chases, castings, and building in of electrical equipment but the responsibility for correct execution will remain with the Electrical Subcontractor.

The Electrical Subcontractor is responsible for all damage to the building structure, paintwork and other services caused by him.

14.16.6 Medium Voltage Cables - 11 000 Volts

Medium Voltage cable trenches shall be not less than 1 meter deep x 450mm wide.

The laying of medium voltage cables in trenches shall comply with the following:

- The trench shall be clear of stones and any rough particles.
- A layer of river sand 150mm thick shall be spread on the bottom of the trench.
- The cable and the earth wire shall be laid on top of the river sand, taking care to prevent kinks and twists.
- A layer of river sand shall be laid, providing a minimum cover of 150mm over the cable.
- The trench shall then be refilled in layers with the selected soil from the soil removed during the excavation of the trench, taking care properly to compact each layer.
- 300mm from ground level, danger tape shall be laid the length of the trench, and then only the final layer of selected soil.
- All cables shall be marked as described stating size and origin.
- Concrete cable markers shall be placed every 20 metres and at every turn off, above the trench. All joints shall be marked with a concrete marker (HV Joint).
- Only Raychem or 3M joints and termination kits are to be used.

The medium voltage cable reticulation shall be extended from the existing Eskom RMU at the perimeter of the development to the two new miniature-substations as indicated on the drawings.

14.16.7 Medium Voltage switchgear

Medium voltage Switchgear inside the miniature substations forms part of this contract.

14.16.8 Earthing and Bonding

The installation shall be properly and effectively earthed as prescribed in the SANS Code of Practise for the wiring of premises.

The entire electrical installation shall be bonded to the main earth bar by means of separate earth conductors.

Earth continuity shall be maintained at all times.

14.16.9 Cable work – general

All cables inside buildings shall be laid in a workmanlike fashion onto cable trays or in trunking. No cables shall be tied to any building structure, without specific approval.

Cables shall be fixed and supported in such a way that they will remain in the position as installed.

Cable ends shall be complete with suitable glands and shrouds.

No joints shall be allowed unless approved by the Electrical Engineer.

All cables shall be clearly marked at each termination and at each joint by means of PVC labels or other approved method. The label on a main supply cable shall state the source of supply at the load end, and the function and designation at the supply end. A label shall also state the size of the cable. All other cables shall be coded to identify the cables and the same code shall be used at both ends.

Cables shall never be allowed to span any distance unsupported.

Where main cables are to be laid in concrete or under roadways, sleeving with manholes shall be provided.

All cables to machines shall be supplied directly from above and no connections on ground level shall be allowed.

If it is not possible to connect from above, PVC sleeving shall be chased into the floor from the nearest main structural member. PVC sleeves shall have a minimum cover of 40mm. Not more than 1 slow bend shall be allowed without a proper size draw box, complete with a 6mm thick flush steel cover.

Cables leaving or entering a sleeve, embedded in a floor shall be protected by a suitable kick plate.

All single run cables shall be protected in black enamelled steel conduit and supported with galvanised hospital saddles, evenly spaced.

Space between a protective conduit and any electrical equipment shall be a minimum of 200mm.

Where no steel structure members exist to support cable trays, trunking or conduit the Subcontractor shall install a support structure to suit the requirement.

Cable trays, trunking and conduits shall be fixed at distances not greater than 1,5m.

The Structural engineer shall approve the installation of additional supporting steel structures exceeding 3 meters, before installation starts.

14.16.10 Distribution Board Wiring

The insulation colour shall correspond to the phase colour code.

All jumpers between bus bars and circuit breakers, rated over 200 ampere, shall be solid copper, insulated with at least two half-lapped layers of PVC tape.

All wiring shall be ferruled or provided with lugs at the terminations.

No joints shall be allowed in internal wiring.

All connections to bus bars or earth bars shall be made with tinned copper cable lugs soldered or crimped to the ends of the conductors and bolted to the bus bars with cadmium plated high tensile steel bolts and nuts together with spring washers.

14.16.11 Conduit or trunking

Where single circuits have to be installed, these shall be run in conduit painted Electric Orange - Code B29 SABS 1019-1975, to specification. All surface conduit work, in production related areas, shall be executed in metal.

PVC conduit will be allowed, with the approval of the Engineer. Where PVC conduit is used, all accessories shall be manufactured from a similar material.

All conduits, for normal use, shall be for heavy-duty application, drawn or welded type. Conduit shall comply with the requirements of SABS 162, and shall bear the SABS mark. No conduit shall be smaller than 20mm diameter.

Conduit shall be firmly secured with hospital saddles and screws, in accordance with SANS 0142, par 5.4. Conduit shall be secured within 150mm before and after each 90 bend. Nails and crampets shall not be allowed.

Where 2 or more circuits run together, galvanised Unistrut trunking shall be used.

All horizontally mounted Unistrut shall be supported at distances not exceeding 1,5 metres.

All horizontal Unistrut shall be mounted with the open side facing upwards.

All Unistrut, which is to be suspended from steelwork, shall be secured with threaded rod, the minimum diameter of which shall be 8mm, and standard Unistrut clamping brackets.

Connections between motors and lockable motor switches shall be executed in Kopex flexible conduit.

14.16.12 Cable trays or ladders

Cable tray and ladders shall be provided with at least 50 % of rack width spare space, for future additions.

14.16.13 Cable work – Exposed

PVC/SWA/PVC cables or Bus bar to be used as far as possible or as specified.

Cables shall always be laid, supported and fixed as required in the prescribed Regulations.

Cables shall be fixed and supported by means of approved clamping devices, which shall not damage the cable during the installation or over the life of the cable. Cables shall never be laid over any sharp edges, without suitable protection against damage.

All cable ends shall be made off with a suitable gland, which shall be effectively earthed and bolted to equipment or board. The cable gland shall be complete with Neoprene shroud.

No joints shall be allowed in cable runs, except where specifically approved by Electrical Engineer. Where a joint is approved, a proper jointing kit, approved by the Engineer, shall be used.

No cable shall be bent to a radius less than specified in the prescribed Regulations.

Sufficient slack is to be provided at each end of the cable.

14.16.14 Distribution Boards

All distribution boards shall be fitted with lockable doors; however access is required to the main isolating switch.

All outgoing circuits shall be labelled with their circuit numbers. A legend card shall be mounted, inside the board, in a metal pocket with a clear plastic window.

The legend card shall have a description of each circuit, each of which shall be identified by its circuit number.

Circuit numbers shall not be duplicated.

The legend card shall also indicate the circuit breaker size (Amperes) and the interrupting capacity in kA.

As an alternative on old Distribution Boards, the circuit breakers may be labelled with the description of the purpose of the circuit, i.e. Lights, Plugs, etc.

The size of the feeder cable shall be typed on the legend card.

Distribution boards shall be fitted with circuit breakers as identified on the schematic diagrams.

All Distribution Boards shall be painted Electric Orange, unless otherwise specified.

Phases shall be properly balanced.

A minimum of 30% spare space, for future circuit additions, shall be provided on all Distribution Boards.

Outdoor cabinets shall be arranged for bottom entry only, and weatherproof glands shall be used.

Outdoor cabinets shall be weatherproof and shall be constructed from sheet metal not less than 2,5mm thick and shall be hot dip galvanised.

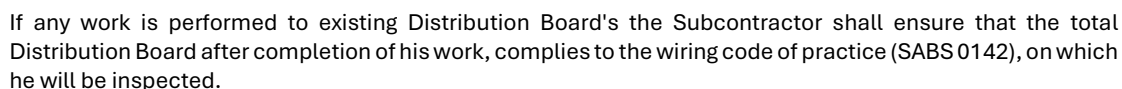
All wiring in distribution boards shall be done in a neat manner, properly secured with plastic straps similar or equal to "Insulock". Neutral, Live and Earth wires shall be bundled separately and Earth wires shall be kept to the back of the board.

Wiring trays (Unistrut or similar) shall be properly jointed. All sharp edges shall be cleaned and shrouded where Unistruts enter distribution boards. They shall be pop riveted to the distribution boards or secured with screws and nuts.

For all PVC insulated wires up to 6mm entering circuit breakers, the copper strands shall be twisted and folded double, or terminated with a suitable lug.

Only single-phase earth leakage units shall be used protecting single-phase circuits, and 3 phase earth leakage units shall be used to protect 3-phase equipment.

All spare positions to be fitted with blanks.



This Specification covers the design, installation and commissioning of Control Panels including the components therein for all types of Machines and Equipment supplied to the development.

Any items not specified but reasonably assumed to be necessary, for the completion of the control panels to recognise standards of workmanship and practice, shall be deemed to be included in the Contract.

All work must be executed and finished in a substantial, permanent and neat manner by competent persons, incorporating accepted methods in recognised practice and in conformity with the various Codes of Practice listed in this Specification.

Where deviations are made to the Equipment Layout or Panel Construction during manufacturing, marked up drawings showing the changes, must be submitted to the Engineer before the final acceptance of the Control Panel.

The agreed delivery dates are firm and binding and any costs incurred to associated Subcontractors caused by delays of the control panel commissioning, will be to the account of the control panel manufacturer/supplier.

The guarantee period of any Control Panel shall commence from the date of the final acceptance by the engineer.

- The nominal voltage is 400 Volt, 3 phase 4 wire, 50 hertz.
- The neutral point is only earthed at the supply transformer.
- The phase Rotation is to be confirmed.
- Environmental conditions:
- 45°C Max
- 85% relative humidity Max
- Standard Control Voltages are:
- Internal (inside panel) 220V AC or 24VDC
- External (outside panel or field) 24VDC

- Control Cabinets Grey RAL 7032
- Plinth Black
- Handles Black

The cabinets of all Control Panels must be constructed in cold rolled sheet metal not less than 1,6mm thick for general areas and 2mm thick for doors.

All Control Panel doors must be provided with 6mm diameter threaded earth lugs at the lower edge nearest the hinge and frame.

All control panel doors must be pad-lockable, unless otherwise specified.

All Control Panel doors must be fitted with drawing holder pockets.

All Control Panel doors must be fitted with a rubber-sealing gasket so as to prevent the ingress of dust.

All Control Panel doors must be so hinged as to allow the door to open through 150° minimum.

All equipment and wiring must be individually protected using suitably rated protective equipment.

Ventilation intake apertures must be fitted with filters so as to maintain the IP54 standard of Protection for Electrical Equipment.

Where operating temperatures are likely to exceed 40°C, forced ventilation must be provided and be thermostatically controlled.

Extension of the actuating shaft on the main switch is not permitted. No interlock required between door and main switch.

All emergency control circuits must be hardwired.

No cabling, wiring or wire ways are permitted to enter through the side of any Control Panel unless prior permission has been obtained from the Engineer, in writing. Either top or bottom entry through a gland plate is permitted.

All Control Panels must be solidly earthed to the main earth bar via a BCEW with diameter the same as that of the supply cable. The earthing conductors must be bolted to the panel earth bar or frame using brass bolts and nuts.

Suitably sized narrow slotted PVC wiring channel must be fitted to all edges of the mounting plate and between the rows of equipment, for all interconnecting cabling. All wiring channels to be not more than 50% full of wiring.

CODES OF PRACTICE

The entire installation shall be executed in accordance with the latest revision and amendments of:

The Machinery and Occupational Safety Act and Regulations.

Special Note: Revision 2920 of 23rd of October 1993.

The SANS 0142 Code of Practice for the Wiring of Premises.

The Local By-laws and any special requirement of the local supply authority.

No claims for extra work in respect of failure by the Electrical Subcontractor to comply with any of the above regulations will be considered.

Where conflict exists between any of the above regulations and the tender specifications, the said conflict must be referred to the Electrical Engineer in writing for his written ruling.

CONSTRUCTION AND GENERAL ARRANGEMENT

Control Panel Cabinets should be of Rittal, Regona or Le Grand manufacture approved by the Engineer.

~~The floor-mounted cabinets must be manufactured to the following dimensions:~~

- Height 1800 mm to 2000 mm (excluding plinth)
- Width Single Door 800mm
- Double Door 600mm
- Depth 600mm (overall)

~~The wall-mounted cabinets must not exceed the following dimensions:~~

- Height 1500 mm
- Width Single Door 650mm

● Double Door	1250mm
● Depth	400mm (overall)

The Panels must be fitted with a Plinth constructed of R.S.C. 100mm x 3mm. The Plinth must be flush with the panel on all sides.

Equipment Mounting Plate must be constructed of 3mm thick steel and the perimeter must be turned up by 20mm for rigidity.

The mounting plate must be 2mm smaller than the door opening all round.

The mounting plate must be fixed by means of 4 bolts screwed into captive nuts or tapped holes (No loose nuts).

The Panel doors must have vertical pre punched reinforcement down both edges, 10mm on the inside of the sealing gasket.

The door locking mechanism must be a three point locking system i.e. sliding bolts operated by a centre door handle with latch securing the door at the top, bottom and centre.

The gland plates must be constructed of 2mm thick sheet steel with turned up edges of 20mm for rigidity. The gland plates must be in two halves back and front for access to the cable glands. The halves must be secured separately by 4 bolts and captive nuts per half section. (No loose nuts).

Bracketing must be fitted in each panel for the mounting of a luminaire and for the limit switch that must be activated by the door to control the luminaire.

The cable chamber must be constructed of 1,6mm sheet steel and have a front access door for the cable installation.

The front access door must be removable and have a rubber-sealing gasket to prevent the ingress of dust.

The door must be secured in position by means of square key catches.

All Panels must be fitted with lifting lugs on the top at each corner.

A drawing holder pocket must be fitted to the door of the panel.

Back access to the Panels is not permitted unless otherwise stated in the project Specification.

All Panels must be fitted with a 16A socket on the side of the Panel unless otherwise specified.

INCOMING POWER SUPPLY MODULE ARRANGEMENT

The size of the incoming cable, mains circuit breaker and bus bars must be in accordance with SANS 10142 and estimated on the total load plus 30% spare capacity.

The incoming module must be on the left hand side of the control panel.

All copper bars must be colour coded and insulated with heat shrink PVC sleeving.

Cable ends must be fitted with hexagon crimped lugs and bolted onto the copper bars via high tensile cadmium plated bolts and nuts.

All supply cabling or bus bars must be terminated on the top of the main switch and fitted with shrouds or shielded via a Perspex cover.

The cover must be marked "Danger" "Live" and the circuit number displayed.

These suitably rated bus bars for load distribution must be clearly colour coded throughout the subsequent modules and rigidly fixed to suitably rated insulators.

The lockable main switch must be mounted immediately behind the door not lower than 1200mm and not higher than 1600mm to the centre of the switch from finished floor level.

Power supply of 100 amps or more must have individual ammeters fitted per phase.

The minimum ammeter dial face size must be 72mm x 72mm. All ammeters must be fitted directly above the main switch not higher than 1500mm AFFL. Ammeters required for smaller rated loads will be specified in the Contract Specification.

Current Transformers must be rigidly fixed in an accessible position.

A suitably rated copper earth bar no less than half the cross sectional area of the incoming supply cable core must be rigidly fixed at the bottom of the panel and the main earth wire terminated onto this earth bar.

If the load of the consumers on the board exceeds 200A, distribution to the other modules of the panel must be done via suitably rated bus bars at the top of the panel.

MANUAL CONTROLS, INDICATORS AND INSTRUMENTATION

All manual controls, indicators, and instrumentation operating individual circuits must be mounted to the door of the module containing those circuit controls.

All pushbutton actuators must be of the flush type size 22,5mm, except for the emergency stops that must be a twist release mushroom type button. The designated operations must be coloured as follows:

- | | |
|-------------------|-------|
| • Start | Green |
| • Production Stop | Red |
| • Emergency Stop | Red |
| • Up or Forward | Blue |
| • Down or Reverse | Green |
| • General | Black |

Illuminated pushbuttons are permitted and each actuator must have not more than two contact blocks i.e. only one normally open contact, and one normally closed.

Indicator lamps must be Ø 22,5mm and be mounted onto the module door and the following colours apply:

- | | |
|----------------------|------------------|
| • Run or Power on | Red |
| • Trip or Fault | Amber (Flashing) |
| • Up or Forward | Blue |
| • Down or Reverse | Green |
| • General Indication | White |

Where a fault or trip condition occur the indicator lamp of the affected circuit must flash.

There must be separate indication for internal faults (CB trip, O/L trip, emergency stop), and external faults (Isolator off, limit switch, emergency stop).

PROGRAMMABLE LOGIC CONTROLLERS (PLC) AND POWER SUPPLIES

Programmable controllers must be housed in a separate module with a glass window and ventilation as per manufacturer's specification.

All wiring to the PLC inputs and outputs must be via terminal connector blocks mounted directly below the PLC.

All wiring must be run in adequately sized PVC wiring channels and 50% spare capacity must be allowed for.

The Power Supply required to drive the inputs and outputs must be of a regulated type with a current limit.

Incandescent lighting must be provided in the PLC module no fluorescent fittings are permitted.

All PLC's should have at least 10% or 10 spare of each inputs and outputs whichever is the greater.

Volt potential free input/output units must be used. Interfacing to 220V contactors to be done via 24 VDC interposing relays.

Emergency stop circuits must be hard wired with a separate contact circuit and not via the PLC.

Wiring from the PLC to the terminal strips must be not less than 1.0 mm² PVC wire.

CONTROL CIRCUIT WIRING

Unless otherwise specified all control circuit wiring must be done in single core PVC insulated flexible "cable" of 1.0mm² cross sectional area comprising not less than 32 strands of 0,2 diameter wire. Solid drawn single strand wiring is not permitted.

All interconnection between equipment must be installed in PVC wiring channels and wiring behind the mounting plate is not permitted. Control and power wiring must be separated where possible.

Wiring between modules must be via marked terminal connector blocks and multicore cables fitted with suitably sized glands secured to the gland plate.

The total cross sectional area of cables including the insulation must not exceed 50% of the total cross sectional area of the wiring channel.

Conductors carrying different voltages must not be run together in the same cable or trunking.

All cable terminations must be either by crimped lugs or cable ferrules and no exposed conductor must exist between the insulation and the lug or ferrule.

Control cabling in field to be either steel wire armoured on cable tray or un-armoured inside metallic wiring trunking or duct.

All multi-core cables must have at least 4 or 30% of the number of cores spare whichever is greater.

Wiring by-passing the main isolator or not switched by the isolator must be clearly marked as such.

Metallic cable glands must not be used in non-metallic gland plates and connection boxes.

No more than 2 wires must be connected to either side of individual terminals including earthing terminals

Terminals of different voltages must be separately grouped and so marked.

Wire colours for single conductors for panel wiring:

- | | |
|---------------------------|----------------------------|
| • Earth | Green/Yellow |
| • Neutral | Black |
| • Control Voltage > 24VDC | Orange |
| • < 24VDC | Grey |
| • Auxiliary supplies | Magenta |
| • Power Supplies 380V | Red, White, Blue and Black |

The spare cores of multi-core cables must be marked as such and left inside the trunking as long as to reach to the furthest terminal connector inside the panel.

MARKING AND LABELLING

All terminals must be numbered according to the contract drawing.

The terminal strips must be divided into control and supply groups.

Dividers must be used to identify the different voltages in each section of terminal strips.

Cable cores must be numbered as per the drawing number using additional markers irrespective of the cable core number at either end on control circuits.

Cable marking must be as per cable layout accompanying the drawing and identified using preferred cable markers securely fastened to the cable prior to the gland at either end.

Cable labels must also be fitted to each cable directly below the terminal strip or just prior to where the inner sheathing is removed.

All interconnecting wires between the various equipment and terminal strips etc. must be numbered and marked.

All equipment installed in the panel must be marked as per the drawing. The marking labels must be fixed to each piece of equipment and also to the mounting plate adjacent to such equipment.

Each module or section of the panel must be labelled on the outside of the door.

PAINTING

All metal components of the boards, trunking, conduit, trays and ladders shall be painted in accordance with the procedure detailed herein. Either baked enamel or electro statically applied powder coating may be used.

Prior to coating, all metal parts shall be thoroughly cleaned of rust, mill scale, grease and foreign matter to provide a consistent metallic finish. Sand or shot blasting or acid pickling and washing may alternatively be employed.

BAKED ENAMEL FINISH

Immediately after cleaning, all surfaces shall be covered by rust inhibiting unbroken metal phosphate film and then thoroughly dried, to SABS 064. Within 48 hours after phosphating, a passivating layer consisting of a high quality zinc chromate primer shall be applied, followed by 2 coats of high quality baked enamel, to SABS 783 Type 1.

POWDER COAT FINISH

Immediately after cleaning, the metal parts shall be pre-heated and then covered by a micro structured epoxy paint powder applied electro-statically. The paint shall be baked on and shall harden within 10 minutes at a temperature of 190°C.

The minimum paint thickness, after baking, shall be 0,6mm.

The paint shall have a shock resistance of 25kg-cm on a 0,9mm soft steel plate and a scratch resistance of 2kg.

POWER SKIRTING.

Power skirting shall be used to tenant specification.

Power skirting colour shall be standard Light Grey – to be confirmed prior to ordering.

Where power skirting is installed, no plugs or isolators shall be fixed on the outside except telephone jacks, on the bottom channel.

220/380V electrical channel shall always be at the top, the central inside channel shall be for telephone cables and the bottom channel shall be for data wires.

The height of the power skirting shall be determined on site.

All circuits in the power skirting shall be taped or strapped separately at intervals of 500mm minimum.

All power skirting joints shall be pop riveted to ensure earth continuity.

A separate earth shall be installed from the Distribution Board earth bar to the nearest point on the power skirting.

Only the "loop in system" shall be used in power skirting and no joints shall be allowed.

Every SSO must be wired with a 2m loop to allow final positioning.

One telephone blank must be installed for every 2 SSO's.

MOTORS AND CONTROL GEAR

All wires entering motor connection boxes shall be fitted with crimped lugs, and shall enter at the bottom of the box.

Each motor shall be marked with labels at the motor, on the starting gear and at the circuit breaker.

Care must be taken to install the correct overload protection.

All contactors and accessories shall be Telemecanique, unless otherwise approved.

All control circuits shall not exceed 110 volts.

A Klockner Moeller 3LC triple pole metal clad pad lockable motor isolator or approved alternative shall be installed not more than 1 metre away from any electrical motor, in a position easily accessible for maintenance. The isolator shall be rated in accordance with the rated input power demand of the motor. The degree of protection shall be IP65 to DIN 40050.

A lock out isolator on motors up to 7KW can be installed in the main circuit. Lockable lock stops shall be installed in the control circuits of motors above 7KW.

Isolators shall be labelled

Emergency stops shall be installed on all types of conveyors.

FLAME PROOF EQUIPMENT

All flame proof equipment shall comply with the relevant SANS Code of Practice and as stipulated in the Occupational Health and Safety Act, (Act 85 of 1993).

AIR CONDITIONERS

Only one air conditioner will be allowed per circuit, wired with 4mm² PVC insulated conductors and protected by means of a 30A SPCB on the Distribution Board except where indicated otherwise.

A double pole isolator will be installed, not more than 1 metre from the air conditioner unit.

Circuits will be wired with phase colours, Red, White and Blue and Black for the neutral.

If a unit is within 1 metre of the power skirting, the isolator will be inserted in the power skirting.

Isolator type shall be similar or equal to a Crabtree CCI-20A DP complete with cover.

Air conditioner units shall not be connected to earth leakage units.

GEYSERS

Isolators shall be installed not further than 1 meter from the geyser. Double pole isolators shall be utilised. Current ratings as identified on the relevant drawings.

Silicon insulated wires shall be used from the isolator to the geyser.

14.16.16 Preferred Electrical Equipment

LOW VOLTAGE SWITCHGEAR

Refer to schematic diagrams for preferred suppliers for all below mentioned.

Circuit breakers	0 - 100 A
	100A >
Isolators (local)	0 - 100 A
	100A >
Isolators (field)	0 - 100 A

MEDIUM VOLTAGE SWITCHGEAR AND EQUIPMENT

Refer to schematic diagrams for preferred suppliers for all below mentioned.

Circuit breakers & Isolators
Protection relays

Distribution Transformers

Battery charger

MOTOR CONTROL SWITCHGEAR

Refer to schematic diagrams for preferred suppliers for all below mentioned.

Note: Type 2 coordination required.

Contactors
Overload Relays
Starters
Control relays and Time relays
Metering displays (Digital)
Safety equipment

FIELD SENSING DEVICES

Proximity switches	Peppelr& Fuchs, Turk,
Limit or position switches	Siemens, Telemecanique
Photo sensors	Banner, IFM , Sick
Flow, Pressure and Temperature sensors	Endress & Hauser

WIRING AND CABLING EQUIPMENT

All below mentioned are to be confirmed prior to ordering.

Cable and wire markers	Grafoplast, Murr Plastik
Terminal contact blocks	Phoenix Contact, Wago Cage clamp
Cable glands	Pratley
Trunking or ducting	O-Line P1000 - P9000
Power skirting	O-Line P801 - P803



Cable tray	O-Line Light duty
Ladders	O-Line O-L76
Cable jointing kits	3M
PVC perforated trunking	Le Grand
Conduit	Bosal galvanized
Flexible conduit	Copex

POWER POINTS

All below mentioned are to be confirmed prior to ordering.

13A Switch Socket outlets	Crabtree
16A Switch Socket outlets	Crabtree
5A Switch Socket outlets	Itemaster
20A Stove isolators	Crabtree
25-63A Lockable rotary isolators	Klockner Moeller
16-63A CEE Switch Socket outlets	Gewiss
Light switches	Crabtree

DISTRIBUTION BOARDS

Detailed equipment list to be supplied by Manufacturer.

PART 5

SANSA MATJIESFONTEIN

DETAILED TECHNICAL SPECIFICATION

ELECTRICAL INSTALLATION

This index refers to the Part numbers [Part 5.1] as per the CAI standard document.

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PART 5

SANSA MATJIESFONTEIN

DETAILED TECHNICAL SPECIFICATION

ELECTRICAL INSTALLATION

5.1 GENERAL

Scope

This specification covers the supply, delivery, installation, finishing and site clearance, testing, commissioning, maintenance and handover in a satisfactory condition during the guarantee period of the General Electrical Installation.

Description of proposed development

The development consists of various facilities for SANSA Matjiesfontein

The development consists of the following areas:

- a) Operations Building
- b) Energy Centre
- c) Gatehouse building

Programme

The Principal Contract has not been awarded as yet. A draft programme will be included in the tender document for information to the electrical sub-Subcontractor. It will be expected of the tenderers to discuss the programme with the successful contractor and to ensure they are au fait with the programme and the accuracy thereof.

Site

The site is located as per the contract data in the preliminaries.

Summary of Works

A summary of the works for the electrical installation is as follows. The description below constitutes a general description of the electrical installation and covers the major packages related to the electrical installations and scope of work but is under no means to be considered conclusive.

The works comprise the supply and installation of:

- Medium Voltage cabling between the various buildings
- Miniature substations
- Medium voltage cabling – all trenching by others
- Low Voltage cables from the miniature substations to the MLV board or relevant DB's as indicated on the drawings.
- Generators
- UPS
- Transformers

- MV Ring main units
- Conduit and cable trays/baskets to data and telephone installations.
- Supply and installation of all distribution boards
- Cable racks and associated cabling to control panels.
- Light fittings as indicated on the drawings and specified.
- The complete Electrical Reticulation consisting of conduit work, cable ways, wiring and electrical connections of equipment as indicated on the drawings.
- The supply and installation of all conduit work, conduit boxes and cable ways for telephone/data systems.
- External lighting.
- ~~Post contract installations for tenants.~~
- Power supply to AC units
- Testing, commissioning and preparation of "As Built" drawings.
- Installation and commissioning of all light fittings as indicated on the working drawings.
- Complete Electrical Reticulation consisting of conduit work, cableways, wiring and electrical connections of equipment as indicated on the drawings that have been included in the tender.
- Supply and installation of all cable ladders and cable baskets as indicated on the drawings.
- The installation of all site lighting. Trenching has been excluded from the tender.
- Electronic Security conduiting, trunking and power supplies.
- HVAC power supplies to the distribution boards
- Laminated drawings for all services pertaining to this tender. This will apply to all service areas as well as any specialised areas.
- General earthing installation. In specialised areas all specialised earthing will be installed by the successful tenderer for the installation with that being excluded from this scope of work. The earthing responsibility for this contract will be general earthing to areas, earth mats ~~not executed by other Sub-contractors~~ as well as general earthing throughout.
- All areas such as the office, walkways, external areas and general areas which will include distribution boards, power distribution units, cable trays, earthing and power leads.

The electrical contract comprises the supply and installation of the following:

- MV Cabling
- Miniature substations
- Cable trays
- LV Cable Reticulation
- Metering
- General lighting and Power Distribution - Internal and External
- Light fittings (Internal and External)
- Labelling
- As built documentation
- Testing and commissioning
- Quality assurance and quality control documentation
- Co-ordination of electrical services with construction activities
- Issue of Certificate of Compliance

5.2 RELATED WORKS BY OTHERS

Electrical and Building Contract

The following work will be provided by a general building Contractor:

- [a] Supply and installation of sleeves and manholes.
- [b] Closing of ducts and openings through concrete slabs after the installation of cables, etc.
- [c] Building in of conduits and distribution boards supplied and positioned by the Electrical Subcontractor.
- [d] Supply and installation of backing boards in telephone riser ducts, where required.
- [e] Construction of distribution board cupboards.

[f] Construction of Main Low Voltage Panel external room as per detail.

[g] Fireproofing of all openings through walls.

[h] Excavations for medium voltage cabling.

5.3 DOCUMENTATION

The Electrical Installation shall comply in all respects to the documentation and the drawings forming part of this document.

The Tenderers attention is drawn to the General Technical Requirements. Where contradictions occur between this section and the General Technical Requirements, of the documentation, preference shall be given to this section, i.e., Detailed Technical Specification.

5.4 PROVISIONAL BILLS OF QUANTITIES

The Provisional Bills of Quantities shall be read and priced in conjunction with the specification and associated tender drawings.

5.5 LOCAL AND SUPPLY AUTHORITY

The successful tenderer shall ensure that he is fully conversant with all the by-laws of the Authorities and he shall liaise with the Authorities to ensure the timeous testing and approval of the installation.

5.6 SERVICE CONDITIONS

All equipment shall be suitable for the following site conditions:

Nominal LV Supply	400/231 [no load] 4 wire, 3 phase system earthed neutral.
Nominal HV Supply	11 000V 3-wire unearthed system.
Frequency	50 Hz.
Fault Level	350 MVA at 11 000V.

5.7 MAINTENANCE AND GUARANTEE

The installation and equipment supplied under this contract shall be guaranteed and maintained for a period of twelve [12] months from the date of final completion in all respects and commissioned for continuous service. The tender price shall include the above.

A proposal shall be submitted by the electrical Subcontractor for extended maintenance to the equipment and material supplied and installed as part of this contract. The proposal shall be for 24, 36 and 48 months after the “free” 12-month maintenance period.

- Additional cost of 12 months maintenance over and above the 12-month “free” maintenance period: R.....
- Additional cost of 24 months maintenance over and above the 12-month “free” maintenance period: R.....
- Additional cost of 36 months maintenance over and above the 12-month “free” maintenance period: R.....

This section shall be completed, as this information will be used as part of the adjudication of the tender and the selection of a successful tenderer. If not completed the tender may be disqualified.

5.8 SCAFFOLDING

All scaffolding required for the entire Electrical Installation shall be provided by the Electrical Subcontractor and the price thereof shall be included in the relevant sections of the Provisional Bills of Quantities. Tenderers may assume that scaffolding erected by the Principal Subcontractor will not be available for their use.

5.9 INSURANCE

Tenderers shall ensure their insurance policies provide adequate cover for the installation activities as the construction work progresses. Documentary proof shall be presented with the tender. Should insurance have to be extended to cover eventualities that may arise from the construction activities, these additional premiums may be included in the tender price and shall be enumerated in the Provisional Bills of Quantities under P&G Allowances.

5.10 REGULATIONS

The total installation shall conform to SABS Code of Practice 0142 as amended, for the Wiring of Premises as well as all the regulations and by-laws of the Local and Supply Authority.

5.11 CONDUIT

The conduit installation shall comply with the requirements of the General Technical Requirements forming part of this document. PVC conduit bearing the SABS mark of approval will be considered for the following installations:

- [a] Cast in concrete.
- [b] Built into brickwork.
- [c] Surface mounted in slab soffits and ceiling voids.
- [d] Surface mounted conduit work down vertical surfaces and at work top level shall consist of galvanised metal conduit.

Installation methods of PVC conduit shall be approved by the Engineer prior to work being carried out. The Electrical Subcontractor shall familiarise himself with all expansion joints as well as positions where shrinkage cracks may occur on the slabs and shall apply evasive action to prevent damage to cast in conduit work.

5.12 ELECTRICAL CONNECTION

General

The main incoming supply has not been installed.

It is not envisaged that a service connection will be obtained from Eskom with the site being energized by a combination of PV, batteries and generators. All of the aforementioned will be accommodated in an energy centre.

~~The current service connection comprise of:~~

- ~~● council ring main unit~~
- ~~● bulk metering kiosk~~
- ~~● ring main unit for the point of isolation~~

The electrical contractor will extend from the energy centre medium voltage cabling to the miniature substations located at the various buildings

New miniature substations of various capacities will be installed.

The reticulation between the miniature substation and the various buildings areas to be done from an energy Centre comprising of a main LV Board, step-up transformers, generators and ring main units and will be part of this contract.

The miniature substation will have a ring main unit to allow for reticulation to a future miniature substation to cater for other phases.

The medium voltage installation therefore shall consist of the following:

- 11 kV Cable installation as per specification above
- Miniature Substation as per specification

High Voltage Compartment

The high voltage compartment of the miniature substation shall be equipped with a ring main unit. The following shall be provided:

- Rated voltage 12kV
- Network switch (I function) - 400A
- TX feeder (D function - 200A set to 50A)
- Echelon billing class meter as per NRS 057
- Voltmeter on low voltage side
- Ammeter 0 – 1200A on LV side.

The minimum clearances between connecting cables and jumpers and any sharp earthed metal edges or protrusion shall be at least 150mm.

"DELARON" or "THIOLITE" resin bound synthetic wood or similar dielectric material shall be used to maintain the phase-to-phase and phase-to-earth spacing of the cables and jumpers. The surfaces of these spacers shall be treated to prevent surface tracking.

Only stranded annealed copper conductors shall be used for jumper cables.

All terminals shall be shrouded with "RAYCHEM" or similar heat shrinkable shrouds. Taping is not acceptable.

Transformer Compartment

The transformer compartment shall be equipped with a low loss transformer as specified and in accordance with this specification and the requirements of SANS 1029. The Contractor shall advise if the transformer can be equipped with silicon oil. The transformer shall conform to the following:

- Primary voltage 11000V
- Secondary voltage 400V
- Phases: 3
- Vector group Dyn 11
- Cooling method: ONAN
- Mineral oil (~~Silicon oil~~)
- Nominal Voltage Taps: 95-105% (2.5% increments)
- Buchholz relay and over temp relay for alarm and external trip purposes

Low Voltage Compartment

Equipment

The specified equipment shall be in accordance with this specification.

The low voltage compartment shall provide space for future requirements as specified as well as the breakers as detailed in the BoQ.

Low Voltage circuit breakers are to be provided as per the BoQ.

Ensure adequate fault current rating for LV circuit breaker based on transformer size.

Equipment Support Frame and Gland Plates

An angle iron or similar type rigid support framework shall be provided.

The frame shall be bolted down on the base with at least four M16 high tensile steel bolts.

A cable gland plate shall be provided at the bottom of the frame across the full width of the compartment. The gland plate shall be at least 100mm above the plinth height. A minimum distance as required by the bending radius of the cores of the outgoing cable shall be provided between the lowest terminals of major equipment and the gland plate. The gland plate shall be suitably punched to accept the number and size of cables specified as well as future cables.

All steelwork shall be hot dipped galvanised in accordance with SANS 763.

A "DELARON" or "THIOLITE" resin bound synthetic wood or similar dielectric material shall be provided for the mounting of all equipment and busbars. Impregnated hardboard, other treated or untreated wood products are not acceptable.

Application

Unless specified to the contrary, busbars shall be manufactured of solid drawn high conductivity copper with a rectangular cross-section in accordance with SANS 784 and 1195 and BS 159 and 1433, where applicable.

Earthing of Metal Parts

All non-current carrying metal parts of the mini substation, e.g., framework, panels, base, steel housing, transformers, MV switch etc., shall be bonded to the earth busbar. Also refer to the relevant sections of this specification.

Load End Connections

The supply end connections to equipment shall be at the top and the load end connections at the bottom.

Conductor Terminations

All conductors terminating on equipment with screwed terminals shall be fitted with lugs. The lugs shall be soldered or crimped to the end of the conductor with the correct amount of insulation removed from the end to fit into the lug. Strands may not be cut from the end of the conductor.

Connections to circuit breakers, isolators or contactors shall be installed by one of the following methods:

- A ferrule of the correct size.
- Soldering the end of the conductors.

Identification

The colour of the conductors for all 230V circuits shall correspond to the colour of the supply phase for that circuit. Neutral conductors shall be black. All other conductors supplying control circuits, etc., shall be coded in colours other than those specified above. The devised colour codes shall be shown on a wiring diagram. Coloured PVC or other tape will not be acceptable for colour coding.

Mounting of Equipment

The mounting of equipment shall conform to SANS 1180 where applicable. Equipment shall be fixed to the

support panel with bolts, nuts, washers and spring washers. Self-tapping screws will not be accepted.

Equipment shall be arranged and grouped in a logical fashion.

All equipment shall be mounted flush behind panels with only circuit breaker and isolator toggles and meter faces protruding. The front panels shall be secured in position with 6mm studs and hexagonal chromed brass dome nuts and washers or hank nuts or "DZUS" or "CAMLOC" fasteners.

Self-tapping screws are not acceptable.

Blanking plates shall be fitted over the slots intended for future equipment.

These plates shall be fixed so that fixing holes need not be drilled through from the panel.

Access

All equipment, busbars and wiring shall be completely accessible with the front flush mounting panel removed.

Wiring and Cabling

Incoming and outgoing cables shall be terminated on the gland plate. Cable tails with sizes up to 70mm² may terminate on clamp type terminals where the clamping screws are not in direct contact with the conductor. All cable sizes larger than 70mm² shall terminate on busbar stubs, which are connected directly to the equipment. Parallel connected cables shall be connected to a collector busbar without crossing the conductors. Cable connections to busbars shall be by means of crimped lugs and bolted fixing only.

Current Ratings

The current rating of conductors for the internal wiring shall be sufficient to carry the maximum continuous current that can occur in the circuit. This value shall be determined from the circuit breaker or fuse protection of the circuit. (Refer to Table 41.2 in VDE 0100) The smallest conductor size to be used for power wiring shall be 2.5mm².

The following table shall be applied for ambient temperatures up to 40°C. For higher ambient temperatures the values shall be derated as prescribed by SANS 175.

Nominal Cross Section mm ²	CONDUCTOR RATING (A)				
	1	2 – 3	4 - 5	6 – 9	10 and more
2.5	26	23	21	18	16
4	38	34	30	27	23
6	47	42	38	33	28
10	60	54	48	42	36
16	75	68	60	52	45
25	94	85	75	66	56
35	120	108	96	84	72

Nominal Cross Section mm ²	CONDUCTOR RATING (A)				
	1	2 – 3	4 - 5	6 – 9	10 and more
50	150	135	120	105	90
70	187	168	150	130	112

Internal Wiring

Standard 600V Grade PVC insulated stranded annealed copper conductors to SANS 150 shall be used for the internal wiring.

Wiring shall be installed away from terminals, clamps or other current carrying parts. Wiring shall also be kept away from exposed metal edges or shall be protected where the cross-metal edges.

No joints will be allowed.

Labelling

All equipment shall be fully labelled, and accurate descriptions shall be given in both official languages.

Engraved plastic or ivory sandwiched strips shall be used for labels. The labels shall bear white lettering on a black background. Painted or printed labels are not acceptable.

The following labels shall be supplied as a minimum requirement:

- Designation of Mini substation

Lettering At least 40mm high. Label on the outside in a prominent position on both the front and back of the substation.

- Designation of circuit i.e., circuit breaker, isolator, meter, etc.
e.g. HOUSE 473

PUMP SUPPLY

Lettering At least 5mm high. One label installed directly below each item of equipment pertaining to the particular circuit shall be provided.

- The function and circuits of all other equipment shall be clearly identified. Flush mounted equipment within the front panel shall be identified with labels fixed to the front panel. The labels for all equipment installed behind panels shall be fixed to the support panel close to the equipment.
- The labels shall be secured by means of brass nuts and bolts, self-tapping screws, pop rivets or slotted label holders. Engraved labels shall be secured to facilitate a neat alteration of the destination of the labels. *Labels shall not be glued to their mounting positions.*

Sufficient fixing points shall be provided to prevent labels from warping.

- All label designations shall be confirmed with the Engineer before manufacture.

Supply cables

It is important to note the location of the sub-distribution boards is tentative at this stage and the final position is subject to confirmation prior to the cable finally being terminated. Adequate slack shall therefore be left at each distribution board location to accommodate at least 10m of repositioning in the final position of the sub-distribution board.

It will be expected of the electrical Subcontractor to be pro-active in this regard and liaise with Electrical Engineer to finalise the locations of the sub-distribution boards.

5.13 MAIN LV RETICULATION

It should again be noted a pro-active approach will be required from the electrical Subcontractor in the secondary co-ordination of the location of the cable ladder to prevent clashes with the ventilation ducting, sprinkler piping and process steelwork if installed on this project. In cases cables may have to be reticulated via alternative routing of primary routing is not available. The extent of the cable reticulation shall be properly understood and coordinated prior to any final lengths being ordered and installed. If any of the above is not adhered to the abortive cost for cables not being used or being too short will be for the account of the electrical Subcontractor.

The extent of the cable installation has been measured in the Bills of Quantities. In the pricing of the installation rates an allowance shall be required for the additional onsite co-ordination and time required to fully understand the full extent of the cable installation prior to the actual cable being installed. The electrical Subcontractor shall ensure to fully understand the intricate nature of this requirement.

General

The LV cable installation shall be carried out in accordance with the requirements of the Code of Practice and as specified in the General Technical Requirements.

All LV cables, as indicated on the drawings and the cable schedule, shall be supplied and installed by the Electrical Subcontractor.

Quantities in the Provisional Bills of Quantities will not be used for ordering purposes. Cables shall be ordered from drawings issued for construction read in conjunction with the relevant specifications, on site measurements and final installation information.

Cables

All cables shall have stranded copper conductors and shall be of the **PVC/SWA/PVC/ECC** type, 600/1000V grade with an internal earth conductor. No external earth conductors will be used. Cables with aluminium conductors are unacceptable.

The cables shall be armoured with a single layer of galvanised steel wire.

All cables shall bear the SABS mark of approval and shall have colour coded PVC insulated conductors.

Installation

All LV cables shall be installed as indicated on the drawings. The installation shall be carefully planned to reduce the number of cable crossings, which should be kept to a minimum.

The following different types of installations shall be employed:

[a] On cable trays, ladders or baskets as specified on the drawings.

[b] In excavated cable trenches.

Cables on Cable Trays, Ladders or Baskets

Cables on cable trays and ladders shall be neatly laid on the ladders and strapped to the ladders/trays at 1200mm intervals

Cables in Trenches

Cables installed in trenches shall be installed in accordance with the General Technical Requirements. Cable

markers complying with the requirements of the General Technical Requirements shall be provided at 30m intervals and at all direction changes.

The excavation and backfilling of cable trenches shall be carried out by the Electrical Subcontractor. Cable trenches shall have a minimum depth of 600mm.

Identification of Cables

Cables shall be identified as described in the General Technical Requirements. All cables entering or exiting the Main LV Board, sub-distribution boards, and/or any other equipment, shall be clearly marked at both ends with a suitable cable marker fixed to the cables.

5.14 DISTRIBUTION BOARDS

The supply and delivery of Distribution Boards to the workshops and individual areas will form part of the Electrical Contract. The Distribution Boards will be schematically indicated on the drawings.

The Electrical Subcontractor will be responsible for liaison with the supplier regarding programme, submission of workshop drawings, and inspections of Distribution Boards at the factory, taking delivery, unpacking, placing in position and assembling, where required. Final connections to all Distribution Boards, testing, preparation of legend cards and commissioning shall be carried out by the Electrical Subcontractor.

The fault levels will be indicated on the schematic diagram. It is the responsibility of the Distribution Board manufacturer to select current limiting type circuit breakers and select suitable downstream switchgear to ensure that the fault levels indicated will be achieved.

Documentary proof, calculations and selection of switchgear are to be submitted with the shop drawings for the various Distribution Boards. Prices entered into the schedules for the various Distribution Boards shall include for all current limiting and cascading switchgear.

The Distribution Board manufacturers shall ensure that distribution boards are correctly sized in order that they may be fitted within the allocated spaces as indicated on the drawings.

5.15 SCHEDULE OF DISTRIBUTION BOARDS

Tenderers shall note that all by-laws of the Local Authority shall be complied with as far as normal/standby power sections of boards are concerned.

Tenderers are advised the complete separation of non-essential, essential and UPS power supplies in the relevant sections of boards shall be strictly maintained at all times.

The colours of the various compartments of Distribution Boards shall be as follows:

- | | |
|-------------------------|-----------------|
| • Non-Essential Section | Electric Orange |
| • Essential Section | Red |
| • UPS Section | Blue |

This is subject to confirmation once the order for the distribution boards is to be placed.

The UPS sections of the Distribution Boards shall be provided with an insulated earth bar. The Electrical Subcontractor will only install cabling to these sections.

5.16 LIGHTING INSTALLATION

General

The Lighting Installation shall comply fully with the General Technical Requirements of the specification, unless otherwise specified in this section.

The circuit wiring of lighting circuits shall be 2.5mm² PVC insulated copper conductors and a 2.5mm² bare

copper earth conductor in P8300 trunking or 25mm diameter conduits.

Light switches, where indicated, shall be similar or approved equal to Crabtree and shall be of the flush type complete with covers, suitable for switching of the actual complements and types of lamps utilised.

The wiring trunking in ceiling voids shall be suitably sized to accommodate the number of lighting circuits as indicated on the drawings and shall be pre-fitted with knockouts for unswitched 5A socket outlets to accommodate the number of lighting circuits as indicated on the drawings.

Light Fittings

Tenderers shall base their rates on the handling, storage, installation, commissioning, guarantee and maintenance of the light fittings. The rates entered into the Provisional Bills of Quantities shall include the supply, handling fee and Subcontractors profit, assembly and installation of lamps as well as the electrical connection to the light fittings.

The description of light fitting types given in the Provisional Bills of Quantities shall serve as a basis for tenderers to price the items in the Provisional Bills of Quantities regarding supply, handling, installation and commissioning.

All globes, lamps and control gear shall be new and in working order when the project is handed over.

The permanent fittings shall not be used for temporary lighting during construction unless prior arrangements have been made with the Main Contractor. Should the fittings be utilised before practical completion and the hand over date, the Electrical Subcontractor shall obtain an extended guarantee from the supplier. All light fittings shall be guaranteed for a period of twelve [12] months after the practical completion and hand over date.

All lamps, fittings and accessories shall comply with the General Technical Specification of the document unless specifically specified to the contrary in this section.

Emergency Lighting

The emergency light fittings shall be fitted out with battery back-up, 1 lamp for 30 minutes at 50% output, and shall be supplied from an essential lighting circuit. The positions of all emergency lights will be indicated on the drawings. All emergency fluorescent fittings shall be marked with a red dot on the side for future visual identification.

The Electrical Subcontractor shall provide an additional live conductor with each essential lighting circuit as a power source for the batteries to maintain the battery 5A charge. This conductor shall be fed from the circuit breaker feeding the specific circuit and shall be colour coded brown.

Emergency lighting shall be a separate circuit from the distribution board of which section is supplied with generator power.

Site Lighting

The work shall consist of the following and shall be carried out strictly in accordance with the General Technical Specification:

- [a] Excavation of cable trenches and backfilling.
- [b] Supply and installation of PVC/SWA/PVC cables with earth conductors.
- [c] Installation of outdoor type light fittings as indicated on the drawings and specified.
- [d] Final connections and commissioning.
- [e] ~~Installation of mast lighting in parking area.~~

Lighting Schedule and Specification

The light fittings shall be supplied and installed in the positions shown on the drawings. The Electrical Subcontractor is advised that only fittings and control gear bearing the SABS mark of approval will be accepted.

5.17 SOCKET OUTLETS

General purpose socket outlets

All general-purpose socket outlets shall be similar and equal to the Crabtree range.

General purpose socket outlets shall be of the switched, surface, flush or power skirting mounted types as indicated in the drawings and Provisional Bills of Quantities. Socket outlets shall be mounted at 300 AFFL unless otherwise indicated on the drawings. Socket outlets shall be supplied by means of 4 or 6mm² insulated copper conductors and a 2.5 or 4mm² bare copper earth conductor in conduit or P8300 trunking. The plug circuit conductors shall be colour coded red for live and black for neutral.

UPS socket outlets

UPS power socket outlets, where applicable, shall consist of red 16A sockets with “D” type earth pin and shall be wired with green PVC insulated earth wire. The Electrical Subcontractor shall ensure that the earth pin maintains the integrity of the isolated earth. No provision has at this stage been made for UPS sockets

Three Phase Socket Outlets

Three phase socket outlets indicated on the drawings shall consist of the 5-pin type supplied complete with male plug. The ratings are indicated on the drawings.

Welding plugs

Welding plugs shall be provided with integral earth leakage protection and shall be of the 32A 5-pin type.

Offices

The offices workstations will be serviced by way of overhead trunking in the ceiling. Again, this is for flexibility as the client wish to make changes in the space planning in future.

From the fixed installation in the ceiling power will be extended to the workstations by way of either ceiling partition mounted boxes or power poles. Samples shall be approved by the architect prior to installation

5.18 CONNECTION OF ELECTRICAL EQUIPMENT

General

A variety of equipment shall be supplied by specialist Subcontractors, which require electrical connections. These connections shall be carried out in accordance with the Codes of Practice and as specified hereunder.

The following equipment shall be connected if instructed to do so:

- [a] Geysers.
- [b] Air Conditioning equipment.
- [c] Smoke detection
- [d] Security

Geysers

The positions of the geyser outlets are as indicated on the drawings.

Tenderers may assume that all geysers are 4kW or less, single phase units unless otherwise indicated on the drawings.

A 20A double pole isolator shall be provided adjacent to the geyser. The electrical connection of the geyser shall form part of this contract.

5.19 POWER SKIRTING

Power skirting shall be installed as indicated on the drawings. The power skirting shall have two compartments, each compartment measuring approximately 70mm x 50mm. The power skirting shall be provided with two separate cover plates fixed to the power skirting by means of locating screw type fixing butterfly clips. "Clip in" type covers will not be acceptable. The power skirting covers shall be delivered pre-cut in a modular form as detailed on the drawings. A data and telephone termination plate shall be provided at each 16A socket outlet as indicated on the drawings. All 16A sockets shall be of the switched type, equal or similar to Clipsal Series 2000. The top compartment shall be reserved for power, middle for telephone and bottom compartment for data outlets.

5.20 UPS [UNINTERRUPTABLE POWER SUPPLY]

This is covered under a separate section

5.21 STANDBY GENERATOR

The full facility will be on generator. ~~It is intended to reticulate a pilot cable from the generator to each distribution board and in the event of a power failure the normal circuits not to be supplied from generator power will be isolated.~~

5.22 PROVISION FOR TELEPHONE, DATA CABLING, ACCESS CONTROL AND FIRE DETECTION

General

Tenderers shall allow for the supply, delivery and installation of all conduits, draw boxes, outlets, draw-wires, etc. as specified and as indicated on the drawings for the above services.

Draw-wires

All conduits, sleeves, etc. required for the electronic services installation shall be fitted with galvanised steel draw-wires.

Telephone and Data

All telephone and data outlets shown shall consist of 100 x 100 x 50mm boxes, complete with cover, installed at 300mm AFFL unless otherwise specified on the drawings.

Access Control and Fire Detection

Access control and fire detection conduit outlet boxes shall be as indicated on the installation detail drawings.

Conduits

Conduits shall be installed as indicated on the drawings, fitted with draw-wire and shall comply with the General Technical Requirements.

5.23 EARTHING, BONDING AND LIGHTNING PROTECTION

The complete Electrical Installation shall be earthed and bonded as required by the Code of Practice.

The Earthing and Lightning protection system will be supplied and installed under this contract ~~by an external contractor appointed under the principal contractor.~~

5.24 POST CONTRACT WORKS

~~It will be required of the Electrical Subcontractor to remain on site to assist with the Post Contract Works.~~

~~It will be required by the Electrical Subcontractor to remain on site to assist in the final connection of the cabling as well as the installation of lighting in areas of the process manufacturer where lighting has not been allowed for or installed. This portion of the works will be covered by a provision sum in the Bills of Quantities.~~

5.25 TESTING

The Electrical Subcontractor shall have the complete installation tested and approved by the Local Authorities.

Subsequent to the testing of the installation by the Local Authorities, the Electrical Subcontractor shall in the presence of the Engineer, test all lighting and power circuits with respect to:

- [a] Phase Balance.
- [b] Insulation Level.
- [c] Earth Continuity.
- [d] Voltage Levels.
- [e] Polarity.

The Electrical Subcontractor shall have the following instruments available on site for the full duration of the last nine months of the contract:

- [a] Phase rotation meter.
- [b] Digital current and voltmeters [0-600A, 0-400V].
- [c] Null-balance megger testers.
- [d] Earth leakage testers.
- [e] 0-2500A tong tester.

All instruments required for special tests such as pressure testing, etc. shall be provided when required.

A Certificate of Compliance duly signed by an authorised person shall be provided for each tested area.

5.26 "AS BUILT" DRAWINGS

The Electrical Subcontractor shall provide "As Built" drawings comprising of one [1] complete set of the electrical drawings, showing the final positions of all outlet points and electrical equipment.

5.27 MAINTENANCE MANUALS

The Electrical Subcontractor shall provide a maintenance manual, which shall contain the following:

- [a] A list giving the name and address of the Manufacturer of each item of equipment.
- [b] A preventative maintenance programme for all equipment.
- [c] Operating instructions for each item of equipment

PART 6

EARTHING AND LIGHTNING PROTECTION

GENERAL TECHNICAL REQUIREMENTS

This index refers to the Part numbers [Part 6.1] as per the CAI standard document.

PART 6.1	GENERAL
PART 6.2	REGULATIONS
PART 6.3	SITE CONDITIONS
PART 6.4	ARRANGEMENTS WITH THE SUPPLY AUTHORITY
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PART 6

EARTHING AND LIGHTNING PROTECTION

GENERAL TECHNICAL REQUIREMENTS

6.1 GENERAL INFORMATION

The General Technical Requirements cover the delivery, installation, testing, commissioning and maintenance of the Earthing and Lightning Protection Installation.

The complete Earthing and Lightning Protection shall comply with the requirements of this specification. Should any discrepancies or contradictions arise between this part of the Specification and the Detailed Technical Specification then the latter shall take preference. Should any discrepancies appear between the written specifications, Bills of Quantities and the drawings, Tenderers shall ascertain the position before tender closing date, otherwise the decision by the Engineer will be final.

This specification is of simplified form and includes abbreviated sentences. The omission of words or phrases shall be implied by inference. Unless clarified by the Contractor prior to submitting the tender interpretation of clauses, words and phrases shall be as determined by the Engineer.

The Contractor is required to provide all material, equipment, labour and services and to perform all operations required for the installation to be complete and operative.

"Document" shall mean the complete set of contract documents including all drawings, variation orders and Engineer's instructions issued in terms of the contract.

The Engineer will inspect the installation from time to time during the progress of the work. Discrepancies will be pointed out to the Contractor and these shall be remedied at the Contractor's expense.

Under no circumstances shall the abovementioned inspections relieve the Contractor of his obligations in terms of these Documents. It is the responsibility of the Contractor to ensure that the materials supplied, and the installation conforms fully to this specification.

The Contractor shall notify the Engineer timeously when the installation reaches important stages of completion [e.g., equipment installation, pressure testing, etc.] so that the Engineer's representative may schedule his site inspections in the best interests of all concerned. Work shall not be unduly closed up prior to inspection.

Unless it is explicitly stated to the contrary the words "Sub-Contractor" and "Contractor" shall refer to the successful Tenderer for the Earthing and Lightning Protection Installation.

6.2 REGULATIONS

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

MOSA	The Machineries and Occupational Safety Act of as amended.
	The regulations of the local Gas Board.
SANS	The SANS Code for the Wiring of Premises - SANS 10142 - 1978 as well as SANS 0180-1974 as amended.

	SANS 10313
	SANS 1312
	The local Municipal bylaws and regulations as well as the regulations of the Local Supply Authority.
	Code of Practice for Engineering Drawing (Metric Units).
BS 308	(Including Supplement No. 1) Engineering Drawing Practice.
ISO Recommendation R370	Conversion of Tolerance Dimensions.
BS 3939	Recommended Graphical Symbols.
BS5486 Part 1: 1977	Factory built assemblies of Switchgear and Control gear for voltages up to and including 1000V AC and 1200V DC.
BS5419:1977	Air Break switches, Air Break disconnectors.
IEC 148:1972	Air break switch disconnectors and fuse combination units for voltages up to and including 1000V AC and 1200V DC.
BS 5424 Part:1977 IEC 158.1:1970	Control gear for voltages up to and including 1000V AC and 1200V DC.
IEC 144	Degrees of Protection of Enclosures for low voltage switchgear.
IEC Technical Sub-Committee	Draft Guiding principles in the preparation of Circuit Diagrams
BS4752 Part 1: 1977	Circuit breakers of rated voltage up to and including 1000V AC and 1200V DC.
BS 142:1966	Electrical protective relays.
BS89:1977 IEC 51	Direct Acting Electrical Indicating Instruments.
BS 3693 Part 1: 1964	Instruments of bold Presentation and for rapid reading.
BS3938: 1973	Current Transformers.
BS3941: 1975	Voltage Transformers.
BS 3535: 1962	Safety isolating transformers for domestic and industrial purposes.
DIN 43620	Low Voltage High Current Fuses 500V with contact blades - NH fuse cartridges.
VDE 0660 Part 4	Regulations for low voltage power fuses (NH Fuses) with rated voltages up to 1000V AC and up to 3000V DC.
IEC 269-1/-2	Low Voltage Fuses.
BS 158	Marking and arrangement of switchgear busbars, main connections and small wiring.
BS 159	Busbars and Busbar connections.
BS 1433	Copper for Electrical purposes.

BS 1706	Electroplated coatings of Cadmium and zinc on iron and steel.
BS 5472-1977	Specification for low voltage switchgear and control gear for industrial use, terminal marking and distinctive number (General rules).
BS 4794 Part 1:1973 Part 2:1977	Control switches, switching devices including contactor relays for control and auxiliary circuits up to, and including 1000V AC and 1200V DC.
SANS 763:1977	Hot dip (Galvanized) Zinc coatings other than continuously coated steel sheet and wire.
SANS 1091	National Colour Standards for Paint.
SANS 135:1971 & Amendment 1 1974	ISO Metric Black Bolts, Screws and Nuts.
SANS 10313	The Protection of Structures against Lightning
SANS 0199	The Design and Installation of an Earth Electrode
SANS 089	The Earthing of Electrical Systems
SANS IEC 61024	Protection of Structures against Lightning
SANS IEC 61312	Protection against Lightning Electromagnetic Impulse

6.3 SITE CONDITIONS

Tenderers are advised to visit the site and acquaint themselves with all local conditions pertaining to the execution of the installation before tender closing date. No claims from the Contractor which may arise from insufficient knowledge of site access, type of site, labour conditions, establishment space, transport and loading/unloading facilities, power and water supply, etc., will be considered after submission of tenders.

~~For facilities where prior permission is required before Contractors can visit the site, a visit will be arranged for all interested parties.~~

6.4 ARRANGEMENTS WITH THE SUPPLY AUTHORITY

The Contractor shall give all notices required and pay all necessary fees, including any inspection fees, ~~which may be required by the Local Supply Authority unless otherwise specified.~~

~~It shall be the responsibility of the Contractor to make the necessary arrangements at his own cost with the local Supply Authority and to supply the labour, equipment and means to inspect, test and commission the installation to the requirement of the Local and Supply Authorities. The Contractor shall supply and install all notices and warning signs that are required by the appropriate laws, regulations and/or the documents.~~

6.5 MATERIAL, EQUIPMENT AND WORKMANSHIP

All material shall conform in respect of quality, manufacture, tests and performance, with the requirements of the South African Bureau of Standards or where no such standards exist, with the appropriate current specification of the IEC Standards.

All material shall be new and in accordance with the specifications and suitable for the conditions on site. These conditions shall include weather conditions as well as conditions under which materials are installed, stored or used. Should the materials not be suitable for use under temporary site conditions then the Contractor shall at his own cost provide suitable protection until these unfavorable site conditions cease to exist.

The Contractor shall, where requested to do so, submit samples of equipment and materials to the Engineer for his approval prior to installation. Samples may be retained in the Engineer's possession until the contract is

completed after which they will be returned.

Locally manufactured equipment shall be used where possible and practical in preference to imported equipment. The Owner in no way binds himself to assist the Contractor in obtaining import permits for imported equipment.

The works shall be so installed as to provide ease of inspection, cleaning and maintenance.

All artisans employed on site shall be competent in terms of the Regulations and Acts. All installations shall be carried out by qualified artisans or under the direct supervision of qualified artisans. Installations (or part thereof) carried out by unskilled persons will be rejected.

The contract shall be executed to an acceptable standard and to the satisfaction of the Engineer. Should any workmanship, equipment or material not be to the satisfaction of the Engineer, it shall be rectified at the cost of the Contractor and all rejected materials shall be removed from site.

If, in the opinion of the Engineer, any member of the Contractor's staff is not competent to carry out the work to the required standard, then that person shall be removed from the project if so, instructed by the Engineer.

6.6 TOOLS AND EQUIPMENT

Unless otherwise specified, the Contractor shall provide all tools, materials, scaffolding, power, water, etc., necessary for the proper and efficient execution of the work covered by this specification.

No extra payment will be made for plant, equipment and materials required by the Contractor to complete the work.

The Contractor shall provide all rigging, cranes, lifting, equipment, etc., necessary to execute the works.

6.7 DRAWINGS

The Engineer's drawings for the contract shall be those issued at the times of tender together with any others issued to cover the variations to the contract.

As part of this contract, the Contractor shall provide the following drawings:

- Manufacturing and Installation drawings

The manufacturing and installation drawings ["shop drawings"] shall provide all details of the components necessary for the manufacture and installation of the system in accordance with the specification.

- Builder's Work Drawings

All necessary builder's work drawings, as described elsewhere in this specification, shall be provided as part of this contract.

- Record Drawings

On completion of the installation, but before the plant is handed over, the Contractor shall provide a complete set of drawings showing the completed installation including all underground and other conductor routes.

In addition to the drawings listed above, the Contractor shall provide all drawings necessary for the execution of the contract and shall submit such general and detailed drawings of the components and apparatus, as the Engineer may require, to approve construction of the system.

Details and drawings of all major items of equipment, made by the Contractor or his suppliers, shall be submitted for approval without specific request from the Engineer.

All required drawings shall be submitted to an agreed programme to suit the construction of the system.

All drawings shall be clearly numbered or marked with the equipment item numbers, area references etc.

Approval of Drawings

The Contractor shall submit, for approval, copies of all abovementioned drawings prior to starting work or issue to other parties. Any work started [off site or on site] prior to receiving the Engineer's approval of drawings shall be at the Contractor's own risk.

The Engineer may require from the Contractor further detailed drawings and/or calculations which clarify features not adequately shown on the layout drawings. The request for additional details shall not be construed as extending the scope of this contract or altering the programme.

The Contractor shall submit two copies of each drawing to the Engineer for approval.

The Engineer will return to the Contractor, within two weeks of their receipt by him one copy of each drawing marked 'CONFORMS TO SPECIFICATION' or marked with any changes, which are necessary. The Contractor shall modify the details and drawings as required by the Engineer. The nature and date of each modification and a distinguishing symbol shall be added, and the drawings shall be submitted again for approval.

Alterations to drawings, by the Engineer, are not intended to change the scope of work unless explicitly stated as doing so. Should any alterations, in the opinion of the Contractor, change the scope of work the Contractor shall notify the Engineer immediately of receipt of the altered drawings before any further drawing work or fabrication is carried out. Claims for a change of scope, made after performance of the work constituting the claimed change of scope of work will not be considered.

The "CONFORMS TO SPECIFICATION" of drawings by the Engineer shall not relieve the Contractor of any responsibility in terms of the contract. The Engineer will check the drawings for design only and approval of the drawings, schedules and catalogues shall not be construed as a complete check.

The Contractor shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars supplied by him whether such drawings or particulars have been approved by the Engineer or not, provided that such discrepancies, errors or omissions are not due to inaccurate information or particulars furnished in writing to the Contractor.

The Contractor shall provide, at his own expense, all copies of drawings required by him in the execution of the work and shall also, at his own expense, supply to the Engineer such drawings and copies thereof as are provided for in the specification.

On completion of the installation, but before final handover, the Contractor shall provide two high quality paper prints of each of the drawings listed below showing the system as fixed:

- Complete 1: 100 scale drawings of the whole installation
- Detailed drawings of all elements of Earthing and Lightning Protection System
- Details of any other items requested by the Engineer

The drawings shall be sufficient in detail to enable the Employers staff to maintain, dismantle, reassemble and adjust any part of the works.

6.8 MAINTENANCE AND GUARANTEE

Maintenance

The Earthing and Lightning Protection Contractor shall maintain the entire installation as described in this specification for a period of one [1] year from the date where the Main Contractor achieves Practical Completion.

The Contractor shall carry out all necessary visits due to failure of any item of the system. The Contractor shall attend to all complaints by the Employer.

The Contractor shall report to the Employer's nominated representative both on arriving and leaving the site. The Contractor shall provide the Employer and Engineer with a Service Report for each visit.

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

Guarantee

The Contractor shall guarantee the entire installation, as described in this specification for a period of one [1] year from the date where the Main Contractor reaches Practical Completion. The guarantee shall provide for all parts, spares and equipment that become defective during the guarantee period and these shall be replaced free of charge. The guarantee shall cover all costs including material, labour, overheads, travelling, etc.

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

The guarantee shall cover all materials, plant and equipment whether or not it is covered by a manufacturer's guarantee. The one-year guarantee, in terms of this contract, on the entire installation shall not be affected by the prior expiry of any guarantee provided by the manufacturer of any item of equipment or plant, nor shall it affect the Employer's Common Law rights regarding defects.

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

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

PART 6T

EARTHING AND LIGHTNING PROTECTION

DETAILED TECHNICAL SPECIFICATION

This index refers to the Part numbers [Part 6T] as per the CAI standard document.

PART 6.1	GENERAL
PART 6.2	DIVERSE EARTH CONNECTIONS
PART 6.3	TEST TESTING
PART 6.4	AS BUILT DRAWINGS
PART 6.5	OPERATING AND MAINTENANCE MANUALS
PART 6.6	SOIL RESISTIVITY SURVEYS

PART 6T

EARTHING AND LIGHTNING PROTECTION

DETAILED TECHNICAL SPECIFICATION

6.1 GENERAL

The project comprise of a few buildings as has been measured separately in the BoQ.

The Installation consists of the following:

- Soil resistivity test included in the data pack
- Ground floor
- Roof level
- ~~Provision for the bonding of the following equipment:~~
 - ~~Generator Set~~
 - ~~LV Panel~~
 - ~~Etc.~~

For further clarification, refer to drawings forming part of this tender.

Note:

ALL communication and/or correspondence with Claassen Auret Inc. shall be in email/ written format; failure to adhere to this will result in immediate disqualification of the tender. Any queries must be in writing and submitted to the Consulting Engineer whereby a reply by means of an Addendum will be submitted to all tenderers.

All tenderers shall submit an accompanying covering letter as part of their document to list qualifications, alternative offers, clarification, BEE ratings, as well as description of the equipment offered; failure to adhere to this will result in immediate disqualification of the tender.

This specification covers the supply, delivery, installation, commissioning and free maintenance during the guarantee period of the Mains Earthing System and Lightning Protection Installation

A summary of the work involved and for which the tenderer must allow is as follows:

- The implementation of the design and subsequent approval by SABS of all plans for Earthing and Lightning Protection systems.
- The supply and installation of all materials to protect the buildings against lightning as recommended by the SANS Code of Practice 10313. ~~This includes the protection from lightning of all equipment placed on the roof of the building. Equipment potentially includes communication antennas and satellite dishes.~~
- ~~The successful tenderer will be required to submit SABS approved drawings to the Engineer within ten days of an official order being placed. The drawings will be returned within fourteen [14] days with the Electrical Engineer's stamp, marked 'CONFORMS TO SPECIFICATION' or "Not Approved" with comments.~~
- Installation of a Mains Earth Electrode for the various buildings consisting of specific earthing components together with the bonding of key structural columns.

Local and Supply Authorities

The Local Authority is Matjiesfontein and the successful Tenderer shall ensure that he is fully conversant with

all by-laws of the authorities.

Service Conditions

All equipment shall be suitable for the following site conditions:

AMBIENT TEMPERATURE	40°C. max., -5°C. min.
ALTITUDE	Approx. 650m.
LIGHTNING	High
DUST	Mild
RELATIVE HUMIDITY	20 - 60% at 27°C.
NOMINAL LV SUPPLY	400/231 [no load] 4 wire, 3-phase system with earthed neutral.
NOMINAL HV SUPPLY	11000V 3-wire unearthed system.
FREQUENCY	50 Hz.
FAULT LEVEL	350 MVA at 11000V

~~Tenderers are advised to visit the site and thoroughly acquaint themselves with the nature and extent of the site conditions, availability of labour and storage of material.~~

Tenderers are to make allowance for items obviously intended and necessary for the proper completion of the work, although not specifically specified.

Inspection of Site

The site is situated at Matjiesfontein

Insurance

Tenderers shall ensure their insurance policies provide adequate cover for the installation activities as the construction work progresses. Documentary proof shall be presented with the tender. Should insurances have to be extended to cover eventualities that may arise from construction activities, these additional premiums shall be deemed to be included in the tender price. Tenderers shall refer to the Contract Preliminaries and ensure that their insurance policies comply with the requirements of the Contract Preliminaries.

Documentation

The Lightning Protection and Earthing Systems shall comply in all respects with the conditions of this document and the drawings which form part of this specification. In the event of contradictions between the General Technical Requirements and the Detailed Technical Specification; the Detailed Technical Specification section shall take preference.

Details to be submitted with tenders

The attention of the Tenderer is drawn to the fact a tender is subject to disqualification if all the information called for is not submitted with the tender.

Should the Tenderer in any way differ from the specification, he shall explicitly state such differences in detail. This information shall be submitted in a covering letter accompanying the tender, stating the paragraph of the specification where the requirements of the specification are deviated from.

It should be noted that information entered in the schedules would not relieve the Tenderer of his obligations to comply with the specification.

Maintenance and Guarantee

The installation and equipment supplied under this contract shall be guaranteed and maintained for a period of twelve [12] months, from the date where Practical Completion is achieved by the Main Contractor. The tender price shall include the above.

~~Tenderers shall allow for four [4] quarterly visits to inspect and test the total Earthing and Lightning protection system during the free maintenance period.~~

Time Programme

~~The Principal Contractor is still to be appointed. It will be expected of the tenderers to discuss the programme with the Principal Contractor once appointed to ensure they are au fait with the programme and the accuracy thereof.~~

It will be expected of the Earthing and Lightning Protection Contractor to record digital photographs of the earthing terminations to all earth electrode connection points, as well as all pile structural reinforcing connections as and when these are completed, before any covering of backfilling is done. The Contractor shall advise the Engineer timeously when records are to be done, to allow the Engineer to be present if required. These photographs shall be duly catalogued and recorded and submitted to the Engineer for record keeping.

Lightning Protection

Tenderers shall allow for the protection of the basic building periphery.

The periphery protection shall consist of ridge conductors, finials and the necessary expansion loops, as well as acceptable jointing and mounting equipment. Protection shall be bonded to no less than every second structural column on the perimeter. Tenderers shall provide details of such equipment and method of installation offered in the tender. No part of an aluminum conductor shall be allowed in direct contact with concrete, cement or plaster.

Steel reinforcing bars shall be used as down conductors. Tenderers shall state the type and method of installation of reinforcing bar clamps to be used. For tender purposes, a reinforcing bar, thickness of 32mm diameter, may be assumed. The electrical continuation of the steel reinforcing shall be ensured by the introduction of a 70mm² bare copper earth wire cast into the concrete columns. The copper wire shall be clamped to the reinforcing bars both at the top as well as the bottom earth inspection boxes cast into the columns.

The inspection boxes shall consist of 100 x 100 x 50 conduit boxes cast into the columns, complete with cover plates. The successful tenderer shall be responsible for the installation of these boxes in the columns prior to the shuttering and casting of the columns.

All columns indicated on the drawing will be supported on piles, and a 70mm² PVC insulated copper conductor shall be provided from the pile to the inspection box.

Terminations between the PVC insulated copper conductors and the earth spikes shall be exothermically welded.

Terminations between the steel reinforcing and down conductors shall be by means of 50mm² steel cable clamped onto reinforcing bars terminating in a brass terminal in an inspection box.

The aluminum conductor installed on parapet walls shall be linked to the column down conductor inspection boxes by means of 70mm² PVC insulated copper conductors.

Equipment installed in structure

It shall be the responsibility of the Earthing and Lightning Protection Contractor to arrange with the Principal Contractor for the satisfactory and timeous installation of all boxes, conduits, etc. into the structure of the building. The responsibility for the satisfactory location of these will rest with the Earthing and Lightning

Protection Contractor.

Earthing System

A mains earthing system of less than 1 Ohm shall be provided, consisting of all collective bonded pile caps and additional installed impedance elements as required.

Materials

All separate earthing conductors shall be PVC insulated stranded copper where enclosed in conduit or trunking.

Earthing conductors on cable tray or un-enclosed by mechanical protection shall be PVC insulated and sheathed with stranded copper conductors.

Do not use aluminum or copper-aluminum alloy for the Earthing Conductor.

The Contractor shall, except where specified, determine the size and rating of all earth conductors and bonding conductors based on the method of calculation or tabulation prescribed in SANS 10142 and in accordance with Supply Authority requirements for earthing.

Conductor size and ratings shall take into account the following factors:

- Physical strength and protection against mechanical damage and corrosion.
- The capacity to carry earth fault current without thermal damage to the conductor and its surroundings.
- Earth conductors may not be subjected to sharp bends exceeding 135° at any points in the conductor routes.
- All earth cable terminations to be made using proprietary clamps and termination devices.
- All below grade terminations of earth continuity conductors shall be exothermically welded connections

Warning Notices and Accessibility of Earth Bonds.

All separate earth bonds to exposed conductive parts, extraneous conductive parts and other services shall be fitted with warning notices in accordance with SANS 10142.

Provide a warning notice fixed adjacent to the Main Earth Terminal in the Main LV Room in accordance with SANS 10142.

Conductive Parts

Provide supplementary bonds between exposed conductive parts to ensure there is no possibility of differential earth potentials arising between them under any circumstances.

All earth conductors shall be lugged at both ends prior to being terminated.

All above ground terminations shall be secured with brass bolts, nuts and washers. Spring washers will be used on all M12 bolts. All above ground connections shall be coated with “denso” paste.

6.2 DIVERSE EARTH CONNECTIONS

The connection of all metal encased services leaving or entering the area of the earth system shall be bonded to the main earth system by means of suitable copper straps.

A variation in the number of connections arising during construction will be valued on the basis of the Schedule of Rates.

6.3 TESTING

The complete system shall be tested for continuity and exact resistance levels achieved as the construction progresses.

Test the complete earthing system in accordance with the recommendations as set out in the latest SANS Codes of Practice as applicable.

Test main primary earths for compliance with earth path resistance and fault clearance requirements.

The Engineer shall witness these tests. The Contractor shall give 7-days' notice of intent to carry out these tests.

The Contractor shall note that in the event that any of these tests fail to meet the Engineers requirements, or fully comply, then the Subcontractor shall be held responsible for carrying out all rectification works necessary to bring the installation to an acceptable standard.

6.4 "AS BUILT" DRAWINGS

The successful Tenderer will be responsible for the compilation of "As Built" drawings showing the exact location of all the conductors and connections installed as part of the contract, as well as all readings taken during testing.

The drawings shall show the exact, dimensioned location of conductors and connections.

On completion of the works, a SABS certificate for the entire Earthing and Lightning Protection system shall be provided.

The Earthing & Lightning Protection Contractor will be required to test and certify the total earthing and bonding system [including the work to be done by the Electrical Contractor] on completion of the project.

6.5 OPERATING AND MAINTENANCE MANUALS

The Earthing and Lightning Protection Contractor shall provide three [3] hard copies and two [2] electronic copies of the Operating and Maintenance Manuals, which shall contain the following:

- A list giving the name and address of the Manufacturer of each item of equipment.
- A preventative maintenance programme for all equipment.
- Operating instructions for each item of equipment.

6.6 SOIL RESISTIVITY SURVEYS

A soil resistivity survey was done. The copy of this report has been included in the tender document.

NOTE:

The installation will not be considered complete until the above drawings and schedules have been issued.

PART 7

GENERATOR INSTALLATION

GENERAL TECHNICAL SPECIFICATION

This index refers to the Part numbers [Part 7] as per the CAI standard document.

PART 7.1	GENERAL INFORMATION
PART 7.2	STANDARDS
PART 7.3	SITE CONDITIONS
PART 7.4	ARRANGEMENTS WITH THE SUPPLY AUTHORITY
PART 7.5	MATERIAL, EQUIPMENT AND WORKMANSHIP
PART 7.6	OPERATOR TRAINING
PART 7.7	MAINTENANCE TOOLS
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PART 7.9	OPERATING AND MAINTENANCE MANUALS
PART 7.10	SCOPE
PART 7.11	MAKING GOOD
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PART 7.14	GUARANTEE
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PART 7.23	PACKAGING, TRANSPORT, LOADING AND STORAGE
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PART 7.34	ENGINE PROTECTION
PART 7.35	ALTERNATOR
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PART 7.38	BEARINGS
PART 7.39	TERMINATIONS
PART 7.40	RADIO AND TV INTERFERENCE
PART 7.41	SWITCHBOARD
PART 7.42	EARTHING
PART 7.43	SYSTEM OPERATION (AMF OPERATION ONLY)
PART 7.44	OPERATION SELECTOR
PART 7.45	PROTECTION AND ALARM DEVICES
PART 7.46	AIR CIRCUIT BREAKERS
PART 7.47	BATTERY CHARGER
PART 7.48	REMOTE MONITORING

PART 7

SANSA MATJIESFONTEIN

GENERATOR INSTALLATION

GENERAL TECHNICAL SPECIFICATION

7.1 GENERAL INFORMATION

- 7.1.1 The General Technical Requirements cover the delivery, installation, testing, commissioning and maintenance of the Emergency Generator Set Installation as specified.
- 7.1.2 The complete installation shall comply with the requirements of this specification. Should any discrepancies or contradictions occur between this part of the Specification and the Detailed Technical Specification then the latter shall take preference. Should any discrepancies between the written specification and the drawings become evident, the Sub-Contractor shall ascertain the position before tender closing date, otherwise the Engineer's decision will be binding.
- 7.1.3 This specification is of simplified form and includes abbreviated sentences. The omission of words or phrases shall be implied by inference. Unless clarified by the Sub-Contractor prior to submitting the tender, interpretation of clauses, words and phrases shall be as determined by the Consulting Engineer.
- 7.1.4 The Sub-Contractor is required to provide all material, equipment, labour and services and to perform all operations required for the installation to be complete and operative.
- 7.1.5 "Document" shall mean the complete set of Contract documents including all drawings, variation orders and Engineer's instructions issued in terms of the Contract.
- 7.1.6 The Engineer will inspect the installation from time to time during the progress of the work. Discrepancies will be pointed out to the Sub-Contractor and these shall be remedied at the Sub-Contractor's expense.
- 7.1.7 Under no circumstances shall the abovementioned inspections relieve the Sub-Contractor of his obligations in terms of these Documents. It is the responsibility of the Sub-Contractor to ensure that the materials supplied, and the installation conforms fully to this specification.
- 7.1.8 The Sub-Contractor shall notify the Engineer timeously when the installation reaches important stages of completion (e.g., equipment installation, pressure testing, etc.) so that the Engineer's representative may schedule his site inspections in the best interests of all concerned. Work shall not be unduly closed up prior to inspection.

7.2 STANDARDS

- 7.2.1 The installation shall be erected and tested in accordance with the following standards as amended:

OHSA	The Occupational, Health and Safety Act, Act 85 of 1993.
SABS	The SABS Code for the Wiring of Premises - SABS 10142 - 1978as well as SABS 0180-1974 as amended.
The local Municipal bylaws and regulations as well as the regulations of the Local Supply Authority.	
Code of Practice for Engineering Drawing (Metric Units).	
BS 308	(Including Supplement No. 1) Engineering Drawing Practice.
ISO Recommendation R370	Conversion of tolerance dimensions.

BS 3939	Recommended graphical symbols.
BS5486 Part 1:1977	Factory built assemblies of switchgear and control gear for voltages up to and including 1000V AC and 1200V DC.
BS5419: 1977	Air break switches, air break disconnectors.
IEC 148:1972	Air break switch disconnectors and fuse combination units for voltages up to and including 100V AC and 1200V DC.
BS 5424 Part: 1977	Control gear for voltages up to and including
IEC 158.1:1970	100V AC and 1200V DC
LEC 144	Degrees of protection of enclosures for low voltage switchgear.
IEC Technical	Draft guiding principles in the preparation of Sub-Committee circuit diagrams.
BS4752 Part 1:1977	Circuit breakers of rated voltage up to and including 1000V AC and 1200V DC.
BS 142:1966	Electrical protective relays.
BS89: 1977 IEC 51	Direct acting electrical indicating instruments.
BS3693 Part 1:1964	Instruments of bold presentation and for rapid reading.
BS3938: 1973	Current transformers.
BS3941: 1975	Voltage transformers.
BS3535: 1962	Safety isolating transformers for domestic and industrial purposes.
BS 588	Cartridge fuses for voltages up to and including 1000V AC and 1500V DC.
DIN 43620	Low voltage high current fuses 500V with contact blades - NH fuse cartridges.
VDE 0660 Part 4	Regulations for low voltage power fuses (NH Fuses) with rated voltages up to 1000V AC and up to 3000V DC.
IEC 269-1/-2	Low voltage fuses.
BS 158	Marking and arrangement of switchgear busbars, main connections and small wiring.
BS 159	Busbars and busbar connections
BS 1433	Copper for electrical purposes.
BS 1706	Electroplated coatings of cadmium and zinc on iron and steel.
BS5472: 1977	Specification for low voltage switchgear and control gear for industrial use, terminal marking and distinctive number (General rules).
BS4794 Part 1:1973 Part 2:1977	Control switches, switching devices including contactor relays for control and auxiliary circuits up to and including 1000V AC and 1200V DC.
SABS 763:1977	Hot dip (galvanised) zinc coatings other than continuously coated steel sheet and wire.

SABS 1091 National colour standards for paint.

SABS 135:1971 ISO metric black bolts, screws and nuts.
& Amendment 1 1974

7.2.2 The Sub-Contractor shall issue all notices and pay all the required fees in respect of the installation to the authorities, and shall exempt the Employer from all losses, claims, costs or expenditures which may arise as a result of the Sub-Contractor's negligence in not complying with the requirements of the regulations.

7.2.3 It shall be assumed the Sub-Contractor is conversant with the abovementioned regulations. Should any requirements, bylaws or regulations, which contradict the requirements of this Document, apply or become applicable during erection of the installation, such requirements, bylaws or regulations shall overrule this Document and the Sub-Contractor shall immediately inform the Engineer of such a contradiction. Under no circumstances shall the Sub-Contractor carry out any variations to the installation in terms of such contradictions without obtaining written permission to do so from the Engineer.

7.3 **SITE CONDITIONS**

~~The Sub-Contractor is advised to visit the site and acquaint himself with all local conditions pertaining to the execution of the installation before tender closing date. No claims from the Sub-Contractor which may arise from insufficient knowledge of site access, type of site, labour conditions, establishment space, transport and loading/unloading facilities, power and water supply, etc., will be considered after submission of tenders.~~

7.4 **ARRANGEMENTS WITH THE SUPPLY AUTHORITY**

~~7.4.1 The Sub-Contractor shall give all notices required by and pay all necessary fees, including any inspection fees, which may be required by the local Supply Authority unless otherwise specified.~~

~~7.4.2 It shall be the responsibility of the Sub-Contractor to make the necessary arrangements at his own cost with the local Supply Authority and to supply the labour, equipment and means to inspect, test and commission the installation to the requirement of the Local and Supply Authorities.~~

~~The Sub-Contractor shall supply and install all notices and warning signs that are required by the appropriate laws, regulations and/or the documents.~~

7.5 **MATERIAL, EQUIPMENT AND WORKMANSHIP**

7.5.1 All material shall conform in respect of quality, manufacture, tests and performance, with the requirement of the South African Bureau of Standards or where no such standards exist, with the appropriate current specification of the British Standards Institution.

7.5.2 All material shall be new and of acceptable quality and suitable for the conditions on site. These conditions shall include weather conditions as well as conditions under which materials are installed, stored or used. Should the materials not be suitable for use under temporary site conditions then the Sub-Contractor shall at his own cost provide suitable protection until these unfavourable site conditions cease to exist.

7.5.3 The Sub-Contractor shall, where requested to do so, submit samples of equipment and materials to the Engineer for his approval prior to installation. Samples may be retained in the Engineer's possession until the Contract is completed after which they will be returned.

7.5.4 Locally manufactured equipment shall be used where possible and practical in preference to imported equipment. The Employer in no way binds himself to assist the Sub-Contractor in obtaining import permits for imported equipment.

7.5.5 The works shall be so installed as to provide ease of inspection, cleaning and maintenance.

7.5.6 All artisans employed on site shall be competent in terms of the Regulations and Acts. All installations shall be carried out by qualified artisans or under the direct supervision of qualified artisans. Installations (or part thereof) carried out by unskilled persons will be rejected.

7.5.7 The Contract shall be executed to an acceptable standard and to the satisfaction of the Engineer. Should any workmanship, equipment or material not be to the satisfaction of the Engineer, it shall be rectified at the cost of the Sub-Contractor and all rejected materials shall be removed from site.

7.5.8 If, in the opinion of the Engineer, any member of the Sub-Contractor's staff is not competent to carry out the work to the required standard, then that person shall be removed from the project if so, instructed by the Engineer.

7.6 OPERATOR TRAINING

7.6.1 On completion of all tests, to the satisfaction of the Engineer, the Sub-Contractor shall continue to be responsible for the complete operation and maintenance of the plant for a period of three weeks during which time instructions shall be given to the Employer's staff of the proper operation and maintenance of the plant. The cost for such training shall be included in the tender price.

7.6.2 The operation and maintenance of the plant, for the duration of the instruction period, shall not in any way relieve the Sub-Contractor of his responsibility under the terms of the Contract.

7.7 MAINTENANCE TOOLS

7.7.1 The Sub-Contractor shall provide one set of all special tools, panel keys, etc., required for testing, maintaining and operating of all items of equipment.

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

7.8 DRAWINGS

7.8.1 The Engineer's drawings for the Contract shall be those issued at the times of tender together with any others issued to cover the variations to the Contract.

7.8.2 As part of this Contract the Sub-Contractor shall provide the following drawings:

- **Manufacturing and Installation drawings**
The manufacturing and installation drawings ("shop drawings") shall provide all details of the components necessary for the manufacture and installation of the system in accordance with the specification.
- **Wiring Diagrams**
The wiring diagrams shall provide details of all the wiring associated with the installation. The same drawing symbols and system shall be used, as used on the Engineer's drawings.
- **Builder's Work Drawings**
All necessary builders' work drawings, as described elsewhere in this specification, shall be provided as part of this Contract.
- **Record Drawings**
On completion of the installation, but before the plant is handed over; the Sub-Contractor shall provide a complete set of drawings showing the completed installation including wiring.

7.8.3 In addition to the drawings listed above, the Sub-Contractor shall provide all drawings necessary for the execution of the Contract and shall submit such general and detailed drawings of the components and apparatus, as the Engineer may require, to approve construction of the system.

7.8.4 Details and drawings of all major items of equipment, made by the Sub-Contractor or his suppliers, shall be submitted for approval without specific request from the Engineer.

7.8.5 All required drawings shall be submitted to an agreed programme to suit the construction of the system.

7.8.6 All drawings shall be clearly numbered or marked with the equipment item numbers, area references etc.

7.8.7 Approval of Drawings

The Sub-Contractor shall submit, for approval, copies of all abovementioned drawings prior to starting work or issue to other parties. Any work started (off site or on site) prior to receiving the Engineer's approval of drawings shall be at the Sub-Contractor's own risk.

The Engineer may require from the Sub-Contractor further detailed drawings and/or calculations, which clarify features not adequately shown on the layout drawings. The request for additional details shall not be construed as extending the scope of this Contract or altering the programme.

The Sub-Contractor shall submit three copies of each drawing to the Engineer for approval.

The Engineer will return to the Sub-Contractor, within two weeks of their receipt by him one copy of each drawing marked 'APPROVED IN PRINCIPLE' or marked with any changes, which are necessary. The Sub-Contractor shall modify the details and drawings as required by the Engineer. The nature and date of each modification and a distinguishing symbol shall be added, and the drawings shall be submitted again for approval.

Alterations to drawings, by the Engineer, are not intended to change the scope of the work unless explicitly stated as doing so. Should any alterations, in the opinion of the Sub-Contractor, change the scope of work the Sub-Contractor shall notify the Engineer immediately of receipt of the altered drawings before any further drawing work or fabrication is carried out. Claims for a change of scope, made after performance of the work constituting the claimed change of scope of work will not be considered.

The approval in principle of drawings by the Engineer shall not relieve the Sub-Contractor of any responsibility in terms of the Contract. The Engineer will check the drawings for design only and approval of the drawings, schedules and catalogues shall not be construed as a complete check.

The Sub-Contractor shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars supplied by him whether such drawings or particulars have been approved by the Engineer or not, provided that such discrepancies, errors or omissions are not due to inaccurate information or particulars furnished in writing to the Sub-Contractor.

The Sub-Contractor shall provide, at his own expense, all copies of drawings required by him in the execution of the work and shall also, at his own expense, supply to the Engineer such drawings and copies thereof as are provided for in the specification.

On completion of the installation, but before final handover, the Sub-Contractor shall provide two high quality paper prints of each of the Contract drawings showing the system as fixed.

Complete 1: 50 scale layouts of plant rooms
Complete 1: 100 scale drawings of the whole installation
Detailed drawings of all items of plant
Electrical layouts and wiring diagrams
Details of any other items requested by the Engineer

The drawings shall be sufficient in detail to enable the Employer's staff to maintain, dismantle, reassemble and adjust any part of the works.

7.9 OPERATING AND MAINTENANCE MANUALS

- 7.9.1 The Sub-Contractor shall provide three copies of the Operating and Maintenance Manuals.
- 7.9.2 The Sub-Contractor shall submit, for approval to the Engineer, four weeks before completion of the installation, two copies of the maintenance and operating manuals for the system supplied.
- 7.9.3 The Engineer will return these to the Sub-Contractor, within ten working days of their receipt by him, marked with all changes, which are necessary.
- 7.9.4 The Sub-Contractor shall modify the manuals, as required by the Engineer and submit to the Engineer, within ten working days, two revised copies of the manuals. On completion of the installation, but before the plant is

handed over to the Employer; the Sub-Contractor shall provide three copies of the Final Operating and Maintenance Manuals for the system supplied. The manuals shall be bound in book form with hard plastic covers to withstand constant use.

7.9.5 The manuals shall be properly indexed to facilitate easy reference.

7.9.6 The manuals shall include:

- [a] A list of recommended servicing tools and specialist equipment.
- [b] A list of spares to be supplied by the Sub-Contractor to cover the period of warranty. The spares to be supplied during the warranty period will however not be limited to the listed items.
- [c] A priced list of recommended spares necessary for a period of 2 years of operation.
- [d] Exploded drawings for detailed spares list from which every item of every piece of equipment can be positively identified for ordering replacements.
- [e] A list giving the name and address of the local agent for each item of equipment.
- [f] A list giving the name and address of the manufacturer of each item of equipment.
- [g] Originals of all test certificates obtained with the system.
- [h] A list of recommended lubricants.
- [i] A preventative maintenance programme for all equipment.
- [j] Operating instructions for each item of equipment.
- [k] Performance data and/or characteristic curves.
- [l] Commissioning data.
- [m] Record drawings.

7.10 **SCOPE**

7.10.1 The Contract shall include the complete manufacture, testing, supply, delivery, installation, commissioning, guarantee and maintenance during the guarantee period of the Emergency Generator Equipment.

7.10.2 The scope of work/system shall comprise of the following:

- [a] AMF-operated, diesel driven generating sets, each capable of delivering the load specified.
- [b] Complete cooling and exhaust systems, including all ducting and piping.
- [c] Complete control board including input and output switchgear.
- [d] Automatic synchronising and load shedding control gear where required.
- [e] All power and control cabling between the generating sets and control board.
- [f] All piping from the bulk tanks to the sets as well as foam and diesel filter points, will form part of this Contract. The diesel tanks forms part of this contract. ~~however all connections and pipe work to and from the diesel tank do form part of the contract.~~ The Contractor shall ensure that all the necessary tank outlet points, (as installed), are in accordance with the Contractors' requirements.
- [g] Obtaining fire approval and clearance from the local authority for the bulk diesel storage installation.

7.10.3 The following will be provided by others:

[a] ~~Plant room accommodation as shown on the drawing. Where applicable~~

[b] ~~Main LV distribution board.~~

7.11 **MAKING GOOD**

The Sub-Contractor will be responsible for making good in all trades, damage or disturbance to the buildings, installation, tarred surfaces, concrete surfaces which he or his employees may have caused in the course of the installation of equipment. The Sub-Contractor will be responsible for keeping the site tidy and shall remove from the site all rubble and litter resulting from his work.

7.12 **EQUIPMENT**

[a] All equipment shall conform in respect of quality, manufacture, tests and performance, with the requirements of the SABS or where no such standards exist, with the appropriate current specification of the British Standards Institution.

[b] All equipment shall be of acceptable quality and suitable for the conditions on site. These conditions shall include weather conditions as well as conditions under which materials are installed, stored or used. Should the equipment not be suitable for use under temporary site conditions, then the Sub-Contractor shall at his own cost provide suitable protection until these unfavourable site conditions cease to exist.

[c] Locally manufactured equipment shall be used where possible and practical in preference to imported equipment. The Employer in no way binds himself to assist the Sub-Contractor in obtaining import permits for imported equipment.

7.13 **INSTALLATION**

All installation costs shall be incorporated in the tender.

A system schematic diagram shall be prepared and mounted on the plant room behind clear Perspex.

7.14 **GUARANTEE**

7.14.1 The Sub-Contractor will be required to guarantee the complete system for a period of 12 **months from the date of building practical completion.**

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

7.15 **MAINTENANCE**

7.15.1 The Sub-Contractor will be required to maintain the plant in good running order for a period of 12 **months from the date of building practical completion.** The cost of this maintenance shall be included in the tender price.

During this time, the Sub-Contractor shall undertake to arrange a three-monthly visit to the plant by a qualified member of his staff, who shall:

[a] Report to the Employer keeping the maintenance records and enter into a logbook the date of the visit, the tests carried out, the adjustments made, and any further details that may be required.

[b] When necessary clean the plant and its components.

[c] Grease and oil moving parts where necessary.

[d] Check the lubricating oil, and top-up when necessary.

- [e] Check the air filter and, when necessary, clean the filter and replace filter oil.
- [f] After the plant has run on one oil change for the number of hours stipulated by the manufacturers, drain the sump and refill with fresh lubricating oil. The reading of the hour meter on the switchboard will be taken to establish the number of hours run by the plant.
- [g] Clean the lubricating oil filter, and/or replace the filter element at intervals recommended by the engine manufacturer, the cost of a new filter element to be charged as an extra on the monthly account.
- [h] Check and when necessary adjust the valve settings and the fuel injection equipment.
- [i] Check the battery and top-up the electrolyte when necessary.
- [j] Test-run the plant for ½ hour, check the automatic starting with simulated faults on each mains phase, and check the proper working of all parts, including the electrical gear, the protective devices with fault indicators, the change-over equipment and the battery charger. The necessary adjustments shall be made.
- [k] Report to the Employer on any parts that become unserviceable through fair wear and tear, or damaged beyond the control of the Sub-Contractor.
- [l] Advise the Employer when it has become necessary to decarbonise the engine and submit a quotation for this service.

7.15.2 At the end of this 12-month period, the Sub-Contractor may be required to enter into a maintenance agreement.

This agreement may initially be for one calendar year and visits shall take place at three monthly intervals. The agreement may subsequently be renewed on an annual basis.

7.16 DRAWINGS

As soon as possible after the award of the Contract, the Sub-Contractor shall at his expense submit for approval three prints of all layout and schematic drawings, showing the complete system and all associated accessories.

7.17 INSTRUCTION OF OPERATOR AND MANUALS

7.17.1 After completion of the installation, and when the plant is in running order, the Sub-Contractor will be required to instruct an attendant in the operation of the plant, until he is fully conversant with the equipment and the handling thereof.

7.17.2 Three copies of a maintenance, fault-locating and operating manual are to be handed over on site together with the drawings specified above.

7.18 TESTS

7.18.1 The complete testing, including the provision of test facilities, instruments, dummy loads and switchgear shall form part of this Contract. Integrated testing with the other contractors shall form part of the contract

7.18.2 For both tests at the manufacturer's premises (**Factory acceptance test**) and on site (**Site acceptance test**), two weeks advance notice shall be given to the Engineer and the representative appointed by the Employer in order to witness these tests.

7.18.3 The Sub-Contractor shall prove all specified values contained in this document and issued in his own specifications and literature.

7.18.3 On completion of the tests, a full test report shall be issued. The report shall contain all measurements taken.

7.19 AVAILABILITY OF SPARES

- 7.19.1 Spares and replacement parts shall be readily available in the Republic of South Africa and a guarantee of availability for a period of ten years shall be furnished.
- 7.19.2 The Sub-Contractor shall submit a priced schedule of recommended spare parts, which should be carried on site.

7.20 INFORMATION

The Sub-Contractor is required to submit the following information with their tender:

- [a] The information requested in the Schedule of Information.
- [b] A paragraph-by-paragraph schedule of compliance with this specification with detailed description of any deviations from this specification.
- [c] If alternative systems are offered, a clear description of the operating characteristics and special features of the equipment along with a motivation for offering the alternative.
- [d] Descriptive and illustrated brochures and other information pertaining to the system offered.
- [e] The proposed layout.
- [f] A priced schedule of recommended spare parts and special tools to be maintained on site.
- [g] The Sub-Contractor shall submit a list of successful installations completed in the Republic of South Africa.

7.21 OTHER EQUIPMENT

The following additional equipment shall be supplied and installed by the Sub-Contractor:

- [a] A set of tools for routine maintenance.
- [b] Warning notices

In the plant room, a clearly legible and indelible warning notice shall be mounted in a conspicuous position.

The notice shall be made of non-corrodible and non-deteriorating material, preferably plastic, and shall read as follows:

DANGER

This engine will start without notice. Turn selector switch on control board to "OFF" before working on the plant.
- [c] A 10 litre plastic container and funnel for distilled water for battery.
- [d] A wall chart containing bilingual step-by-step checking procedures in the event that the set does not start.

7.22 SYSTEM REQUIREMENTS

The plant operation shall be fully automated, i.e., it shall start when any one phase of the mains supply fails and shall shut down when the normal supply is re-established.

Curves furnished by the engine manufacturer, showing the output of engines offered against the speed, for both intermittent and continuous operation, as well as fuel consumption curves when the engines are used for

electric generation, shall be submitted with the tender.

7.23 PACKAGING, TRANSPORT, LOADING AND STORAGE

Each set shall be suitably packed for transporting to the site from the factory. The cost of packing and transport shall be included in the tender price. The Sub-Contractor shall be responsible for the loading, transport to the site, off-loading, storage rigging into position and security of the equipment on site or elsewhere as required. The regulations of the South African Government regarding shipping, customs tariff and inspection shall be complied with.

7.24 ENGINES

- 7.24.1 Engines shall comply with the requirements laid down in BS 5514 and shall be of the direct injection, compression ignition type, running at a speed of 1500 rpm. Engines shall be suitable rated for the required electrical output of the set, when running under the mentioned site conditions. The engine shall be capable of providing for the total stated load in a period not exceeding 30 seconds.
- 7.24.2 Engines shall be of the multi-cylinder compression ignition type, water cooled, naturally aspirated or turbocharged, cold starting, rated for continuous heavy-duty operation and having overload capacity of overcome transient heavy motor starting as specified.
- 7.24.3 Engine speed shall be 1500 rpm. A reduction gearbox shall not be used.
- 7.24.4 The cylinders shall be fitted with fully interchangeable liners and carried in individual galvanised water jackets.
- 7.24.5 The engine shall be fitted with replaceable valve seat inserts and valve guides made of suitable material.
- 7.24.6 The engine installation shall be of neat appearance and all water, lubrication oil and diesel oil lines, filters and stopcocks shall be leak free.
- 7.24.7 All engine flexible or rigid piping which is not heat resistant, shall be adequately protected against damage by radiant heat. Engine wiring shall be silicon rubber insulated and moving parts must be well protected.
- 7.24.8 The Sub-Contractor is at liberty to offer alternatives to the above. Such alternatives shall be fully motivated and be accompanied by relevant documentation and details of previous installations.

7.25 GOVERNOR

The speed of the engine shall be controlled by a governor in accordance with Class AO of BS 5514. When full load is suddenly applied or removed, the temporary speed variation shall not exceed 10%. The permanent speed variation shall not exceed 0.5% of the nominal engine speed. External facilities shall be provided on the engine to adjust the nominal speed setting.

The cyclic irregularity of the set shall be within the limits laid down in BS 5514.

7.26 LUBRICATION

Lubrication of the main bearings and other important moving parts shall be by forced feed system.

An automatic low-pressure cut-out shall be fitted, operating the stop solenoid on the engine, and giving a visible and audible indication on the switchboard.

Full flow fine filters with replaceable elements capable of 250 hours running without attention shall be fitted and arranged for easy access and maintenance.

An oil pressure gauge shall be fitted. Separate sensors for the oil pressure gauge and low oil pressure cut-out system shall be fitted.

Recommended oil types shall be indicated on the engine by means of suitable labels.

7.27 FUEL SYSTEM

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

The governor-controlled fuel injection pump(s) and injectors shall be arranged for easy access and maintenance. An engine mounted fuel feed (lift) pump shall be fitted.

A microfilter with replaceable elements suitable for the full flow rate of the injection pump(s) and rated for 500 hours running time without attention, shall be fitted between the lift and injection pump(s) and shall be arranged for easy access and maintenance.

An additional heavy-duty primary filter (sludge filter) of the washable screen mesh type shall be fitted in the fuel line between the fuel tank and lift pump. The filter bowl shall serve as a water trap. Interconnecting fuel piping shall be copper and shall be neatly run from the sludge filter to the other parts of the fuel system.

All piping shall be securely fixed by means of saddles and clamps.

The Sub-Contractor shall allow for all interconnecting fuel piping between the Bulk fuel tank and the header tanks in the Plant room. The header tank, pumps and all interconnecting piping will form part of this Contract.

7.28 AIR FILTERS

The engine shall be fitted with high efficiency cartridge type air filters suitable for 500 hours running without attention. The filters shall be complete with differential pressure service indicators.

7.29 EXHAUST SYSTEMS

7.29.1 Exhaust systems, to suit the layout of the plant room as shown on the drawings (if the set is to be installed in a plantroom) shall be supplied and installed. These systems shall be designed for "Residential areas" to limit the exhaust noise to a minimum.

7.29.2 The Sub-Contractor shall include the necessary high and low frequency exhaust silencers, piping, expansion pieces, rain-caps, supports etc., to complete the installation in its entirety. Special care shall be taken to avoid the blackening of the ventilation plenum and any HVAC equipment on the roof.

7.29.3 The system components within the confines of the plant room and ventilation shaft shall be effectively lagged and clad with an approved material to reduce the amount of heat dissipated into the plant room to a minimum.

7.29.4 The exhaust pipes shall terminate at roof level in accordance with the requirements of the local authority. The route to be followed by the exhaust pipes is shown on the drawings.

7.30 STARTING AND STOPPING

7.30.1 The engine shall be easily started from cold without the use of any special ignition devices under summer as well as winter conditions and shall provide the load acceptance characteristics specified.

7.30.2 An electric starter motor of the non-hold-in duty type shall be fitted to the engine. In addition to the automatic starting and stopping facility, provision shall be made on the control panel for manual starting and stopping of the set.

7.30.3 The automatic control shall make provision for three consecutive starting attempts.

7.30.4 Provision shall be made on the plant management system for the full manual operation of the generator in the event of malfunctioning of the automated controls of the plant management system.

7.30.4 Thereafter the set must be switched off, and the start failure relay on the switchboard shall give a visible and audible indication of the fault.

7.31 STARTER BATTERY

- 7.31.1 The set shall be supplied with a fully charged lead-acid or lead calcium battery complete with the necessary electrolyte. The battery shall have sufficient capacity to provide the starting torque stipulated by the engine manufacturers for at least three consecutive starting attempts and the capacity shall not be less than 140 Ah. The battery capacity shall be determined by the minimum ambient temperature specified. The battery shall be housed in a suitable acid resistant battery box, with suitable cover to protect against possible short circuits.
- 7.31.2 Starting batteries shall be charged from an engine driven alternator with automatic charging rate control during engine operation and from a mains charger when the plant is stationary. An ammeter to indicate the battery charging current shall be provided.

7.32 ACCESSORIES

The engine shall be supplied complete with all accessories, air filter, oil filter, fuel filter, standard set of tools, instruction manuals, spare part lists, etc.

The first fill of lubricating oil and full tank of fuel of the header tank (after site tests have been completed) shall be supplied.

7.33 MOUNTING

The engine and alternator shall be directly coupled by means of a flexible coupling and mounted on a common simplex base of fabricated steel. Lifting hooks or holes shall be incorporated to facilitate handling of the unit.

Anti-vibration mountings shall be provided on the base.

A suitable drip tray shall be provided to fit below the engine oil sump.

7.34 ENGINE PROTECTION

The necessary sensors for low oil pressure and engine over-temperature protection shall be fitted.

Over-speed protection shall be derived from the frequency sensor mounted on the control panel.

A fail-safe series circuit for the engine mounted protection devices shall actuate the fuel cut-off solenoid in the event of the operation of a sensor, failure of a sensor, breaks in wiring or failure of the associated timing or control circuits.

A fail-safe device shall bypass the protection circuits during engine cranking and shall become operative with the start-discontinue signal.

7.35 ALTERNATOR

The alternator shall be of the self excited brushless type, with self ventilated drip-proof housing, and shall be capable of supplying the specified output continuously with temperature rise not exceeding the limits laid down in BS 4999 for rotor and stator windings with Class F insulation. The insulation provided shall be Class F or better. The alternator shall be capable of delivering an overload of 10% for one hour in any period of 12 hours without exceeding the temperature limits specified above.

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

7.36 REGULATION

The alternator shall be self regulated, the inherent voltage regulation not exceeding plus or minus 1.5% of the nominal voltage at all loads with the power factor between unity and 0.8 lagging and within driving speed variations of 4.5% between no load and full load.

7.37 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 2½% of the steady state within 300 milliseconds following and application of full load and the transient voltage dip shall not exceed 15%.

7.38 BEARINGS

The Sub-Contractor shall clearly state whether single or double bearing alternators are offered.

7.39 TERMINATIONS

All alternator windings shall terminate in a suitable terminal box with removable cover plate. The terminal box shall be large enough to accommodate the cables and cable glands.

7.40 RADIO AND TV INTERFERENCE

Radio and TV interference suppression shall comply with the requirements of the South African Bureau of Standards and Telkom SA Limited.

7.41 SWITCHBOARD

- 7.41.1 A switchboard completely separated from the set incorporating all equipment necessary for the automated and manual control and protection of the emergency generator set, battery charger, alarms and incorporating switchgear for outgoing circuits shall be supplied and installed in the plant room.
- 7.41.2 The switchboard shall consist of a power section and control panels housed in physically separated compartments.
- 7.41.3 The switchboard shall be a totally enclosed floor mounted unit and shall be vermin and dust proof.
- 7.41.4 All equipment, connections and terminals shall be easily accessible. The front panels shall be hinged and fixed in position by BARKER NELSON or similar catches. A chromium plated handle with lock shall be fitted to the front panel.
- 7.41.5 The metalwork of the board shall be thoroughly de-rusted, primed and finished electrical orange.
- 7.41.6 Suitably rated terminals shall be provided for all main circuits and for the control and protection circuits. Where cable lugs are used, these shall preferably be crimped on the cable, instead of soldered. Screw terminals shall be of a type, which prevents spreading of cable strands. All terminals shall be clearly marked.
- 7.41.7 For the control wiring, each wire shall be fitted with a cable or wire marker of an approved type, and the numbering of these markers must be shown on the wiring diagram of the switchboard.
- 7.41.8 The automatic control and protection equipment shall be mounted on a separate easily replaceable panel with printed circuits. This equipment shall preferably be of a locally developed and supported manufacture.
- 7.41.9 All equipment on the switchboard, such as contactors, isolators, busbars, etc., shall have a current carrying capacity to handle the full load current of the circuit.
- 7.41.10 Special attention shall be paid to complete and correct labelling of all equipment in both official languages. Suitable engraved "IVORENE" or similar plates with white letters against a black background shall be used and shall be fixed by means of brass bolts and nuts. Self-tapping screws or glue will not be accepted. All equipment mounted either internally or externally shall be suitably labelled.
- 7.41.11 Where equipment is mounted close together such as single pole circuit breakers or instrument fuses; they may be designated by a number and described on a chart mounted inside the board behind a transparent protective cover.
- 7.41.12 The colour of insulated conductors supplying AC power to any equipment shall correspond with the phase colour of the supply and black for the neutral. All other conductors shall be wired according to a consistent colour code different from the AC power, to identify the function. These codes shall be clearly indicated on the

wiring diagrams.

- 7.41.13 Cable gland support brackets shall be fitted at the bottom of the switchboard not less than 300mm above the room floor level for all incoming and outgoing power cables.
- 7.41.14 Busbars where applicable, shall be solid copper of sufficient cross-section to carry the currents in the various sections of the switchboard with a maximum density of 1.3 A/mm^2 . The neutral busbar shall have the same cross-sectional area as the phase busbars. Busbars shall be covered with heat shrinkable material coloured according to the phase colours.
- 7.41.15 The rating and fixing of the busbars shall be capable of withstanding fault currents of 30kA. Complete drawings of the switchboard showing equipment layout, circuit diagrams and mechanical details shall be prepared and submitted in triplicate for approval prior to manufacture.
- 7.41.16 Upon completion of the switchboard and control system, the Engineer shall be informed so that he may inspect the switchboard in the factory prior to dispatch.
- 7.41.17 All sundries necessary for erection and commissioning of the board shall be supplied under this Contract.
- 7.41.18 The main outgoing air circuit breakers in the control panels shall be fully compatible (with regards to closing time, protection, etc.) with the synchronising equipment as specified in Part 6 or as indicated on the drawings. The Sub-Contractor shall provide complete details of the air circuit breakers offered.

7.42 EARTHING

- 7.42.1 A solid copper earth bar of at least 40mm x 10mm shall be fitted in the switchboards to which all non-current carrying metal parts of the switchboard shall be bonded.
- 7.42.2 The outer casing of the alternator, the engine and all parts of the base frame shall also be earthed to this bar.
- 7.42.3 The star point (neutral) of the generator shall be earthed to the earth bar.
- 7.42.4 The size of the earth conductors shall comply with the Code of Practice for the Wiring of Premises, SABS 0142 as amended.
- 7.42.5 All earth conductors shall be individually bolted to the earth bar.

7.43 SYSTEM OPERATION (AMF OPERATION ONLY)

- 7.43.1 The system shall automatically start-up and initiates the change-over following mains failure and shall reverse the change over on the restoration of the mains power and shall shut down the set automatically.
- 7.43.2 An adjustable timer of 0-60 seconds (set at 15 seconds) to adjust the time between mains failure and the initiation of the start-up cycle shall be provided.
- 7.43.3 If the mains should be restored during the preset time delay, the start-up cycle shall not proceed.
- 7.43.4 A Start Process Timer shall initiate the starting of the engine after the required time delay following mains failure. The timer shall initiate three starting attempts of approximately 15 seconds each.
- 7.43.5 After three unsuccessful starting attempts the "Start Failure" alarm shall be initiated.
- 7.43.6 After voltage build-up, the change-over contactor to the generator supply shall be activated.
- 7.43.7 Upon restoration of mains supply an adjustable timer of 0-60 seconds (set at 15 seconds) shall be activated. If at the preset time delay the mains power is still present the change over contactor shall connect the mains supply to the outgoing circuits.
- 7.43.8 A stop delay timer shall keep the set running for an adjustable period of 0-15 minutes after the return of the mains supply to run the engine on no-load for cooling down purposes before the engine is automatically shut

down.

- 7.43.9 Should one or more the engine protective devices become operative and shut the engine down, the automatic restoration of mains supply shall nonetheless take place when the mains supply returns. To prevent hunting of the contactors the restoration of the change-over contactor shall be initiated after the protective device has operated and shut the engine down.
- 7.43.10 The control equipment shall be battery operated, either from the engine starting battery or from auxiliary batteries.
- 7.43.11 The control equipment shall be designed to operate satisfactorily under both battery boost charge conditions and a partially discharged battery after 3 starting attempts with the charger supply disconnected.

7.44 OPERATION SELECTOR

- 7.44.1 A four-position selector shall be provided on the control panel, marked:
"AUTO", "MANUAL", "TEST", and "OFF"
- 7.44.2 With the selector on "AUTO", the set shall automatically start and stop, according to the mains supply being available or not.
- 7.44.3 With the selector on "TEST", it shall only be possible to start and stop the set with the push buttons, but it shall not be possible to switch the set on to the mains, or the mains onto the running set.
- 7.44.4 With the selector on "MANUAL", the set shall take the load when started with the push button, but it shall not be possible to switch the set on to the mains, or the mains onto the running set.
- 7.44.5 With the selector on "OFF", the set shall be completely disconnected from the automatic controls, for cleaning and maintenance of the engine.

7.45 PROTECTION AND ALARM DEVICES

- 7.45.1 Protection shall be provided for high engine temperature, low lubricating oil pressure, over-speed and start failure. The indicators and reset pushes shall be marked in both official languages respectively:

"Temperature high"

"Oil pressure low"

"Over-speed"

"Under-speed"

"Start failure"
- 7.45.2 In addition one relay with reset push shall be fitted, giving an audible and visible signal when the fuel level in the tanks is too low. The reset push button of this relay shall be marked "Fuel low".
- 7.45.3 The relays shall operate a communal hooter. An acknowledging switch shall be installed in the hooter circuit. The protection and signalling circuits shall be operated from the battery. The audible range of the hooter shall be 0.5km.
- 7.45.4 The fault indicators may be either electrical or mechanical. A test pushbutton shall be provided to test all indicator lights.
- 7.45.5 Software alarms shall be utilised in conjunction with the above alarms.

7.46 AIR CIRCUIT BREAKERS

7.46.1 The air circuit breakers to be supplied as part of the Contract shall conform to the general requirements as listed below:

- [a] The circuit breakers shall be metal clad and shall comply with BS 4752 and IEC 157.
- [b] The circuit breaker shall be horizontally withdrawable and shall be a self-contained unit of the dead front type, allowing maintenance and tests to be carried out without having to remove the circuit breakers from the withdrawal mechanism.
- [c] The unit shall contain the necessary mechanical interlocks to prevent:
 - Access to "LIVE" terminals when the circuit breaker is withdrawn.
 - The withdrawal or insertion of the unit, when the circuit breaker is in the closed position.
 - Closing of the circuit breaker following an automatic trip condition without resetting the mechanism.
- [d] Adjustable thermal overload releases shall be provided to suit the required current range. In addition, instantaneous magnetic short circuit trips, which are adjustable, shall be fitted. The tripping devices shall be direct acting. The delay adjustment shall be bypassed with an instantaneous making current release when the circuit breaker is closed to prevent the delay timer from operating when the circuit breaker is closed on a fault.
- [e] The air circuit breakers shall be of the quick-make and quick-break type with a stored-energy spring assisted operating mechanism provided with:
 - A trip free mechanical hand operated closing mechanism.
 - A manually operated mechanical trip mechanism suitably protected to prevent inadvertent tripping.
 - A positively driven mechanical device to provide ON/OFF/TRIP indication. This indication shall be clearly visible with the circuit breaker in position.
- [f] Provision shall exist for the addition, if required, of a supply-side undervoltage release.
- [g] The complete circuit breaker and its electrical and mechanical constituents and accessories shall be from a standard product range of a single original supplier.
- [h] A description and illustration of the circuit breaker as well as trip curves, operating manuals and rupturing test certificates shall be provided.
- [i] Circuit breakers shall be derated if necessary, to compensate for the following environmental factors:
 - Maximum ambient air temperature in excess of 40°C or the daily average ambient air temperature in excess of 30°C. This is especially important with regard to the type of enclosure in which the circuit breaker is to be installed.
 - Height above sea level.
 - Operational duty cycle and estimated loading.
- [j] The Sub-Contractor shall state the type and operating characteristics of air circuit breakers offered.
- [k] In addition, the Sub-Contractor shall state operating characteristics required of air circuit breakers which will be supplied and installed under the electrical contract, as far as they will be affected by the automatic controls initiated by the generator control system.

7.47 BATTERY CHARGER

- 7.47.1 Whilst the set is stationary, the engine battery shall be charged via a battery charger mounted in the Control Panel.
- 7.47.2 The charger shall be suitable for the AC mains with a maximum voltage variation of approximately 10% and a maximum frequency deviation of approximately 3 Hz.
- 7.47.3 The charger shall be of the constant voltage type with current limiting facilities. Output voltage shall be kept within 1% of the float charge voltage designed for maximum charge conservation and maximum life of battery. The charger shall be suitably sized to supply any standing load on the battery plus a charging current, which will recharge a fully discharged battery in less than 8 hours.
- 7.47.4 The ripple content in the output of the charger shall be less than 2%.
- 7.47.5 The battery charger shall be equipped with the following additional equipment:
- Mains input isolator and fuse in the AC input supply.
 - HRC fuse in DC positive output lead of the charger.
 - One flush mounted voltmeter for indication of battery voltage.
 - One ammeter for indication of battery charging current.
 - A low voltage alarm with a two second time delay and visible indication. The low voltage alarm shall activate the hooter.
- 7.47.6 If auxiliary batteries are supplied for the control equipment, the auxiliary charger shall comply with the above.

7.48 REMOTE MONITORING

- 7.48.1 Voltage free, N/O alarm contacts from all the major protection devices shall be wired to a separate terminal box in the control board. All wiring and terminals shall be clearly identified in accordance with the relevant wiring diagrams.
- 7.48.2 All outgoing wiring from this terminal box shall be done by the BMS contractor.
- 7.48.3 A comprehensive BMS system is being installed and all alarms shall be presented in the format of MODBUS or SNMP protocol to the BMS system as well as hardwired normally closed contacts of the critical alarm.

PART 7T

GENERATOR INSTALLATION

DETAILED TECHNICAL SPECIFICATION

This index refers to the Part numbers [Part 7] as per the CAI standard document.

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PART 7.2	SYSTEM REQUIREMENTS
PART 7.3	ENGINES
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PART 7T

GENERATOR INSTALLATION

DETAILED TECHNICAL SPECIFICATION

7.1 GENERAL

1.1.1 Scope

This specification covers the supply, delivery, installation, testing, commissioning and maintenance during the guarantee period of the Standby Power Generator Installation.

Upon any discrepancies or contradictions existing between this specification and the General Technical Specification for the specific installation, then the Detailed Technical Specification shall take preference.

A brief summary of the installation includes but shall not be limited to the following:

- The supply and installation of standby power generating plants comprising:
 - 2 x diesel generators, sound attenuated canopy set with base mounted fuel tanks
 - Bulk fuel tanks
- Supply and installation of input/output control panel.
- Supply and installation of sound attenuated canopy to 70 dBA
- Commissioning, maintenance, guarantee and preparation of operating and maintenance manuals.
- Installation of associated power and control cabling
- Obtaining fire approval and clearance from the local authority where required

1.1.2 Site Visit

~~Tenderers are advised to visit site to acquaint themselves with the installation if they feel the need for additional information. No claims will be entertained for lack of knowledge about the site conditions.~~

1.1.3 Programme

The project programme for the Standby Power Generator Installation shall be discussed with and determined by Main contractor

1.1.4 Generating Equipment

The Generator Plant shall have an output capacity as stated in the specification, rated at the specified altitude, in accordance with BS 5514.

The system shall be equipped with load shedding and plant management controls as specified in the general Technical Specification.

- 1.1.5 The schematic layout of the system and the physical layout of the plant has been included in the drawings. Drawings for the plant have been provided as part of the tender documents.

7.2 SYSTEM REQUIREMENTS

The sets shall operate fully automatically, i.e.. It shall start when any one phase of the mains supply fails and shall shut down when the normal supply is re-established. The sets shall be able to synchronise with main supply upon restoration of mains following a power failure and transfer seamlessly, both manually and automatically.

On mains failure the sets on the A and B bus should both start and synchronise the A and B bus. Based on the running hours the control system is to select a generator to take load. The system should then open and close circuit breakers to allow the generator taking load to supply power to the A and B bus so that the A and B legs of the 11kV ring is energised. This operation should be executed automatically.

Curves furnished by the engine manufacturer, showing the output of the engines offered against the speed, for both intermittent and continuous operation, as well as fuel consumption curves when the engines are used for electrical generation, shall be submitted with the tender.

7.3 ENGINES

1.4.1 Engines provided shall comply with the requirements as stipulated in this specification.

1.4.2 ~~Due to the location of the engines in the basement, the contractor shall give special attention to the heat rejected to ambient in the plant room.~~

The contractor shall state the total heat dissipated to air, exhaust and cooling system, (at 10% overload), as well as details of the limitation measures taken regarding heat dissipation from manifolds and turbo chargers. Manifolds shall be of the water-cooled type or be clad to reduce heat rejection to the plant room.

7.4 GOVERNORS

Governors shall be provided as specified in this document and shall be fully compatible with the automatic synchronising controls.

7.5 FUEL SYSTEM

1.6.1 A 1000-litre base mounted fuel tank shall form part of this contract. All connections to and from the tank, including all fuel supply piping, filler piping, vents, etc., will form part of this contract. The interconnecting piping, all safety measures, sludge filters and water traps must be included in the price.

1.6.2 The contractor shall allow in his price for 500l of fuel for complete commissioning purposes.

1.6.3 Bulk tanks to be configured to allow for the 4th tank as a diesel testing tank when diesel is delivered. If the diesel quality is acceptable, it is to be pumped into the bulk tank storage consisting of the remaining 3 tanks. This is to be achieved by means of pumps and valves. There must also be an option to use the 4th tanks as part of the bulk storage should additional storage be required. This change should be easily made by means of automatic valves and a selector switch on the diesel storage control panel.

7.6 COOLING SYSTEM

1.7.1 Cooling of the machine shall be by way of set mounted radiators.

7.7 ALTERNATOR

1.10.1 The alternator provided shall be in accordance with the requirements of this specification.

1.10.2 The contractor shall state the total heat dissipation of the alternator, (at 10% overload), in the plant room.

7.8 SWITCHBOARD AND CONTROLS

1.11.1 Schematic diagrams of the control panel to be provided for the generating sets are shown on the drawings. The panel shall conform in all respects to the requirements of this specification.

1.11.2 The switchboard shall consist of power section and a control panel housed in physically separated

compartments.

- 1.11.3 The control panel shall be painted red.
- 1.11.4 The switchboard shall be totally enclosed floor mounted units and shall be vermin and dust proof.
- 1.11.5 The switchboard shall be equipped with plant management and load shedding interface to the existing machines. **The sets must be capable of synchronising with mains with seamless transfer.**
- 1.11.6 The switchboard will be manufactured and designed as a fully automatic, control panel suitable for all controls, load shedding and engine management.
- 1.11.7 The automatic change over switchgear will be housed in the main LV and does not form part of this contract. The control of and interfacing with the changeover breakers will form part of the contract.
- 1.11.8 Soft synch will be allowed for

7.9 RIGGING

The rigging of the generator on site shall form part of this contract. It is recommended the tenderers visit site to familiarise themselves with the rigging required to install the generator. Drawings of the plant have been provided as part of the tender.

7.10 MONITORING

- 1.13.1 The remote monitoring functions described in this specification shall be provided.
- 1.13.2 Hard wired and software interfaces to an interface point shall be allowed for as per the BMS schedule included in the tender.
- 1.13.3 All controller software points shall be available via MODBUS

7.11 OPERATOR TRAINING

On completion of all tests, to the satisfaction of the Engineer, the contractor shall continue to be responsible for the complete operation and maintenance of the plant for a period of three weeks during which time instructions shall be given to the Employer's staff of the proper operation and maintenance of the plant.

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

7.12 DRAWINGS

1.15.1 Approval of Drawings

All tenderers to note the requirement for workshop drawings

The contractor shall submit, for approval, in principle, copies of all above-mentioned drawings prior to starting work or issue to other parties. Any work started (off site or on site) prior to receiving the Engineer's approval of drawings shall be at the contractor's own risk.

The Engineer may require from the contractor further detailed drawings and/or calculations which clarify features not adequately shown on the layout drawings. The request for additional details shall not be construed as extending the scope of this contract or altering the programme.

The contractor shall submit one sepia and one paper print of each drawing to the Engineer for approval.

The Engineer will return to the contractor, within four weeks of their receipt by him, one copy of each drawing marked "APPROVED IN PRINCIPLE" or marked with any changes, which are necessary.

The contractor shall modify these details and drawings as required by the Engineer. The nature and date of each modification and distinguishing symbol shall be added and the drawings shall be re-submitted for approval.

Alterations to drawings, by the Engineer, are not intended to change the scope of work unless explicitly stated as doing so. Should any alterations, in the opinion of the contractor, change the scope of work, the contractor shall notify the Engineer immediately of receipt of the altered drawings before any further drawing work or fabrication is carried out. Claims for a change of scope, made after performance of the work constituting the claimed change of the scope of work will not be considered.

The "APPROVAL IN PRINCIPLE" of drawings by the Engineer shall not relieve the contractor of any responsibility in terms of the Contract.

The Engineer will check the drawings for design only and approval of the drawings, schedules and catalogues shall not be construed as a complete check.

The contractor shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars supplied by him whether such drawings or particulars have been approved by the Engineer or not, provided that such discrepancies, errors or omissions are not due to inaccurate information or particulars furnished in writing to the contractor.

Six copies of the Final Manufacturing and Installation Drawings shall be issued to the Engineer by the contractor within ten days or receipt of "APPROVAL IN PRINCIPLE". Further copies shall be provided and may be required by the Engineer either before or after final approval.

The contractor shall provide, at his own expense, all copies of drawings required by him in the execution of the work and shall also, at his own expense, supply to the Engineer such drawings and copies thereof as are provided for in the specification.

1.15.2 Record Drawings

On completion of the installation, but before final hand over, the contractor shall provide two transparencies plus the necessary prints of each of the contract drawings showing the installation as fixed:

- Complete installation layout
- Detailed drawings of all items of plant
- Electrical layouts and wiring diagrams
- Details of any other items requested by the Engineer

The drawings shall be sufficient in detail to enable the Employer's staff to maintain, dismantle, reassemble and adjust any part of the works.

The layouts shall show the location of all manual and automatic equipment, controls, control panels, outlets, etc.

7.13 MAINTENANCE

The contractor shall maintain the entire installation as described in this specification for a period of 12 months from the date of practical completion.

A proposal shall also be submitted for the maintenance of the machine for the following 24 months after the initial 12 months maintenance period.

The maintenance visits shall be carried out at regular intervals, as necessary.

The maintenance shall cover all items of plant and equipment and shall include replacement of all expendable

items.

In addition to the monthly maintenance visits, the contractor shall carry out all necessary visits due to failure of any item of the system. The contractor shall attend to all complaints by the Employer.

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

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

The equipment shall be cleaned where necessary at each scheduled visit.

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

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

The tender price shall include for a full complement of recommended spares for the total maintenance period as well as the following period of twelve months. The contractor shall detail the allowance for recommended spares as a detailed breakdown of the total allowance.

7.14 GUARANTEE

The contractor shall guarantee the entire installation, as described in this specification for a period of 12 months from practical completion. The guarantee shall provide for all parts, spares and equipment that become defective during the guarantee period and these shall be replaced free of charge. The guarantee shall cover all costs including material, labour, overheads, travelling, etc.

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

The guarantee shall cover all materials, plant and equipment whether or not it is covered by a manufacturer's guarantee. The 12 month guarantee, in terms of this contract, on the entire installation shall be affected by the prior expiry of any guarantee provided by the manufacturer of any item of equipment or plant.

The contractor shall cede to the Employer, the remainder of any equipment guarantee which he has received from his suppliers and which extends beyond the 24 guarantee period. It shall be the responsibility of the contractor to ensure that the guarantee is transferable.

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

7.15 OPERATING AND MAINTENANCE MANUALS

The contractor shall provide three [3] hand and two [2] soft copies of the Operating and Maintenance Manuals.

The contractor shall submit, for approval to the Engineer, four weeks before completion of the installation, two copies of the Maintenance and Operating Manuals for the system supplied.

The Engineer will return these to the contractor, within ten working days of their receipt by him, marked with all changes, which are necessary.

The contractor shall modify the manuals as required by the Engineer and submit the Engineer, within ten

working days, two revised copies of the manuals. On completion of the installation, but before the plant is handed over to the Employer; the contractor shall provide three copies of the final Operating and Maintenance Manuals for the system supplied. The manuals shall be bound in book form with hard plastic covers to withstand constant use.

The manuals shall be properly indexed to facilitate easy reference.

The manuals shall include:

- A list of recommended servicing tools and specialist equipment.
- A list of spares with price breakdown to be supplied by the contractor to cover the period of warranty.
- A priced list of recommended spares necessary for a period of two years of operation.
- Exploded drawings or detailed spares list from which every item of every piece of equipment can be positively identified for ordering replacements.
- A list giving the name and address of local agent for each item of equipment.
- A list giving the name and address of the manufacturer of each item of equipment.
- A copy of all test certificates obtained with the equipment.
- A list of recommended lubricants (if applicable).
- A preventative maintenance programme for all equipment.
- Operating instructions for each item of equipment.
- Performance data and/or characteristic curves.
- Commissioning data.
- Record drawings.

7.16 INFORMATION TO ALL CONTRACTS

- Written guarantees with detailed conditions, (applicable).
- First 12 months guarantee/maintenance contract proposal with conditions, (applicable).
- Follow-up guarantee (if any) and proposal for service/maintenance contract with conditions, (applicable).
- Complete set of documentation, including service instruction manual, three sets, one set should be on microfiche (drawings).
- List of recommended spares to be purchased immediately. Detailed reference to every supplier of such spares.
- List of recommended tools and instruments to be purchased immediately for servicing, repair and testing purposes.
- Proposals for possible training to the Employers staff members (operational and technical).

NOTE:

The installation will not be considered complete until the above drawings and schedules have been issued.

7.17 SOUND ATTENUATION

Attenuators before and after the units to ensure the noise level outside the energy centre are below 65dBA
Tenderers are to list any other costs with details to ensure that all noise and vibration is mitigated outside the energy envelope and that as per SANS regulation 70dB is not exceeded at the boundary

PART 8

BILLS OF QUANTITIES

1. These Bills of Quantities form part of and must be read in conjunction with the specification and must be submitted, duly completed, on the closing date of tenders.

2. Tenderers must complete the Bills of Quantities and detail the unit rate and total amount of each item.

Any discrepancies which might occur between the specification, the Bills of Quantities and the drawings must immediately be brought to the attention, of the Employers Authorised Representative and the tenderer should indicate at the time of tendering whether provision has been made in the tender price covering such discrepancies.

NOTE:

Tenderers are advised to check their item extension and total additions, as arithmetical errors occurring in the priced Bills of Quantities cannot be considered as having an effect on the tender amount.

3. No alteration, erasure or addition is to be made in the text of the Bills of Quantities. Should any alteration, erasure or addition be made, it will not be recognised, but the original wording of the Bills of Quantities will be adhered to.
4. The Employers Authorised Representative will check the completed Bills of Quantities and reserves the right to adjust any individual price and to rectify any discrepancy whilst the total tender price as quoted remains unaltered.
5. The quantities given in the Bills of Quantities for cable, cable markers, earth wire laid with cable and excavations, cannot be regarded as exact and are subject to measurement on site after completion of the service, and adjustments will be made according to the unit rates given in the Bills.

All other quantities will **not** be measured on site.

In the event of discrepancies between the drawings, specification and Bills of Quantities, the Employers Authorised Representative shall decide whether the work as executed, shall be re-measured on site or whether re-measurement shall be effected from the working drawings only.

6. Where alternative prices for gear of different manufacture are quoted, the **lowest** alternative price for gear to specification must be quoted against the relevant item in the Bills of Quantities. The remaining alternative prices must be furnished separately.
7. The unit prices quoted in the Bills of Quantities must include for such small installation materials as are required for the complete installation in accordance with the specification.
8. Quantities in this Bill must not be used for ordering purposes.
9. All quantities are net, unless otherwise indicated, and tenderers must allow in their rates for off cuts.
10. Quantities and rates for day works are included in the total price, but tenderers shall note that these items are provisional only and will only be paid to the successful tendered as and when a written instruction is issued for this.

PART 9

BMS

DETAILED TECHNICAL SPECIFICATION

This index refers to the Part numbers [Part 9] as per the CAI standard document.

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PART 9.2	SOFTWARE LICENCE AGREEMENT
PART 9.3	BMS SPECIFICATIONS
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PART 9.19	XML/SOAP INTEGRATION
PART 9.20	MODBUS SYSTEM INTEGRATION
PART 9.21	OPC SYSTEM INTEGRATION
PART 9.22	GRAPHICAL USER INTERFACE COMPUTER HARDWARE (DESKTOP)
PART 9.23	HAND HELD WIRELESS TERMINAL
PART 9.24	PRINTERS (ALARM REPORT PRINTERS)
PART 9.25	QUALIFICATION SPECIFICATION
PART 9.26	SUPPORT

PART 9

BMS

DETAILED TECHNICAL SPECIFICATION

9.1 GENERAL

Project overview

SANSA is a commercial office and technical building, of approximately 3 000m² of floor space and an energy center which will require monitoring. SANSA identified the following BMS interactions with systems as considered as being an entry level requirement for systems offered:

- A. Lighting Control and Monitoring System
- B. HVAC Control and Monitoring
- C. Uninterruptible Power Supplies
- D. Power Management System
- E. Diesel bulk tank, day tanks and receiving tanks
- F. Water reticulation
- G. Generators
- H. PV plant
- I. BESS system (future)

The primary purpose of the BMS system is reporting and monitoring of the systems. ~~with basic control on the lighting and HVAC systems.~~ However the system must be expandable and capable of advanced control of systems and expandable to all third party connections. The contractor will be required to supply, install and commission all necessary components of the BMS system, including wiring to the field devices.

Summary

This section describes the Building Management System (BMS) specifications for the project.

All labour, material, equipment and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, shall be provided without additional cost to SANSA.

The goal to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. SANSA shall be the named license holder of all software associated with any and all incremental work on the project(s).

System Description

The BMS shall coordinate and integrate with all Building Systems to ensure data exchange between the various BMS building systems meets the project requirements. The BMS shall have within its scope the common GUI, database and data storage, application program and operating systems. This BMS shall act as the link between all the different sub-systems on the site enabling the transfer of relevant information between the systems using the appropriate protocols. The BMS shall provide both client and server functions; the BMS shall request information from the various BMS systems communicating on the Common IP LAN. The BMS shall determine the routing of all data between systems, and the BMS shall determine which system shall be the recipients of the data based on the nature of that data, and all data transferred from one system to another shall be routed via the BMS.



In order to adequately monitor and control the Building systems, the required information like alarm, control point, set temperature, etc. will be transferred to the BMS. The BMS shall have responsibility for providing an interoperable system that enables the sharing of information between the Buildings systems.

The BMS shall at minimum support the following protocols over the Ethernet TCP/IP backbone, BACnet, LonTalk IP, MODBUS, MODBUS RTU, CANBUS SNMP, XML, SOAP, OPC, KNX, oBIX.

ENTERPRISE INTEGRATION SYSTEM (BMS) framework shall provide an open automation infrastructure that integrates diverse systems and devices (regardless of manufacturer, communication standard or software) into a unified platform that can be easily managed in real time over intranets or the internet using a standard web browser. The BMS software shall be classified as a COTS (Commercial off the Shelf) product.

9.2 SOFTWARE LICENSE AGREEMENT

SANSA shall be provided with copies of the manufacturer's standard software and firmware licenses as a condition of this contract. Such licenses shall grant use of all programs and application software to SANSA as defined by the manufacturer's license, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

It is SANSA's express goal to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. SANSA shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, SANSA shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configurations and programming that is generated for a given project and/or configured for use with the BMS and any related LAN/WAN/ intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to SANSA.

The BMS server shall be able to manage at least 2000 monitoring and control points excluding virtual and program points. The operator shall be able to assign on-line, using an interactive procedure, monitoring points, set points and historical data from thin client remote engineering tools.

It shall be possible to add unlimited numbers of thin client workstations connections without requiring additional licenses.

9.3 BMS SPECIFICATION

General

- A. The BMS shall be a comprehensive component model with a structure that serves as a foundation for building applications and integrating diverse connected systems. Through graphical programming and open API's, the component model shall provide a method of modelling the data and attributes of diverse connected systems, while at the same time provide a method of modelling and creating the end applications delivered to the end user.
- B. Key application areas which must be supported by the BMS at a minimum: Scalable and Distributed Architecture, Unified Software Environment, Extensibility, Integrated Control Engine and Web Services.
- C. The BMS specialist shall coordinate with and cooperate with all BMS systems specialists that furnish systems communicating on the IP LAN to ensure that the data exchange between the various BMS Building Systems meets the requirements of these specifications. The BMS specialist shall have responsibility for providing an interoperable system that enables the sharing of information between the different BMS Building Systems and Enterprise System, for example ERP and others. The BMS shall, at minimum support the following protocols over the TCP/IP backbone:
 - 1. BACnet (Server/ Client)
 - 2. LonTalk

3. MODBUS (Master/Slave)
 4. SNMP
 5. XML
 6. SOAP (Server Client)
 7. OPC (Server Client)
 8. KNX
 9. NTP
 10. CANBUS
 11. MODBUS RTU
- D. The BMS shall be configured to ensure reliability of systems. Provide a single, dual fault tolerant server.
- E. All components of the BMS shall operate on UPS.
- F. The BMS components shall be the most recent products offered which meet these specifications. If there are improved models of any BMS components that become available before the on-site commencement of installation then these shall be offered to SANSA at no additional cost.
- G. Each component shall meet, at minimum, the following requirements:
1. Manufactured by experienced manufacturers of the specific component and facilities.
 2. Designed to minimize the requirement for field repair or maintenance.
 3. Modular design
 4. Components, test ports and cable terminations shall be readily accessible
 5. Damage caused by the failure of one component will be limited to the component that has failed without affecting the on-going operation of the other components.
 6. Certify in writing with the tender submittal that all components proposed for this project comply with all of the integration requirements.

9.4 SOFTWARE REQUIREMENTS

Enterprise Server Operating System

The BMS software must be capable of running on either a Windows or Linux operating systems, on both 32 and 64 bit versions of these. The version of Windows used must still be supported by Microsoft at the time of installation.

Computer Antivirus Software

Provide antivirus software for all components that are vulnerable to viruses. Antivirus software shall be provided with free virus definition updates for the duration of the warranty. Antivirus software should automatically scan the computer BIOS and all files opened, created, copied, and/or received for viruses. Include directions for updating virus definition files upon expiration of warranty within the record documentation.

Technical Proposal

Technical proposal shall be prepared in accordance with this specification. The technical proposal shall include the following data/information as a minimum. The order of listing here is not intended to indicate, nor should it be construed to indicate, the relative importance of data/information.

1. Information or organizational capability to handle this project (management personnel, manufacturing, single source responsibility, etc.)
2. Information on training programs to demonstrate specification compliance.
3. System configuration as proposed with specific reference to interoperability:
4. System Operations and functions
5. System Modularity and Provisions against obsolescence due to technological advancement.

6. System software details for this project, In particular detail the protocols that can be handled by the BMS for receipt and distribution of data.
7. Details of protocols that are supported by the BMS over an Ethernet TCP/IP backbone. Highlight any of the protocols listed in part 1.2.1C that are not supported by the BMS.
8. Details of data handling procedures in the event of failure of network communications, power failure, receipts of undecipherable messages and conflicts in data received.
9. Product data regarding system performance such as mean time between failures and mean time to repair. Such data shall be based on manufacturer's published and proven data and the BMS specialist's experiences with systems of a similar nature.
10. Details of at least five BMS installed in excess of R 500 000 of a similar nature. Provide contact details for references.
11. Certification by the original manufacturer and software providers that the BMS specialist is certified to undertake the work of this contract and that they endorse the design proposed by the BMS specialist.

9.5 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

The BMS software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI/ ASHRAE Standard 135-2001, BACnet and LonMark to assure interoperability between all system components is required. For each LonWorks device that does not have LonMark certification, the device supplier must provide an XIF file and a resource file for the device. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level.

Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet, Ethernet IP,) and/or RS-485 (BACnet MSTP) as specified.

The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.

A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.

Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.

Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 30 seconds for remote or dial-up connected user interfaces.

9.6 BMS SYSTEMS

At a minimum the following BMS systems shall be integrated to the BMS via the IP backbone. The number of physical points can be found from the BMS points list.

- Lighting Control and Monitoring System
- HVAC Control and Monitoring System
- Uninterruptible Power Supplies
- Power Management System
- Diesel bulk tank, day tanks and receiving tanks

The BMS system must be expandable to incorporate future Building systems from other SANSA sites.

9.7 NETWORKS

The project IT backbone shall be a one gigabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP for maximum flexibility for integration of building data with enterprise information systems. Local area network minimum physical and media access requirements:

- Ethernet; IEEE standard 802.3
- Cable; 100 Base-T, UTP-8 wire, category 6 for short cable runs from field device to controller
- Minimum throughput; 100 Mbps.
- Multi-Mode Fibre optic cable to be used on the main run from the server to the various field positions

The backbone between the energy center, operations and gate buildings will not form part of the project as the interlinking will be done via the SANSA network

9.8 Network Access

For Local Area Network installations, SANSA shall provide a connection to the Internet to enable access from a remote location via either a high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.

9.9 NETWORK TIME PROTOCOL (NTP) CLOCK

- The BMS shall provide the interface between the MASTER CLOCK using NTP. A clock signal shall be provided by SANSA
- The BMS systems clocks shall be synchronized with a Master Clock.
- The time shall be updated every 24 hours at minimum

9.10 SYSTEM REQUIREMENTS

- A. The BMS shall provide the interface between the LAN or WAN and Building systems, and provide global supervisory control functions over the control devices connected to the systems. It shall be capable of executing application control programs to provide:
1. Scheduling
 2. Trending and reporting
 3. Alarm monitoring and routing
 4. Time synchronization
 5. Integration of LonWorks controller data, BACnet controller data and Modbus controller and Standard Protocols data.
 6. Network Management functions for all LonWorks based devices
- B. The BMS shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.
- C. Event Alarm Notification and actions
1. The BMS shall provide alarm recognition; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 2. The BMS shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, wide-area network.

3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
 - a. To alarm
 - b. Return to normal
 - c. To fault
 4. Provide for the creation of a minimum of fifteen of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
 5. Provide timed (schedule) routing of alarms by class, object, group, or node.
 6. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- D. Control equipment and network failures shall be treated as alarms and annunciated.
- E. Alarms shall be annunciated in any of the following manners as defined by the user:
1. Screen message text
 2. Email and SMS of the complete alarm message to multiple recipients. Provide the ability to route , email and sms alarms based on:
 - a. Day of week
 - b. Time of day
 - c. Recipient
 3. Graphic with flashing alarm object(s)
 4. Printed message, routed directly to a dedicated alarm printer
- F. The following shall be recorded by the BMS for each alarm (at a minimum):
1. Time and date
 2. Location (building, floor, zone, office number, etc.)
 3. Equipment (air handler #, access way, etc.)
 4. Acknowledge time, date, and user who issued acknowledgement.
- G. Alarm actions may be initiated by user defined programmable objects created for that purpose.
- H. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
- I. An Audit Log to record all changes or commands shall be provided and available for review by the user.

9.11 DATA COLLECTION AND STORAGE

The BMS shall have the ability to collect data for any property of any object and store this data for future use for a period of 1 year

The data collection shall be performed by log objects, resident in the BMS that shall have, at a minimum, the following configurable properties:

- Designating the log as interval or deviation.
- For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
- For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
- For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
- Each log shall have the ability to have its data cleared manually using a History Database Maintenance tool.

All log data shall be stored in a relational database in the BMS and the data shall be accessed from a server (if the system is so configured) or a standard Web browser.

All log data shall be available to the user in the following data formats:

- HTML
- XML
- Plain Text
- Comma or tab separated values

Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.

The BMS shall have the ability to archive its log data either locally (to itself), or remotely to a server or other BMS on the network. Provide the ability to configure the following archiving properties, at a minimum:

- Archive on time of day
- Archive on user-defined number of data stores in the log (buffer size)
- Manually employing a History Database Maintenance tool

9.12 AUDIT LOG

Provide and maintain an Audit Log that tracks all activities performed on the BMS. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the BMS), to another BMS on the network, or to a server. For each log entry, provide the following data:

- Time and date
- User ID
- Change or activity: i.e., Change set point, add or delete objects, commands, etc.

9.13 DATABASE BACKUP AND STORAGE

The BMS shall have the ability to automatically backup its database. The database shall be backed up on a monthly basis.

Copies of the current database and, at the most recently saved database shall be stored in the BMS. The age of the most recently saved database will be dependent on the user-defined database save interval.

The BMS database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

9.14 GRAPHICAL USER INTERFACE SOFTWARE

Operating System: The GUI shall run on Microsoft Windows 2008 Enterprise Server or a later version of Windows Server

The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

The Operator Interface shall be English Language with metric units.

Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:

- Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, PNG or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.

- Graphic screens shall have the capability to contain objects for text, real-time values, animation, colour spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
- Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
- Commands to start and stop binary objects shall be done by means of a clicking a mouse. No entry of text shall be required.
- Adjustments to analogue objects, such as set points, shall be done by means of a mouse and using a graphical slider to adjust the value or on single click on selected up and down objects. No entry of text shall be required.

System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:

- Create, delete or modify control strategies.
- Add/delete objects to the system.
- Tune control loops through the adjustment of control loop parameters.
- Enable or disable control strategies.
- Generate hard copy records or control strategies on a printer.
- Select points to be alarm able and define the alarm state.
- Select points to be trended over a period of time and initiate the recording of values automatically,

On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

Alarms shall meet the following requirements: Cause of Alarm - Alarms shall be generated at the workstations upon the occurrence of one the following events.

- Failure of Workstation
- BMSs Communications Failure
- BMSs Application Failure/Down
- Failure of Hardware Components

Alarm Console

The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.

When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

- The Alarm console should have the provision of accessing relevant information and graphical user interfaces with the use of hyperlinks

- The Alarm message shall uniquely identify the cause of the alarm together with the time of detection by the Building's systems.
- A distinct audible alarm will sound in the event of critical alarm or a hardware component failure. This will be in addition to the visual alarm indication.
- The Alarm console will indicate a value in alarm or an item of the equipment that is in alarm. This will be done by the use of colour code. E.g. Alarm points are in red and Normal points in black colour.
- The Alarm shall be classified and forwarded to designated workstations.
- The Operator required level of access shall be able to inhibit any alarm. This facility shall enable an Operator to inhibit an alarm on equipment which is out of service.

9.15 WEB BROWSER CLIENTS

The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer, Google chrome or Firefox. Systems requiring additional software, apart from Java, (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.

The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function, shall not be acceptable.

The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted. (Java accepted)

The Web browser client shall support, at a minimum, the following functions:

User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

Storage of the graphical screens shall be in the BMS, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page. Refresh rate of 5 seconds will apply.

Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

- Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu or on single click on the selected object. No entry, of text shall be required.

- View logs and charts
- View and acknowledge alarms
- Setup and execute SQL queries on log and archive information

The system shall provide the capability to specify a user's (as determined by the logon user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

9.16 SYSTEM PROGRAMMING

The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator. Text based programming is not acceptable

A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

Programming Methods

Provide the capability to copy objects from the supplied libraries, or from a user defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in colour depending on the type of link; i.e., internal, external, hardware, etc.

Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.

The software shall provide the ability to view the logic in a monitor mode. When online, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.

All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.

The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

9.17 LONWORKS NETWORK MANAGEMENT

The Graphical User Interface software (GUI) shall provide a complete set of integrated LonWorks network management tools for working with LonWorks networks. These tools shall manage a database for all LonWorks devices by type and

revision, and shall provide a software mechanism for identifying each device on the network. These tools shall also be capable of defining network .data connections between LonWorks devices, known as "binding". Systems requiring the use of third party LonWorks network management tools shall not be accepted.

Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.

The network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.

These tools shall provide the ability to "learn" an existing LonWorks network, regardless of what network management tool(s) were used to install the existing network, so that existing LonWorks devices and newly added devices are part of a single network management database.

The network management database shall be resident in the BMS, ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system, shall not be accepted.

9.18 OBJECT LIBRARIES

A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.

The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.

In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.

The library shall include applications or objects for the following functions, at a minimum:

- Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day, Data entry to be by graphical sliders to speed creation and selection of on-off events.
- Calendar Object. . The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
- Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals.
- Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.
- Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start 1 stop time object properties based on the previous day's performance.

Night Purge: During night time, the outside temperature is lower than supply air temperature. It can be used directly to purge for building. For normal AHU systems, outside dampers are opened and return air dampers are closed and all exhaust fans are operating in full speed. This results in energy saving and improved indoor air quality

Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of shed able equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each shed able object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.

- **Analogue input Object** - Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
- **Analogue Output Object** - Minimum requirement is to comply with the BACnet standard for data sharing.
- **Binary Input Object** - Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.
- **Binary Output Object** - Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and *off* times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.
- **PID Control Loop Object** - Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.
- **Comparison Object** - Allow a minimum of two analogue objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
- **Math Object** - Allow a minimum of four analogue objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
- **Custom Programming Objects** - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language (e.g. subset of Java) that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Use case examples should also be available. Also, provide a comprehensive online debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.
- **Interlock Object** - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after start-up to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.

- Temperature Override Object: - Provide an object whose purpose is to provide the capability of overriding a binary output to an "On" state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analogue object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.
- Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphical shell of this container.

The object library shall include objects to support the integration of devices connected to the BMS. At a minimum, provide the following as part of the standard library included with the programming software:

LonMark/LonWorks devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. All network variables defined in the LonMark profile shall be supported. Information (type and function) regarding network variables not defined in the LonMark profile shall be provided by the device manufacturer.

For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file and documentation for the device to facilitate device integration.

For BACnet devices, provide the following objects at a minimum:

- a. Analogue In
- b. Analogue Out
- c. Analogue Value
- d. Binary
- e. Binary In
- f. Binary Out
- g. Binary Value
- h. Multi-State In
- i. Multi-State Out
- j. Multi-State Value
- k. Schedule Export
- l. Calendar Export
- m. Trend Export
- n. Device

For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.

For BACnet devices, provide the following support at a minimum

- a. Segmentation
- b. Segmented Request
- c. Segmented Response
- d. Application Services
- e. Read Property
- f. Read Property Multiple
- g. Write Property
- h. Write Property Multiple
- i. Confirmed Event Notification
- j. Unconfirmed Event Notification
- k. Acknowledge Alarm
- l. Get Alarm Summary
- m. Who-has
- n. I-have
- o. Who-is
- p. I-am

- q. Subscribe COV
- r. Confirmed COV notification
- s. Unconfirmed COV notification
- t. Media Types
- u. Ethernet
- v. BACnet IP Annex J
- w. MSTP
- x. BACnet Broadcast Management Device (BBMD) function
- y. Routing

9.19 XML/SOAP INTEGRATION

The BMS shall support the integration of device data via Open Building Information Exchange, over the Ethernet Network. The BMS shall be the server on the network.

The BMS shall communicate to enterprise level software over xml and web services using the web service platform.

Provide the minimum object models as specified below:

1. Object
2. Boolean data types
3. Integer data types
4. Real data types
5. String data types
6. Enumerated data types
7. Absolute and real time
8. Uri
9. List
10. Ref
11. Error
12. Operation
13. Feed
14. Null
15. Facets
 - a. display name
 - b. icon
 - c. minimum
 - d. maximum
 - e. precision
 - f. status
 - g. range
 - h. writable
 - i. unit of measurement

9.20 MODBUS SYSTEM INTEGRATION

The BMS shall support the integration of device data from Modbus RTU, ASCII or TCP control system devices. The connection to the Modbus system shall be via an Ethernet if as required by the device.

Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the Modbus system data into the FPMS. Objects provided shall include at a minimum:

- Read/write Modbus AI Registers
- Read/write Modbus AO Registers
- Read/Write Modbus BI Registers
- Read/write Modbus BO Registers

All scheduling, alarming, logging and global supervisory control functions, of the Modbus system devices, shall be performed by the BMS,

The HVAC supplier shall provide a Modbus system communications driver. The equipment system vendor that provided the equipment utilizing Modbus shall provide documentation of the system's Modbus interface and shall provide factory support at no charge during system commissioning.

9.21 OPC SYSTEM INTEGRATION

The BMS shall act as an OPC client and shall support the integration of device data from OPC servers. The connection to the OPC server shall be Ethernet IP as required by the device. The OPC client shall support third party OPC servers compatible with the Data Access 1.0 and 2.0 specifications

Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the OPC system data into the BAS. Objects provided shall include at a minimum:

- 1 .Read/write OPC AI Object
 - Read/write OPC AO Object
 - Read/write OPC BI Object
 - Read/write OPC BO Object
 - Read/write OPC Date/Time input Object
 - Read/write OPC Date/Time Output Object
 - Read/write OPC String input Object
 - Read/write OPC String Output Object

All scheduling, alarming, logging and global supervisory control functions, of the OPC system devices, shall be performed by the BMS.

9.22 GRAPHICAL USER INTERFACE COMPUTER HARDWARE (DESKTOP)

The browser workstation shall be a high end Dell machine, capable of meeting the minimum requirements of the BMS software. A minimum 17" flat panel colour monitor, 1280 x 4 024 optimal preset resolutions, 25 ms response time, shall also be included.

A system printer shall be provided. Printer shall be laser type with a minimum 600 x 600-dpi resolution and rated for 8 PPM print speed minimum.

9.23 HAND HELD WIRELESS TERMINAL (PDA/HHWT)

The Hand Held Wireless Terminal shall be thin client device shall have a web browser.

- Weight, including carrying case, not to exceed 0.25 kg.
- The operator shall operate (monitor and control) based on the access level.

9.24 PRINTERS (ALARM I REPORT PRINTERS)

Report Printer shall be laser type with a minimum 600 x 600-dpi resolution and rated for 60 PPM print speed minimum.

Alarm Printer shall be laser type with a minimum 600 x 600-dpi resolution and rated for 60 PPM print speed minimum.

Scope of work

The scope of work includes the supply, installation and commissioning of all components required to set up and implement the BMS which meet the requirements as set out in this document.

Installation

All work described in this section shall be performed by system integrators or contractors that have a successful history in the design and installation of integrated control systems. The installing office shall have a minimum of five years of integration experience and shall provide documentation in the submittal package verifying the company's experience.

Install the system and materials in accordance with manufacturer's instructions.

Installation shall include:

- Power cabling
- Network cabling
- Cable trays (to be installed by the electrical contractor)
- Signal cabling
- Installation of all hardware
- Physical connections to BMS devices

Design and Engineering (Hardware)

The design of the system architecture and layout shall be determined by the contractor. The design of the system shall comply with the general specifications as set out in this document. The number of hardware components required shall be determined by the contractor.

Design and Engineering (Software GUI)

The contractor shall provide sample GUI's of previous projects. The design and engineering of the GUI shall incorporate the following systems:

- Lighting Control and Monitoring System
- HVAC Control and Monitoring System
- Uninterruptible Power Supplies
- Power Management System

The GUI shall be submitted for client approval and allowances made for up to 3 revisions of the GUI.

Design and Engineering (BMS point configuration)

The contractor shall be responsible for the software configuration of all the BMS points as indicated on the supplied BMS points list. A 20% provision shall be made for any additional BMS points.

Design and Engineering (Control Logic development)

The contractor shall be responsible for the development and implementation of the control logic required for any of the systems. The contractor shall liaise with the HVAC, UPS and Generator contractors and implement any control philosophies required on the BMS.

Design and Engineering (Alarm development)

The contractor shall be responsible for the development of adequate alarming for the required systems. The alarms shall be developed in order to minimize nuisance alarms, unnecessary alarms and false alarms.

The alarms shall be reviewed and optimized every 6 months during the guarantee period to ensure the alarms generated are correct, show the correct messages and are classified correctly.

IT Server room

The BMS servers shall be installed within the IT server room in the operations building as indicated in the drawings provided as part of the tender.

Wiring

All electrical control wiring power wiring and network wiring to the BMS, computers, network components and field devices shall be the responsibility of the contractor.

Where possible the electronic services cable trays shall be used. If the electronic cable trays cannot be used the contractor shall provide and install the necessary cable trays.

The electrical contractor shall furnish all power wiring to the BMS, computer's and any networking equipment (routers, hubs, switches, etc.).

All wiring shall be in accordance with the Project Electrical Specifications and any applicable local codes.

A list of approximate distances from the BMS server room to the field devices is provided.

Supply and installation of cable trays shall be the responsibility of the contractor.

Cables are to be supplied with the required terminations

Warranty

Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

Within this period, upon notice by SANSA, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by the contractor at no expense to SANSA. SANSA shall grant to contractor the reasonable access to the BMS during the warranty period. SANSA shall allow the contractor to access the BMS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

Software License

SANSA shall be the named license holder of all software associated with any and all incremental work on the project(s). SANSA, or his appointed agent, shall determine which organizations to be named in the "org id" of all software licenses.

SANSA, or his appointed agent, shall be free to direct the modification of the "org id" in the software license, regardless of supplier.

SANSA, or his appointed agent, shall receive ownership of all job specific software configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and /or configured for use within BMS based controllers and/or servers and any related LAN/WAN/intranet and Internet connected routers and devices. Any and all required ids and passwords for access to any component or software program shall be provided to SANSA.

Should the license have a time period attached, the contractor shall provide a fixed price for the renewal of the license for the following 3 years after the expiry of the warrantee.

SANSA already have an installed base of BMS systems in the following locations:

- Hermanus
- Hartebeeshoek

In consideration of the above, it will be expected of the tenderer to advise after taking cognizance of the above if or whether it will be possible to leverage off the current licensing agreements that are in place and demonstrate to the Bank what benefit the Bank will have by investing in the same system that have already been installed.

Acceptance Testing

SANSA Matjiesfontein

Electrical Specification

February 2025

Rev 3

Upon completion of the installation, the contractor shall load all system software and start-up the system. The Consultants / Client shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications. The Consultants / Client contractors are to coordinate the checkout of the system such that each Division has a representative present during system checkout.

The Consultants shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the BMS system operation.

Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of SANSA Representative, as required. Properly schedule these tests so testing is complete at a time directed by SANSA's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

System Acceptance: Satisfactory completion is when the Consultants and HVAC contractors have performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of SANSA's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

Operator Instruction, Training

The contractor shall provide 40 hours of instruction to SANSA's designated personnel on the operation of the BMS and describe its intended use with respect to the programmed functions specified. Operator orientation of the BMS shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.

The training shall be in three sessions as follows:

- Initial Training: One day session (8 hours) after system is started up and at least one week before first acceptance test. Manuals shall have been submitted at least two weeks prior to training so that SANSA's personnel can start to familiarize themselves with the system before classroom instruction begins.
- First Follow-Up Training: Two days (16 hours total) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.
- Warranty Follow Up: Two days (16 hours total) in no less than 4 hour increments, to be scheduled at the request of SANSA during the one year warranty period. These sessions shall cover topics as requested by SANSA such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

Green star BMS commissioning clauses

The contractor shall perform the following building activities for the final setting up of the electrical systems:

Perform comprehensive pre-commissioning, commissioning, and quality management on BMS services in exact accordance with Chartered Institution of Building Services Engineers (CIBSE, UK) Commissioning Codes C (Automated Controls) and M (Management).

Deliver at building handover to the client and project engineer for BMS documented design intent, as built drawings, Operations & Maintenance Manuals, Commissioning Report, and training of building management staff.

Documented design intent

The Project Engineer will provide a report to include a simplified diagram of the system, a description of its intended function, operation and conditions, as well as the initiatives intended to enhance energy efficiency and minimise greenhouse gas emissions

Operations & Maintenance Manuals

Describe how the facility will be operated and by whom, as well as the desired level of training and orientation required for the building occupants to understand and use the building systems.

Commissioning Report

Include commissioning dates, records of all functional/commissioning testing undertaken, a list of future seasonal testing, and a written list of outstanding commissioning issues;

Include the outcomes and changes made to the building as a result of the commissioning process, accounting for all the recommendations;

Reference appended extracts of commissioning records for major plant and equipment as deemed appropriate by the relevant project team members involved in the commissioning process and as referenced in the Commissioning Report;

Demonstrate that the services were commissioned in compliance with CIBSE Commissioning Codes for the electrical services.

The items below have been determined from a review of the CIBSE Commissioning Codes identifying key issues to be addressed with regards to the correct documentation of a CIBSE Commissioning Code compliant commissioning process of building services. This list is not exhaustive and it is expected that the Contractor(s) complete their own review of the CIBSE documents and synthesize the important information which they, in their professional opinion and experience, believe are important and represent an improvement from conventional commissioning practices in South Africa and demonstrate the use of the CIBSE Commissioning Codes:

Provide particular and definitive commissioning specifications from the design engineer of each service/discipline setting out clearly what is expected of the commissioning specialist (independent or otherwise). This should include commissioning tolerances on all commissioning parameters and a clear description of how it is intended that the system should operate and the design parameters. The design should also produce cause and effect sheets showing how the design is intended to operate. Also, commissioning specification details of safety controls and interlocks to protect the equipment and personnel during the commissioning process;

- Provide requirements for witnessing including full details of tolerances applicable to all parameters;
- Provide commissioning program including specific period of time for client witnessing;
- Provide appropriate health and safety risk assessment and method statements for the tasks to be completed;
- Provide commissioning method statement for each system
- Provide pre-commissioning checklists for each system;
- Provide commissioning checklists;
- Provide commissioning certification for each system countersigned by the Project Engineer, Commissioning Specialists (independent or otherwise) and the accepting authority (where relevant), and including the record sheets provided in each CIBSE code.

Training of building management staff

Provide proof that building management staff has all the information and understanding needed to operate and maintain the commissioned features and systems of the building which is to include, at a minimum:

- Information provided in the Design Intent Report issued by the Project Engineer (including energy and environmental features);
- Review of controls set up, programming, alarms and troubleshooting;
- Review of Operations & Maintenance Manuals;
- Building operation (start up, normal operation, unoccupied operation, seasonal changeover, shutdown);

- Measures that can be taken to optimise energy efficiency;
- Occupational Health & Safety issues;
- Maintenance requirements and sourcing replacements;
- Obtaining and addressing occupant satisfaction feedback.

Green star BMS building tuning

The client is to enter into a building tuning contract with the electrical sub-contractor and the BMS contractor to implement a twelve (12) month 'building tuning period' after practical completion (or it can commence within two (2) years of the practical completion) on all building systems. This contract may be an extension of scope of the maintenance contract.

1. Provide monthly monitoring during the 'building tuning period' to relevant systems to:
 - Verify that systems are performing to their design potential during all variations in climate and occupancy;
 - Optimize time schedules to best match occupant needs and system performance;
 - Align systems' operation to the attributes of the built space they serve;
2. Produce four (4) quarterly reports during the 'building tuning period' to the Project Engineer and Client documenting monthly monitoring findings and recommending corrective actions to be taken.
3. Produce one (1) final Building Tuning Report at the end of the 'building tuning period' for review by the Project Engineer summarizing the findings in the four (4) quarterly reports and recommend corrective actions to be taken.
4. Provide Building Tuning Report approved by the Project Engineer to the Client and Project Design Team.
5. Re-commission relevant systems at the end of the 'building tuning period':
 - Undertake a review of all systems to the scope of the initial pre-occupancy commissioning;
 - Incorporate any modifications identified as necessary or beneficial during the 'building tuning period' to improve the performance of building operation in accordance with design intent documentation from the Project Engineer and the Building Tuning Report.

The client is required to sign a **building tuning contract** with each of the responsible (sub) contractor(s). The contract (which may be an extension of the scope of the maintenance agreement) needs to outline the following:

- Show the scope (as indicated above), timeframe, milestones, and deliverables of the building tuning process;
- Be signed by the client and contractor; and
- Stipulate that a building tuning report be generated.
- Stipulate the roles and responsibilities of each party

9.25 QUALIFICATION SPECIFICATION

BMS Specialist Qualifications

- Have local staff, within 200 kilometers of the project site, and trained personnel capable of giving instructions and providing routine and emergency maintenance on the BMS, all components and software/firmware and all other elements of the BMS. The Staff shall be manufacturer certified and shall be experienced in the installation, maintenance, programming and all other aspects of the BMS equipment.
- At minimum 2 numbers of BMS installed of a similar.
- Have a proven record of experience in supply and installation of equivalent systems over a minimum period of 5 years in RSA.

- Have comprehensive local service and support (24 X 7 X 365) facilities for the total BMS that shall be capable of responding to the site within 2 hours.

9.26 SUPPORT

It will be a requirement of the successful tenderer to:

Provide energy support of the system post contract completion

The support will comprise of:

- ~~A minimum of 2 days per week to verify the correct operation of the BMS system;~~
- ~~Compile reports for e.g. energy management, direct usage, utility consumption, etc.;~~
- ~~Confirm performance of systems to be generated within the original design parameters or design baseline;~~
- ~~Address faults on the system;~~
- ~~All aspects related to the original intent of the reasons for the installation and investment of a BMS system;~~

The person for this activity should be someone with proficient knowledge of mechanical / electrical systems to ensure information provided to the Bank can be used for Management purposes.

PART 10

GENERAL TECHNICAL SPECIFICATION

UPS INSTALLATION

This index refers to the Part numbers [Part 9] as per the CAI standard document.

PART 10.1	INTRODUCTION
PART 10.2	MAKING GOOD
PART 10.3	QUALITY AND STANDARD
PART 10.4	SYSTEM REQUIREMENTS
PART 10.5	RECTIFIER
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PART 10

GENERAL TECHNICAL SPECIFICATION

UPS INSTALLATION

General Technical Requirements

10.1 INTRODUCTION

10.1.1 This section covers general requirements for the supply, delivery, commissioning, installation and maintenance of Un-interruptible Static Power Supply Machines.

10.1.2 The UPS equipment shall provide continuous interference free power to essential equipment.

10.1.3 The equipment requiring the power is a critical load, which is sensitive to frequency deviations, voltage transients and voltage dips. The UPS system shall compensate for the variations in the input supply as any irregularities will affect the load. This aspect shall be carefully considered when proposing UPS machines as the static UPS machines will be deployed to supply computer and processing equipment which has shown to be extremely aggressive loads.

10.1.4 The UPS system shall comprise of the following major components for each system as enumerated in the Detailed Technical Specification of this document:

- Rectifier and battery charger.
- Batteries complete with stands.
- Inverter and oscillator.
- Static switch.
- Mechanical bypass switch.
- General control plus controls for parallel mode operation

10.1.5 The Contract excludes the supply and installation of ventilation equipment for the equipment and battery rooms. Adequate ventilation of all equipment racks utilizing air within the plant room (i.e., without forced ventilation from outside the plant room) shall be provided as an integral part of the equipment.

10.1.6 The Contractor shall provide details of the equipment heat loads in order that the plant room ventilation, (to be provided by others), can be determined.

10.1.7 The Contract include the supply and installation of all input and output cabling from the electrical sub-distribution board (installed by others) supplying the UPS system. All interconnecting cables within the UPS system including cables to the batteries shall be installed as part of this contract. Input mains cables and output cables to the sub-distribution board located in on the computer room floor are included in this Contract.

10.1.8 The Contract includes the provision of all connectors, mounting brackets, cable ducts and trays etc., required by the system and indicated on the drawings.

10.1.9 The Contract includes the provision of all test equipment, dummy loads, temporary connections, etc., required to take all measurements and readings specified or stated by the Contractor or as otherwise required to ensure that the installation is handed over in good working order in compliance with the specification. All test equipment remains the property of the Contractor.

10.1.10 The Contract includes the supply and use of all materials and equipment that are not specifically stated in these documents, but which are nonetheless necessary to execute the Contract in accordance with the requirements of these Documents and all the other Regulations, Statutes and Codes of Practice which are applicable to the installation.

10.2 MAKING GOOD

10.2.1 The Contractor will be responsible for making good in all trades, and damage or disturbance to the buildings, installation, tarred surface, concrete surfaces, drains and other services, which he or his employees may have caused in the course of the construction of the system. The Contractor will be responsible for keeping the site tidy during the construction of the system and shall remove from the site all rubble and litter resulting from the construction work.

10.3 QUALITY AND STANDARD

10.3.1 Maximum system reliability is required, and all aspects of the design and installation shall be optimized to this end.

10.3.2 All materials and equipment supplied shall be new and of acceptable quality.

10.3.3 All equipment shall comply with relevant SABS specifications or with the requirements or recognized international standards organizations such as NEC, ISO, NEMA and ANSI. The Contractor shall furnish clear details as which of the following standard are applicable standards that are being complied with:

- 10.3.3.1 DIN/VDE 0100
- 10.3.3.2 DIN/VDE 106 part 1
- 10.3.3.3 IEC 536,
- 10.3.3.4 DIN/VDE 0110 01/89
- 10.3.3.5 IN 470 part 1 1 11/92
- 10.3.3.6 IEC 529
- 10.3.3.7 DIN/IEC 721-2-1-09/86.
- 10.3.3.8 2004/108/EC
- 10.3.3.9 2006/95/EC
- 10.3.3.10 93/68/EC
- 10.3.3.11 IEC 62040 -1 -1
- 10.3.3.12 IEC 62040 – 2
- 10.3.3.13 IEC 62040 - 3

10.3.4 The entire installation shall be executed in accordance with standard practice for the industry and with the approval of the Engineer or his duly authorized representative.

10.4 SYSTEM REQUIREMENTS

- 10.4.1 Under normal operating conditions, the load shall be supplied through a controlled rectifier and inverter circuit. The rectifier supplies DC power to storage batteries and the inverter. The batteries shall be float charged ready for use.
- 10.4.2 During a mains failure or disturbances in the mains supply, the batteries shall provide the DC power to the inverter which in turn shall provide an uninterrupted supply to the load.
- 10.4.3 A static bypass system is required. Although the load shall normally be supplied from the rectifier/inverter, automatic and uninterrupted transfer of the load to the mains supply shall take place in the event of failure of the rectifier/inverter system and the inverter shall be disconnected from the load. Transfer to mains shall also be affected in the event of load switching surges beyond the output capability of the inverter or whenever the output voltage of the inverter deviates beyond the specified output tolerance limits. Transfer of the load to the inverter shall be enabled once the inverter output or load requirements have stabilized.
- 10.4.4 In order to maintain immediate switching capability to the mains, the inverter frequency shall normally remain synchronized with the mains frequency. Should the mains frequency, however, deviate beyond the specified frequency tolerance limits, the inverter oscillator shall run independently of the mains and maintain the output within the specified limits. The inverter shall be synchronized with the mains again as soon as the input frequency has stabilized.
- 10.4.5 Should transfer to the mains become necessary while the oscillator is free running, the automatic operation of the electronic switch shall be inhibited until the inverter output is synchronized with the mains, whereupon transfer shall take place. This synchronization should be achieved within a few cycles.
- 10.4.6 A mechanical bypass switch allowing maintenance of the rectifier/inverter and electronic switches shall be provided. The unit shall be a load break, fault make isolator rated for the full load current and mains fault level. Additional offload isolators to isolate the rectifier/inverter and electronic switches from the mains input and load voltages during maintenance, shall be incorporated in the equipment.
- 10.4.7 The equipment shall be designed for maximum operating efficiency. The efficiency shall be determined when the system is delivering full load at 0.8 power factor with batteries fully charged. The load required by the auxiliary equipment (controls, alarms, bypass switches etc.) and rack fan units shall be included in the determination of the overall efficiency.
- 10.4.8 All cabinets containing thyristors shall be adequately screened and earthed to prevent direct radio frequency radiation. In addition, RFI suppression networks on both the input and output power lines shall be provided to comply with the requirements of BS 800 for Mains Driven Appliances or VDE 0875, Class N.
- 10.4.9 The inverter shall be able to deliver the following overloads without reduction of output voltage tolerance without the aid of the electronic switch connecting the load to the mains:
- 10.4.9.1 Static overloads:

- 10.4.9.1.1 110% of full load for 1 hour
- 10.4.9.1.2 125% of full load for 1 minute
- 10.4.9.1.3 150% of full load for 10 sec.
- 10.4.9.2 Dynamic overloads:
- 10.4.9.2.1 1000% of full load for 100 msec.
- 10.4.10 The dynamic behavior of the system is of the utmost importance to ensure stable operating conditions. Some of the aspects to be considered in this regard are:
- 10.4.10.1 The system shall accept 50% step load changes with the associated transient switch on currents, at least up to the dynamic overload stated above.
- 10.4.10.2 Oscillatory load switching between the electronic switch and rectifier/inverter shall be prevented especially during transient load conditions.
- 10.4.11 The system shall be able to deliver 50% unbalanced phase loads without deviating from the specified voltage tolerance of phase symmetry.
- 10.4.12 The system shall be able to handle load power factors from 0.7 to unity.
- 10.4.13 No more noise than a slightly audible hum will be accepted. The Contractor shall state the noise level, as well as the distance from the unit where the measurements apply.
- 10.4.14 Following a mains failure, the inverter shall start immediately and automatically upon restoration of input. Manual restart will be acceptable following prolonged mains failure and low DC cut out conditions.
- 10.4.15 Control, Indicating and Alarm Functions
- 10.4.16 Each UPS module shall have an integral control and indication panel. All the instrumentation, alarms and indicators showing the operation of the individual UPS Module shall be on the panel, physically located in the proper position. The panel shall be able to measure, control and monitor all the functions of the UPS.
- 10.4.16.1 Control panel in front side shall be provided, indicating the “single line” diagram by indicating symbols and lights of the main components and their status.
- 10.4.16.2 Control panel will provide measurements, monitoring and control of all the functions.
- 10.4.16.3 Events – as a minimum the following UPS status and event list, with relative data and time, shall be provided:
- Rectifier rectifier ON, rectifier OFF, mains rectifier OK
 - Battery start battery test, end battery test, no conditions for battery test.
 - Inverter inverter ON, inverter OFF, inverter cannot be switched ON/OFF
 - Bypass mains bypass OK, bypass locked, bypass free, bypass power insufficient.
 - Load load on inverter, load on bypass, load OFF, overload condition, multiple load transfer.
- 10.4.16.4 Alarms – a common audible alarm and the respective indicating LED’s shall be initiated when any of the following conditions are present:

- UPS load off for overload, battery low and over-temperature conditions; inverter and mains not synchronized: UPS overload.
- Rectifier mains out of tolerance; control logic failure
- Battery low voltage; high voltage; earth fault; contactor closing or opening failure.
- Inverter fuse failure; contactor closing or opening failure; voltage out of tolerance; output power insufficient, overload.
- Bypass mains out of tolerance; contactor closing or opening failure.
- Load overload' load locked on inverter; load locked on bypass.

10.4.17 The list of alarms, with relative data and time, shall be provided.

- Measurements – as a minimum the following measurements shall be provided:
- UPS inverter and mains synchronized/not synchronized, input circuit breakers open/closed, maintenance bypass ON/OFF
- Rectifier input voltage, input frequency, number of rectifier mains failure
- Battery autonomy time, voltage, temperature, charge/discharge current in A
- Inverter output voltage, output frequency, inverter temperature, operating hours
- Bypass input voltage (Ph-n), input frequency, number of bypass mains failure
- Load load level in % (each phase), load current/phase in A. Load power kVA/kW.
- The UPS, through the control panel, shall be able to store up to 256 alarms or events with date and time.

10.4.18 A comprehensive BMS system is being installed and all alarms shall be presented in the format of Modbus protocol to the BMS system. The UPS vendor shall however wire the alarms to an interface panel in the UPS room.

10.5 RECTIFIER

10.5.1 A three phase, solid state, constant voltage type rectifier with associated rectifier transformer providing full wave rectification across a phase-controlled bridge, shall provide a DC supply to the inverter and battery.

10.5.2 The rectifier capacity shall be enough to provide the full load output via the inverter and simultaneously recharge a fully discharged battery within the specified time, even during a mains input voltage of 10% of nominal and input frequency of 5% of nominal.

10.5.3 The DC output voltage shall be controlled to an accuracy of + 1% even during a continuous mains voltage variation of $\pm 10\%$ and frequency deviation of $\pm 5\%$ and with any equipment load or battery charging load within the capacity of the rectifier.

10.5.4 The rectifier shall be capable of recharging a fully discharged battery to 90% of its fully charged capacity within four (4) hours and to 100% capacity within 16 hours while also supplying the specified load.

10.5.5 The DC voltage during float charging of the battery shall be chosen to give maximum life to the battery whilst maintaining the maximum charge conservation and minimizing gas formation and electrolyte loss.

- 10.5.6 A current limiting feature shall be incorporated in the rectifier control circuit, preventing overloading of the rectifier and ensuring that the maximum charging current which the battery can safely absorb in a fully discharged conditions, is not exceeded.

- 10.5.7 An efficient DC filter shall be incorporated in the rectifier output to limit the ripple current through the battery to less than 1% at any point during the charge/discharge cycle in order to ensure extended battery life.

- 10.5.8 Power walk-in – the rectifier/charger must contain a timed walk-in circuit to limit the inrush current. The allowable initial inrush surge and the walk-in time should be adjusted and not exceed 30 seconds.

- 10.5.9 Sequential power walk-in – a sequential walk-in of every single rectifier/charger shall be automatically executed in case of the start-up of a parallel system in order to limit the inrush current to the value of one single system.

- 10.5.10 An input voltage monitoring circuit shall be provided to switch off the rectifier when the R.M.S. value of the mains voltage falls below a pre-set value.

- 10.5.11 The rectifier shall be switched off if any of the rectifier phases should fail.

- 10.5.12 The rectifier transformer shall be double wound to provide galvanic separations from the mains. An earthed electrostatic screen between primary and secondary winding shall be provided in order to minimize primary to secondary capacitive coupling.

- 10.5.13 The rectifier shall be provided with a "soft start" circuit to limit inrush magnetizing current to 2 times full load current. The input circuit protection to the rectifier shall provide the necessary protection against mains voltage surges.

- 10.5.14 Over temperature protection of the rectifier shall be provided. Temperature sensing probes shall be mounted on the thyristor housings, thyristor mountings or on the heat sinks close to the thyristor. The sensing of off coming air temperature alone is not acceptable.

- 10.5.15 The possible effects of "ringing" and harmonics that may be present of the input supply due to non-sinusoidal current waveforms at the rectifier input, phase commutation, etc., shall be considered. The input voltage monitoring circuits of the rectifiers shall be adequately filtered and buffered to ensure reliable load control and to prevent continuous on off switching of the rectifiers.

- 10.5.16 The input current shall be limited, when operating on bypass, to allow battery charging based on the difference between input and maximum output current. Battery charging can preferably be switched from high to low rate charging or de-activated when limited input power is available.

- 10.5.17 Only 12 pulse rectifiers shall be offered.

10.6 BATTERY SYSTEM

- 10.6.1 A Battery System of sufficient capacity to supply the specified inverter load for the required time shall be provided.
- 10.6.2 The Contractor shall state the 10-hour discharge capacity of the batteries and the battery voltage at its terminals under various conditions.
- 10.6.3 The batteries shall be designed to give satisfactory service for a minimum period of 5 and 10 years. The Contractor shall state the maximum expected lifetime of the batteries. Two alternatives shall be priced as part of the pricing schedule.
- 10.6.4 The batteries shall be supported in a suitable framework made either from varnish impregnated wood or suitably painted steel frames. The supporting framework shall stand on porcelain feet.
- 10.6.5 The containers shall be constructed so as to give maximum cooling of each cell and to afford as little likelihood of creepage as possible.
- 10.6.6 Cell containers shall be manufactured from translucent materials affording a view of the electrolyte level. Upper and lower electrolyte levels shall be indelibly marked on the container.
- 10.6.7 The batteries shall be complete with cell inter connectors and row inter connectors. The output terminals shall be robust and adequately dimensioned for the output cable terminations. All terminals shall be covered with silicon grease to prevent corrosion.
- 10.6.8 The inter connectors between cells and rows of cells shall be constructed in a manner giving the lowest volt drop and maximum resistance to corrosion.
- 10.6.9 Each cell shall be numbered consecutively for identification and the positive and negative terminals shall be clearly marked, preferable coloured.
- 10.6.10 Each battery set shall be complete with a wall mounted battery fused isolator or circuit breaker capable of breaking the full load current drawn by the inverter.
- 10.6.11 The supply and installation of suitably rated cables and HRC fuse or circuit breaker protection between battery and equipment is included in the Contract.
- 10.6.12 The Contractor shall conduct a thorough on-site commissioning of the batteries. The battery shall undergo a series of charge and discharge cycles.
- 10.6.13 During this time, cells shall be monitored to detect excessive gassing, water loss or temperature increase. The batteries shall then be fully discharged and then recharged at the predetermined charge voltage for 16 hours. Total battery voltage as well as each cell voltage shall be measured. All batteries

found to be faulty during the above process shall be replaced. Finally, with all defective batteries replaced and the battery fully charged, a full load test through the inverter shall be conducted.

10.7 INVERTER

- 10.7.1 A solid-state DC to AC inverter providing a three-phase output within the specified output requirements from a DC source originating from the rectifier or battery output shall be provided. Self-commutated or load commutated and three single phase units phase controlled within 120 electrical degrees or three phase inverter bridges are acceptable. The inverter shall be amply rated to provide the specified output power between the upper and lower battery voltage limits.
- 10.7.2 The inverter shall be adequately protected against excessive overloads or short circuits that may occur in the load.
- 10.7.3 The output of the inverters incorporates double wound output transformers providing galvanic isolation between load and thyristors bridge and an output filter to ensure that the sinusoidal output wave form distortion falls within the specified tolerances over the entire operating range of the battery. The thyristor bridges, output transformers and output filters shall be designed to match.
- 10.7.4 The conversion of DC to AC must be accomplished by power transistors of the IGBT type controlled with an SVM (Space Vector Modulation) strategy.
- 10.7.5 The inverter output wave form shall be controlled by micro –processor-based software (software generated sine wave) to ensure that the voltage THD is being limited especially for non-linear loads.
- 10.7.6 The inverter shall be switched off as soon as the DC input reaches a predetermined minimum value.
- 10.7.7 The output of the inverter shall be connected through a very high-speed electronic switch to the output busbar. The switch shall be capable of disconnecting the inverter when operating at full load at any power factor from the output busbar in less than 1 msec.
- 10.7.8 The operation of the electronic switch shall be such that failure of the inverter will cause the switch to isolate the faulty inverter from the busbar without any disturbance to the load.
- 10.7.9 The AC ripple current that circulates between battery and inverter shall be minimized in order to maximize the life of the battery. The ripple voltage measured across the battery under and condition of charge and with the rectifier disconnected, shall be less than 1% under any load condition from full to no load. The Contractor shall state what precautions have been taken in the design of their equipment to comply with these requirements.
- 10.7.10 The Contractor shall describe the method by which the load through the inverter thyristors is controlled.

- 10.7.11 The inverter shall have over temperature protection. The temperature sensing probes shall be placed on the thyristor housing, thyristor mounting, or on the heat sink close to the thyristor. The sensing of the off coming air temperature alone is not acceptable.
- 10.7.12 A "soft start" circuit shall be provided at the input to the inverter to limit inrush current at switch on.
- 10.7.13 The DC input to the inverter shall be fuse protected.
- 10.7.14 An isolator shall be provided allowing the inverter and electronic switch to be isolated from the output busbar for maintenance purposes.
- 10.7.15 A control battery shall be provided to furnish logic power which is independent of the inverter input or output power. The battery shall provide the power required to operate the inverter logic until the load is transferred to the alternate source and the inverter is shut down in an orderly manner in the event of a failure of the logic solid state power supply. In addition, the battery shall provide power to the alarm system to maintain event records after a UPS failure and shutdown.

10.8 ELECTRONIC BYPASS SWITCH

- 10.8.1 A very high-speed electronic bypass switch shall be connected in parallel to the rectifier/inverter between the mains and output busbar. The switch shall commutate the load to the mains under the operating conditions specified.
- 10.8.2 The electronic switch shall be separate fuse protected. An input and output isolator shall isolate the switch for maintenance purposes.
- 10.8.3 The thyristors shall be over temperature protected.
- 10.8.4 The cubicle shall be separately ventilated.
- 10.8.5 Should conditions return to normal; the load shall be retransferred to the inverter automatically for an unlimited number of times but avoiding hunting.
- 10.8.6 The number of automatic transfer/re-transfers from bypass to inverter when the status of the inverter logic signals an alarm condition shall be selectable.
- 10.8.7 The electronic bypass switch shall be able to be activated manually by a switch/push button to affect the transfer. The switching time from inverter to reserve and vice versa shall be of no break when synchronized.
- 10.8.8 According to standard IEC 62040-1 the electronic bypass shall be equipped by back-feed protection contactor, to protect UPS input mains from dangerous (electroshock) operating conditions.

- 10.8.9 The electronic bypass switch shall be able to operate in a continuous way. In addition, the static transfer switch shall support 200% overload for 3 minutes and a short circuit capability of 45xIN for 10 milliseconds (non-repetitive).

10.9 MECHANICAL BYPASS SWITCH

- 10.9.1 A manually operated, quick make, quick break, fault break load make isolator rated for the full output load of the system, shall be provided as a bypass circuit from load to mains, enabling maintenance of the rectifier/inverter system and electronic switch.

10.10 OSCILLATOR

- 10.10.1 Two oscillators operating in parallel redundancy shall be provided to drive the inverter thyristors. One oscillator shall act as master until it becomes defective whereupon the second shall take over the operation.
- 10.10.2 The oscillators shall be supplied from two stabilized power supplies operation in parallel redundancy.
- 10.10.3 Under normal circumstances, the master oscillator shall remain locked to the mains frequency. Should the mains frequency however deviate by more than $\pm 1\%$ from nominal the oscillator shall become free running and drive the inverter independently of the mains. The output frequency shall be synchronized with the mains as soon as the latter has stabilized.
- 10.10.4 The control of the oscillator during automatic bypass to mains via the electronic switch or manual bypass to mains via the contactor and isolator.

10.11 CONSTRUCTION OF PANELS

- 10.11.1 All the equipment shall be housed in totally enclosed, free standing, floor mounted metal cubicles, designed to provide adequate ventilation for the equipment. Input/output panels shall match the UPS panel in appearance, size, colour, etc. The colour of the UPS will be Emerald Green, [Paint Specification SABS E14-BS No. 381C-228].
- 10.11.2 All cubicles shall be rigid with suitably braced doors providing front access.
- 10.11.3 All cubicles shall be vermin proof.
- 10.11.4 All equipment apart from the instrumentation shall be mounted on the metal framework suitably arranged to provide safe operation and ease of access. Fuses and switchgear should be safely accessible even under load conditions.
- 10.11.5 All electronic printed circuit cards shall have gold plated contacts and shall be mounted in such a way that measurement of operational parameters can be made with the system operational.

- 10.11.6 All auxiliary power supplies shall be connected to at least two primary sources of power i.e., mains and inverter output.
- 10.11.7 Flexible wires shall not be soldered directly onto terminals but shall have a crimped tab which is soldered onto a terminal or post.
- 10.11.8 All equipment shall be clearly and adequately marked. A single line mimic layout of the switchgear shall be provided on the front of the cubicles providing a graphic display of the circuitry of the equipment involved.
- 10.11.9 Input and output power cables shall be terminated using approved cable glands, onto a cable gland support bracket not less than 300 mm above the room floor level. The cable conductors shall terminate at connecting busbars or shall be connected directly to the appropriate switchgear. Power cable shall be properly numbered and identified by non-conductive cable markers with punched figures shall be used to identify cables at the termination point.
- 10.11.10 External control, alarm, interlocking, measuring and supply circuits to external equipment shall terminate at numbered terminal strips. Wiring ends shall be fitted with ferrules or lugs that are securely crimped or soldered to the wire before insertion into the terminals.
- 10.11.11 Each individual wire at the terminal strips (both for internal and external circuits) and all internal wiring shall be fitted with durable cable or wire markers of approved type. These numbers shall appear on wiring diagrams.
- 10.11.12 Conductors of the internal wiring shall be large enough to carry the current in each respective circuit. The conductors shall be neatly arranged in horizontal and vertical rows and bound by means of suitable plastic bands. Wiring shall be kept free and away from exposed terminals or other un-insulated current carrying components.
- 10.11.13 The rear terminals of instrumentation mounted on the cubicle doors shall be covered by a removable cover plate or insulating sleeves so that no accidental contact with live terminals is possible when a door is opened.
- 10.11.14 Equipment cubicles shall be solidly earthed. A flexible (braided) earth bond shall be provided between cubicle frame and door.

10.12 COMMUNICATION

- 10.12.1 In standard version the UPS shall be equipped with a customer interface card which provide:
- 10.12.2 6 Output dry contact available on terminal blocks (NO/NC), these contacts shall be programmable out of 24 different alarms or events directly from the keyboard mounted on the front panel of the UPS.
 - 10.12.2.1 Input Connections for customer provided signals must be available for “generator on” (reduces battery charging current during mains failures, lock or unlock bypass and

synchronization) and “emergency power off” (to shut down UPS and load in the event of an emergency).

10.12.2.2 RS232 port for the following purposes:

10.12.2.2.1 Serial communication for advances remote monitoring communication via PC.

10.12.2.2.2 Serial printer connection

10.12.2.2.3 Modem connection

10.12.2.3 In addition to the above, it shall be possible to communicate with the UPS controllers via RS485 or Ethernet. This communication shall only be for monitoring and NOT for control.

10.13 ACCOMMODATION

10.13.1 Accommodation for the system is being provided.

10.13.2 Ventilation or air conditioning will be provided for by the building contractor and therefore does not form part of this tender.

10.13.3 Battery rooms will likewise be provided with extraction fans, flameproof electrical fittings and a washbasin with cold water- and acid-resistant working slab.

10.13.4 The Contractor shall indicate the arrangement of their equipment within the accommodation provided.

10.14 INSTALLATION

10.14.1 All installation costs shall be incorporated in the tender.

10.14.2 A system schematic diagram shall be prepared and mounted on the plant room behind clear Perspex.

10.15 MAINTENANCE

10.15.1 The Contractor will be required to maintain the complete system in good running order for a period of 12 months after the plant has been taken over. The cost of this maintenance must be included in the tender price. Maintenance required during the 12-month period is listed and shown separately in Item 15.6.

10.15.2 After the lapse of this 12-month period, the Contractor may be required to enter into a maintenance agreement. This agreement will initially be for one calendar year and may subsequently be renewed for yearly periods.

10.15.3 The Contractor must be able to render 24-hour maintenance and repair service at all times, including statutory holidays. Full details of the firm's standby service facilities must be submitted at the time of tendering.

- 10.15.4 The Contractor shall prepare and submit a pro forma Maintenance and Service Contract. This Maintenance and Service Contract shall be a formal service agreement of the suppliers of the UPS power supply system signed by an authorized employee and shall include the monthly cost of the services to be provided. The Contractor must state to what extent the price quoted will be subject to variation. The Contractor shall consider that maintenance can only be done on Sundays.
- 10.15.5 The entering into a Maintenance and Service Contract shall in no way invalidate the Guarantee above.
- 10.15.6 The Service Contract shall include the following minimum provisions:
- 10.15.6.1 To provide regularly scheduled preventative Maintenance and Service of at least one-man day per three-month period, i.e., at least four-man days per year, by factory trained service representatives of the supplier of the UPS power supply system. On each visit which shall be arranged in advance, a record of maintenance carried out shall be kept. The time and date of visits shall be entered into a logbook.
- 10.15.6.2 To check the mechanical soundness of all parts.
- 10.15.6.3 To check and adjust all the output and control values of the system (voltage, frequency, control voltages etc.).
- 10.15.6.4 To take control measurements on the major system components and record these measurements.
- 10.15.6.5 To replace all defective components.
- 10.15.6.6 Service the batteries.
- 10.15.6.7 Service the UPS cabinet ventilation equipment.
- 10.15.6.8 Clean all equipment or rooms as required.
- 10.15.6.9 To make available, upon request, emergency maintenance service.
- 10.15.6.10 To carry out annually a thorough system check with the use of all the testing equipment and instruments required. A detailed report comparing system performance at the time of testing and the time of handing over shall be prepared and submitted along with comments.

10.16 DRAWINGS

- 10.16.1 As soon as possible after the award of the Contract, the Contractor shall at his expense submit for approval three [3] prints of:
- 10.16.1.1 All general arrangement drawings.
- 10.16.1.2 Detailed dimensioned drawings of all plant and equipment.
- 10.16.1.3 Complete wiring diagrams and block schematic diagrams.
- 10.16.2 At the same time a list of all equipment designations, labels etc., in both official languages shall be submitted for approval.
- 10.16.3 The approval of drawings shall not relieve the Contractor of his liability to carry out work in accordance with the terms of the Contract.
- 10.16.4 On completion of the Contract, three complete sets of "As installed" drawings shall be handed over at the expense of the Contractor.
- 10.16.5 These final drawings shall include:

10.16.5.1 A proper and accurate as made wiring diagram of the complete installation showing circuit numbers, terminal strip numbers and conductor colours.

10.16.5.2 A schematic diagram clearly showing function and component values. A material list showing the make, model and characteristic of all components of the control equipment and switchgear is to be included.

10.16.5.3 Fully dimensioned as made physical layout drawing of the equipment, batteries, and ventilation equipment.

10.16.6 The Contract shall be deemed incomplete until all drawings have been received.

10.17 APPROVAL OF DRAWINGS

10.17.1 The contractor shall submit, for approval, in principle, copies of all above-mentioned drawings prior to starting work or issue to other parties. Any work started (off site or on site) prior to receiving the Engineer's approval of drawings shall be at the contractor's own risk.

10.17.2 The Engineer may require from the contractor further detailed drawings and/or calculations which clarify features not adequately shown on the layout drawings. The request for additional details shall not be construed as extending the scope of this contract or altering the programme.

10.17.3 The contractor shall submit one sepia and one paper print of each drawing to the Engineer for approval.

10.17.4 The Engineer will return to the contractor, within four weeks of their receipt by him, one copy of each drawing marked "DRAWING CONFORM TO SPECIFICATION" or marked with any changes which are necessary.

10.17.5 The contractor shall modify these details and drawings as required by the Engineer. The nature and date of each modification and distinguishing symbol shall be added and the drawings shall be re-submitted for approval.

10.17.6 Alterations to drawings, by the Engineer, are not intended to change the scope of work unless explicitly stated as doing so. Should any alterations, in the opinion of the contractor, change the scope of work, the contractor shall notify the Engineer immediately of receipt of the altered drawings before any further drawing work or fabrication is carried out. Claims for a change of scope made after performance of the work constituting the claimed change of the scope of work will not be considered.

10.17.7 The "DRAWING CONFORM TO SPECIFICATION" of drawings by the Engineer shall not relieve the contractor of any responsibility in terms of the contract.

10.17.8 The Engineer will check the drawings for design only and approval of the drawings, schedules and catalogues shall not be construed as a complete check.

10.17.9 The contractor shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars supplied by him whether such drawings or particulars have been approved by the

Engineer or not, provided that such discrepancies, errors or omissions are not due to inaccurate information or particulars furnished in writing to the contractor.

- 10.17.10 Six copies of the Final Manufacturing and Installation Drawings shall be issued to the Engineer by the contractor within ten days or receipt of "DRAWING CONFORM TO SPECIFICATION". Further copies shall be provided and may be required by the Engineer either before or after final approval.
- 10.17.11 The contractor shall provide, at his own expense, all copies of drawings required by him in the execution of the work and shall also, at his own expense, supply to the Engineer such drawings and copies thereof as are provided for in the specification.

10.18 RECORD DRAWINGS

- 10.18.1 On completion of the installation, but before final hand over, the contractor shall provide two transparencies plus the necessary prints of each of the contract drawings showing the installation as fixed:
- 10.18.1.1 Complete installation layout
 - 10.18.1.2 Detailed drawings of all items of plant
 - 10.18.1.3 Electrical layouts and wiring diagrams
 - 10.18.1.4 Details of any other items requested by the Engineer.
- 10.18.2 The drawings shall be sufficient in detail to enable the Employer's staff to maintain, dismantle, reassemble and adjust any part of the works.
- 10.18.3 The layouts shall show the location of all manual and automatic equipment, controls, control panels, outlets, etc.

10.19 OPERATING AND MAINTENANCE MANUALS

- 10.19.1 After completion of the Installation, and when the plant is in running order, the Contractor will be required to instruct an attendant in the operation of the plant, until he is fully conversant with the equipment and the handling thereof.
- 10.19.2 Three [3] hard copies and two [2] CD copies of a maintenance, fault localizing and operating manual are to be handed over on site together with the drawings specified above.

10.20 TESTS

- 10.20.1 The complete testing including the provision of test facilities, instruments, dummy loads and switchgear at both the manufacturer's premises and on site shall form part of this Contract.
- 10.20.2 For tests at the manufacturer's premises and/or on site, two weeks' advance notice shall be given in order that a representative can be sent to witness these tests.

10.20.3 The Contractor shall prove all specified values contained in this Document and issued in his own specifications and literature.

10.20.4 On completion of the tests, a full test report shall be issued. The report shall contain all measurements taken as well as photographs of oscillograms or storage scope tracers of voltage waveforms, etc.

10.20.5 The entire system is subject to tests, inspection and acceptance by the Engineer and a representative appointed by the Owner.

10.21 AVAILABILITY OF SPARES

10.21.1 Spares and replacement parts shall be readily available in the Republic of South Africa and a guarantee of availability for a period of ten years shall be furnished.

10.21.2 The Contractor shall submit with their tenders a priced schedule of recommended spare parts which should be carried on site.

10.22 INFORMATION

10.22.1 The Contractor is required to submit the following information with his tender:

- The information requested in the Schedule of Information.
- A paragraph-by-paragraph schedule of compliance with this specification with detailed description of any deviations from this specification.
- If alternative systems are offered, a clear description of the operating characteristics and special features of the equipment along with a motivation for offering the alternative.
- Descriptive and illustrated brochures and other information pertaining to the no break system offered.
- The proposed layout.
- A priced schedule of recommended spare parts and special tools to be maintained on site.
- The Contractor shall submit a list of successful installations completed in the Republic of South Africa.

PART 11

DETAILED TECHNICAL SPECIFICATION

UPS INSTALLATION

This index refers to the Part numbers [Part 9] as per the CAI standard document.

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PART 11.5	SYSTEM INPUT SPECIFICATIONS
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PART 11

DETAILED TECHNICAL SPECIFICATION

UPS INSTALLATION

11. DETAILED TECHNICAL SPECIFICATION

11.1 GENERAL

- 11.1.1 The Detailed Technical Specification shall be read in conjunction with General Technical Requirements and the drawings. This part takes precedence over the General Technical Requirements and the drawings in respect of any discrepancies in the description of equipment, materials or methods.

11.2 SCOPE

- 11.2.1 This specification covers the supply, delivery, installation, commissioning and free maintenance during the guarantee period of the Uninterruptible Power Supply Machines at Nexus 2 Waterfall.

- 11.2.1.1 UPS to be installed for the protection of the building load. The various capacities have been included in the Bills of Quantities

- ~~11.2.2~~ The reader should note the input and output distribution is included in the tender ~~and will be supplied by others.~~

Description of proposed development

The development consists of various buildings for SANSA

The development consists of the following areas:

- d) Offices
- e) Technical areas
- f) Energy Centre
- g) Main gate buildings

Programme

The Principal Contract has not been awarded. A draft programme will be included in the tender document for information to the electrical sub-Subcontractor. It will be expected of the tenderers to discuss the programme with the successful contractor and to ensure they are au fait with the programme and the accuracy thereof.

Programme to be confirmed – 20 Week Delivery and 2 Week installation simultaneously for all buildings.

11.3 SYSTEM REQUIREMENTS

- 11.3.1 The systems will be installed in the UPS rooms in the buildings.

- 11.3.2 The UPS machines will be equipped with completely sealed; maintenance free 10-year batteries rated for 30 minutes at battery end of life at full load. Each battery bank shall be split into 2 strings each controlled via separate isolators, to allow each string to be serviced independently, without effecting the operation of the UPS's. It is accepted that during this maintenance period, the autonomy will be reduced by 50%. The batteries will be housed in cabinets.

11.4 SITE CONDITIONS

- 11.4.1 The equipment shall be rated to operate continuously under the following site conditions:

11.4.2	Altitude	1 665m
11.4.3	Temperature	40°C maximum, 0°C minimum
11.4.4	Relative Humidity	95%

11.5 SYSTEM INPUT SPECIFICATION

11.5.1	Nominal mains supply	400/231V \pm 10% 50Hz \pm 5%
11.5.2	System	3 phase, 4 wire, earthed neutral
11.5.3	Input fault level	350 MVA at 400V (r.m.s symm.)

11.6 SYSTEM OUTPUT SPECIFICATION

- 11.6.1 The following output specification will be valid:

11.6.2	Nominal load power factor:	0.8
11.6.3	Output voltage tolerance	\pm 5%
11.6.3.1	Steady state	400V \pm 5%
11.6.3.2	Transient	400V +8%/ 10%
11.6.4	(30 cycles duration)	
11.6.5	Frequency	50 Hz
11.6.6	Load unbalance	30%

11.6.7	Maximum harmonic content	15%
11.6.8	Inverter overload capability	150% 10 sec
11.6.8.1	Static	110% 1 hour
11.6.8.2	Dynamic	1000% : 100ms
11.6.9	Battery capacity	as specified.

11.7 STANDBY SUPPLY

- 11.7.1 The total UPS system will be provided with a supply via the normal incoming cable from the Diesel driven standby plant in the event of a mains failure. The power cables to / from the UPS's shall be supplied and installed by the electrical sub-contractor.
- 11.7.2 The contractor shall state the r.m.s content of harmonics generated by the UPS equipment insofar as it may affect voltage regulation of the standby plant.
- 11.7.3 The UPS control system shall be arranged to limit boost charging of the battery system when the UPS is supplied from the standby supply. A voltage-free N/O contact will be provided by the electrical sub-contractor to signal operation of the standby plant.

11.8 INPUT/OUTPUT PANEL AND ASSOCIATED CABLING

- 11.8.1 A cable suitably rated with a yellow/green insulated earth conductor will be provided by the Electrical Contractor to each of the UPS systems. From there is the responsibility of the UPS supplier to correctly earth the UPS units, etc. to the relevant UPS distribution boards.
- 11.8.2 As noted earlier the reader should note the input and output distribution is excluded from the tender and will be supplied by others. The input and output distribution drawings have been included in the tender document for clarity.

11.9 PLANT ROOMS

- 11.9.1 The UPS's will be located in the UPS room of the operations building. The stands for the batteries shall be supplied and installed by the UPS contractor.

11.10 VENTILATION AND AIR CONDITIONING

- 11.10.1 Air conditioning will be provided by the HVAC subcontractor. Tenderers shall clearly state the heat dissipation of each UPS with the tender documentation.

11.11 BATTERY SYSTEM

- 11.11.1 A battery system conforming to General Technical Requirements and Detailed Technical Specification of this specification shall be provided.
- 11.11.2 The battery system shall be of the 10 years sealed, maintenance free type, located on battery stands and shall be of the front terminal type. The contractor shall clearly state the battery warranties. The following battery specifications shall be adhered to:
- 11.11.2.1 To allow for end-of-life depreciation of the bank, oversizing shall be allowed for to achieve the specified autonomy of the battery bank.
- 11.11.2.2 The selection of the battery bank shall allow for a cut off voltage of 1.7 Volts per cell.
- 11.11.2.3 Capacity of the batteries shall be disclosed to provide the 15-minute back-up. The following information shall be submitted with the tender:
- 11.11.2.3.1 Amp hour capacity of battery offered (single battery)
- 11.11.2.3.2 Number of batteries per string
- 11.11.2.3.3 Number of strings offered.
- 11.11.2.3.4 Capacity per string
- 11.11.2.3.5 Capacity of batteries for total number of strings offered.
- 11.11.2.3.6 Discharge voltage capacity. This will be for the total number of strings and shall be based on at cut-off voltage of 1.7V (lower cut-off voltage shall not be allowed)
- 11.11.3 A separate price shall be submitted, complete with details, for an extended battery manager system for each unit.

11.12 OPERATOR TRAINING

- 11.12.1 On completion of all tests, the contractor shall continue to be responsible for the complete operation and maintenance of the plant for a period of three weeks during which time, instructions shall be given to the Employer's staff of the proper operation and maintenance of the plant.
- 11.12.2 The operation and maintenance of the plant, for the duration of the instruction period, shall in no way relieve the contractor of his responsibility under the terms of the contract.

11.13 MAINTENANCE (DURING GUARANTEE PERIOD)

- 11.13.1 The contractor shall maintain the entire installation as described in this specification for a period of twelve [12] months from the date of final handover.
- 11.13.2 The maintenance visits shall be carried out at regular intervals, as necessary.
- 11.13.3 The maintenance shall cover all items of plant and equipment and shall include replacement of all expendable items.
- 11.13.4 In addition to the monthly maintenance visits, the contractor shall carry out all necessary visits due to failure of any item of the system. The contractor shall attend to all complaints by the Employer.

- 11.13.5 The contractor shall report to the Employer's nominated representative both on arriving and leaving the site. The contractor shall provide the Employer and Engineer with a Service Report for each visit whether scheduled or breakdown. At each maintenance visit, the contractor shall check the function of each item and shall ensure that the equipment is performing to specification. All automatic controls and safety devices shall be checked. All electrical control gear, bulbs, etc., shall be checked and adjusted or replaced as necessary.
- 11.13.6 The equipment shall be cleaned where necessary at each scheduled visit.
- 11.13.7 The contractor shall notify the Engineer prior to the final monthly service so that the Engineer may accompany the contractor.
- 11.13.8 The Engineer may at his discretion allow the maintenance period on any item of equipment or section of the installation start at a date prior to final handover if it is put into operation for beneficial use of the Employer prior to final hand over. This will not be permitted in cases where the final hand over is delayed due to the contractor not carrying out remedial work in good time.
- 11.13.9 The tender price shall include for a full complement of recommended spares for the total maintenance period as well as the following period of twelve months. Tenderers shall detail the allowance for recommended spares as a detailed breakdown of the total allowance.
- 11.14 GUARANTEE**
- 11.14.1 The contractor shall guarantee the entire installation, as described in this specification, for a period of twelve [12] months from the date of final hand over. The guarantee shall provide for all parts, spares and equipment that become defective during the guarantee period and these shall be replaced free of charge. The guarantee shall cover all costs including material, labour, overheads, travelling, etc.
- 11.14.2 The complete installation shall be guaranteed against defects whether patent or latent as well as against faulty materials and workmanship.
- 11.14.3 The guarantee shall cover all materials, plant and equipment whether or not it is covered by a manufacturer's guarantee. The twelve [12] month guarantee, in terms of this contract, on the entire installation shall be affected by the prior expiry of any guarantee provided by the manufacturer of any item of equipment or plant.
- 11.14.4 The contractor shall cede to the employer the remainder of any equipment guarantee which he has received from his suppliers, and which extends beyond the twenty-four [24] month guarantee period. It shall be the responsibility of the contractor to ensure that the guarantee is transferable.
- 11.14.5 The Engineer may at his discretion allow the guarantee period on any item of equipment or section of the installation start at a date prior to final handover if it is put into operation for beneficial use of the Employer prior to final hand over. This will not be permitted in cases where final handover is delayed due to the contractor not carrying out remedial work in time.

11.15 OPERATING AND MAINTENANCE MANUALS

- 11.15.1 The contractor shall provide three [3] hard copies and two [3] CD copies of the Operating and Maintenance Manuals.
- 11.15.2 The contractor shall submit, for approval to the Engineer, four weeks before completion of the installation, two copies of the Maintenance and Operating Manuals for the system supplied.
- 11.15.3 The Engineer will return these to the contractor, within ten [10] working days of their receipt by him, marked with all changes which are necessary.
- 11.15.4 The contractor shall modify the manuals as required by the Engineer and submit the Engineer, within ten working days, two revised copies of the manuals. On completion of the installation, but before the plant is handed over to the Employer, the contractor shall provide three copies of the final Operating and Maintenance Manuals for the system supplied. The manuals shall be bound in book form with hard plastic covers to withstand constant use.
- 11.15.5 The manuals shall be properly indexed to facilitate easy reference.
- 11.15.6 The manuals shall include:
 - 11.15.6.1 A list of recommended servicing tools and specialist equipment.
 - 11.15.6.2 A list of spares with price breakdown to be supplied by the contractor to cover the period of warranty.
 - 11.15.6.3 A priced list of recommended spares necessary for a period of two years of operation.
 - 11.15.6.4 Exploded drawings or detailed spares list from which every item of every piece of equipment can be positively identified for ordering replacements.
 - 11.15.6.5 A list giving the name and address of the local agent for each item of equipment.
 - 11.15.6.6 A list giving the name and address of the manufacturer of each item of equipment.
 - 11.15.6.7 A copy of all test certificates obtained with the equipment.
 - 11.15.6.8 A list of recommended lubricants, [if applicable].
 - 11.15.6.9 A preventative maintenance programme for all equipment.
 - 11.15.6.10 Operating instructions for each item of equipment.
 - 11.15.6.11 Performance data and/or characteristic curves.
 - 11.15.6.12 Commissioning data.
 - 11.15.6.13 Record drawings.

11.16 INFORMATION TO ALL CONTRACTS

- 11.16.1 Written guarantees with detailed conditions, [when applicable].
- 11.16.2 First twelve [12] month guarantee maintenance contract proposal with conditions, [as applicable].
- 11.16.3 Follow-up guarantee, [if any], and proposal for service/maintenance contract with conditions, [as applicable].

- 11.16.4 Complete set of documentation, including service instruction manual, three sets, one set should be on microfiche, [drawings].
- 11.16.5 List of recommended spares to be purchased immediately. Detailed reference to every supplier of such spares.
- 11.16.6 List of recommended tools and instruments to be purchased immediately for servicing, repair and testing purposes.
- 11.16.7 Proposals for possible training to the Employer's staff members, [operational and technical].

11.17 BUILDING MANAGEMENT SYSTEM

- 11.17.1 A Building Management System [BMS] will be provided by a BMS Contractor, and tenderers shall include in their price for the provision of relays, contacts, etc. to allow the BMS System to monitor the points as indicated in the BMS schedule.

11.18 GREEN BUILDING REQUIREMENTS

- 11.18.1 The Static UPS installation must be inspected, tested and commissioned in accordance with CIBSE guidelines. The following documents must be submitted at hand over:
 - 11.18.1.1 Commissioning records
 - 11.18.1.2 Commissioning results and figures
 - 11.18.1.3 Operational and maintenance manuals
 - 11.18.1.4 Monthly, quarterly and yearly maintenance and commissioning.
 - 11.18.1.5 Training and knowledge transfer to builder owner, this was also conducted on site.
 - 11.18.1.6 As-Built Drawings
- 11.18.2 The successful contractor will perform the following building activities for the final setting up of the various systems:
 - 11.18.2.1 Monitor the Static UPS installation on a monthly basis up until one (1) year after practical completion.
 - 11.18.2.2 Produce quarterly reports on the outcomes of monitoring the Static UPS installation system issued to the building owner and project Engineer.
 - 11.18.2.3 Perform corrective actions to the Static UPS installation as stipulated by the building owner (based on Project Engineer recommendations after reviewing subcontractor quarterly reports).

11.19 Technical Data Schedule

UPS

ITEM	DESCRIPTION	REQUIRED	OFFER	REMARKS
1	GENERAL			
1.1	Manufacturer name and location	Specify		
1.2	UPS model / type	Specify		
1.3	UPS topology according to IEC 62040-3	VFI-SS-111		
1.4	UPS power rating	550kVA		
1.5	Dimensions (WxDxH)	Specify	mm	
1.6	Weight	Specify		
1.7	Protection degrees (IEC 60529)	IP20		
1.8	Colour	White		
1.9	Continuous operating temperature	0 - 40 °C	°C	
1.10	Operating relative temperature	Up to 95%	%	
1.11	Cable entry	Top		
1.12	Efficiency at 100% load (guarantee value)	%	%	
1.13	Efficiency at 75% load (guarantee value)	%	%	
1.14	Installation	Centre of room – against wall		
1.15	Normal UPS operation	Front access		
1.16	Maintenance and service activities	Front and top		
1.17	Applicable standard	EN/IEC		
1.18	Applicable standard – safety	EN/IEC 62040-1		
1.19	Applicable standard – EMC	EN/IEC 62040-2		
2	Parallel Operation			
2.1	Parallel operation for redundancy or capacity	As described in the detailed technical specification		
2.2	UPS parallel bypass	Decentralised		
2.3	Current share between units	< 5 %	%	
3	UPS input characteristics			
3.1	Input voltage	3 x 380/ 400/ 415V	V	
3.2	Input voltage range	340 – 460 V		

ITEM	DESCRIPTION	REQUIRED	OFFER	REMARKS
3.3	Input frequency	50/60 + 10% Hz	Hz	
3.4	UPS input current harmonic distortion	< 2 at 100% load < 3% at partial loads %		
3.5	Input power factor	0.99		
3.6	Power walk-in	Yes		
3.7	Output DC voltage ripple	<1 %	%	
3.8	Output DC current ripple	Max 5% battery capacity	%	
4	UPS output characteristics			
4.1	UPS output nominal power per unit	550kVA	kVA	
4.2	UPS output active power at pf = 0.9 per unit	495kW	kW	
4.3	Output power factor – inductive load (without UPS power derating)	0.9 lagging		
4.4	Output power factor – capacitive load (without UPS power derating)	0.9 leading		
4.5	Output voltage	3 x 380 / 400 / 415 + N	V	
4.6	Output frequency	50 / 60 Hz	Hz	
4.7	Output voltage – static	± 1 %	%	
4.8	Output voltage – dynamic load step 0 – 100 – 0 %	± 3 %	%	
4.9	Output voltage – dynamic load step 0 – 50 % - 0%	± 2 %	%	
4.10	Voltage recovery time to + 1%	< 5 ms	Ms	
4.11	Output voltage distortion THD 100% linear load	< 1.5 %	%	
4.12	Output voltage distortion THD 100% non-linear load (EN/IEC 62040)	< 3 %	%	
4.13	Overload capability	125% 10 min 150% min		
4.14	Short circuit characteristics	2.7* I _n for 200 ms		
5	UPS static bypass switch			
5.1	Bypass input mains	Separated/common with rectifier		
5.2	Voltage limits for inverter/bypass load transfer	+ 10 %	%	
5.3	Overload capability	200%* I _n for 3 min 45* I _n for 10 ms non repetitive		

ITEM	DESCRIPTION	REQUIRED	OFFER	REMARKS
5.4	Electro mechanic contactor for back-fed protection integrated in UPS cabinet	Yes		
6	UPS Manual bypass			
6.1	Maintenance manual bypass for service activities	Integrated inside UPS cabinet		
7	Battery			
7.1	Battery Type	Specify		
7.2	Battery model / type	Specify		
7.3	Autonomy at 100% load	15 min	Min	
7.4	Floating voltage	V dc	V dc	
7.5	Boost charging voltage	V dc	V dc	
7.6	Number of battery blocks	Specify		
7.7	Number of parallel strings	Specify		
7.8	Battery cabinet / rack dimensions WxDxH	Specify	mm	
7.9	Weight	Kg	Kg	
8	UPS interfacing			
8.1	Input contacts	Modbus		
8.2	Generator contact	Yes		
8.3	Emergency power off	Yes		
8.4	RS 232	Yes		
9	Options			
9.1	Input isolation transformer	Not required		
9.2	Top entry cables	Yes		
9.3	Surge suppressors	Yes		
9.4	EMC Category C2			
9.5	Parallel output cabinet	Not required		
10.	Delivery Times			
10.1	Delivery of all equipment (Weeks)	Specify		
10.2	Installation (Weeks)	Specify		
10.3	Commissioning (Weeks)	Specify		
10.4	Total time required to complete installation	Sum of 10.1 – 10.3 above.		

PART 12

TRANSFORMER

DETAILED TECHNICAL SPECIFICATION

This index refers to the Part numbers [Part 12] as per the CAI standard document.

PART 12.1	GENERAL
PART 12.2	SCOPE OF WORK
PART 12.3	PROGRAMME
PART 12.4	LOCAL AND SUPPLY AUTHORITY
PART 12.5	SERVICE CONDITIONS
PART 12.6	TECHNICAL SPECIFICATIONS
PART 12.7	CONSTRUCTIONAL DETAILS AND FITTINGS
PART 12.8	DETAILS TO BE SUBMITTED WITH TENDERS
PART 12.9	MAINTENANCE AND GUARANTEE
PART 12.10	INSURANCE
PART 12.11	REGULATIONS
PART 12.12	LV CABLE INSTALLATION
PART 12.13	EARTHING AND BONDING
PART 12.14	TESTING
PART 12.15	AS BUILT DRAWINGS
PART 12.16	MAINTENANCE MANUAL

PART 12

TRANSFORMER

DETAILED TECHNICAL SPECIFICATION

The Detailed Technical Specification covers the supply, off loading in position, assist with commissioning upon request of the sub contractor; 12 months guarantee from date of practical completion and free maintenance during the 12 months guarantee period.

12.1 GENERAL

It is required for Transformers to be supplied and installed at the SANSA Energy Centre.

The Supplier/Manufacturer shall provide all necessary assistance including installing the Transformers in position, until the installation is complete and commissioned.

The tenderer shall be responsible for acquainting himself with the programme as no claims for delays shall be accepted especially dates on which practical completion will commence.

The Supplier/Manufacturer shall also ensure prior to submitting the tender they have familiarised themselves with all the information available regarding the building as well as site conditions. No claims whatsoever will be entertained for items which are of a nature that should have been assessed during tender stage.

12.2 SCOPE OF WORK

The following is a summary of the scope of work:

- [a] Manufacture 2 x Cast Resin Type Transformers

The installation will comprise but not be limited to:

- [a] Transportation to site
- [b] Off load to site
- [c] Place in position
- [d] Liaise closely with the Electrical Sub Contractor appointed to do the Electrical Installation
- [e] Assist and test prior to the Transformer being energised
- [f] 12 month maintenance from Practical Completion
- [g] 12 month guarantee from Practical Completion

12.3 PROGRAMME

The tenderer shall be responsible to acquaint themselves with the programme as no claims for delays shall be accepted. Tenderers are to advise on the lead times of the Transformers.

12.4 LOCAL AND SUPPLY AUTHORITY

The Local Authority for this area is Matjiesfontein. The successful tenderer shall ensure to be fully conversant with all by-laws of the Authorities.

12.5 **SERVICE CONDITIONS**

All equipment shall be suitable for the following site conditions:

Ambient temperature	40°C. max., 0°C. min.
Altitude	Approx. 1600m.
Lightning	Severe.
Dust	Severe.
Relative Humidity	47% at 27°C.
Nominal LV Supply	400/231 [no load] 4 wire, 3 phase system with earthed neutral.
Nominal HV Supply	11kV 3-wire system.
Frequency	50 Hz.
Fault Level	350 MVA at 11000 Volts.

12.5.1 **Regulations**

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

MOSA	The Machineries and Occupational Safety Act of 1983. The regulations of the local Gas Board.
SABS	The SABS Code for the Wiring of Premises – SANS 10142. The local Municipal bylaws and regulations as well as the regulations of the Local Supply Authority. Code of Practice for Engineering Drawing (Metric Units).
BS 308	(Including Supplement No 1) Engineering Drawing Practice.
ISO Recommendation R370	Conversion of Tolerance Dimensions.
BS 3939	Recommended Graphical Symbols.
BS5486 Part 1:1977	Factory built assemblies of Switchgear and Control gear for voltages up to and including 1000V AC and 1200V DC.
BS5419:1977	Air Break switches, Air Break disconnectors.
IEC 148:1972	Air break switch disconnectors and fuse combination units for voltages up to and including 1000V AC and 1200V DC.
BS 5424 Part: 1977 IEC 158.1:1970	Control gear for voltages up to and including 1000V AC and 1200V DC.

IEC 144	Degrees of Protection of Enclosures for low voltage switchgear.
IEC Technical Sub-Committee	Draft Guiding principles in the preparation of Circuit Diagrams
BS4752 Part 1:1977	Circuit breakers of rated voltage up to and including 1000V AC and 1200V DC.
BS 142:1966	Electrical protective relays.
BS89:1977 IEC 51	Direct Acting Electrical Indicating Instruments.
BS 3693 Part 1:1964	Instruments of bold presentation and for rapid reading.
BS3938 : 1973	Current Transformers.
BS3941 : 1975	Voltage Transformers.
BS 3535: 1962	Safety isolating transformers for domestic and industrial purposes.
DIN 43620	Low Voltage High Current Fuses 500V with contact blades - NH fuse cartridges.
VDE 0660 Part 4	Regulations for low voltage power fuses (NH Fuses) with rated voltages up to 1000V AC and up to 3000V DC.
IEC 269-1/-2	Low Voltage Fuses.
BS 158	Marking and arrangement of switchgear busbars, main connections and small wiring.
BS 159	Busbars and Busbar connections.
BS 1433	Copper for Electrical purposes.
BS 1706	Electroplated coatings of Cadmium and zinc on iron and steel.
BS 5472-1977	Specification for low voltage switchgear and control gear for industrial use, terminal marking and distinctive number (General rules).
BS 4794 Part 1:1973 Part 2:1977	Control switches, switching devices including contactor relays for control and auxiliary circuits up to, and including 1000V AC and 1200V DC.
SANS 121	Hot dip galvanized coatings on fabricating iron and steel articles – Specification and test method.
SANS 1091:2004	National Colour Standards for Paint.
SABS 135:1971 & Amendment 1, 1974	ISO Metric Black Bolts, Screws and Nuts.
SANS 60076-11	Dry Type Transformers

It shall be assumed that the Supplier/Manufacturer is conversant with the abovementioned regulations.

12.6 TECHNICAL SPECIFICATION

This specification covers the manufacture of cast resin transformers for general reticulation and distribution systems in normal environmental condition for 50Hz, three phase, 11kV/400V (nominal) primary and three phase four wire 400V (nominal) secondary systems.

The phase rotation of the transformer shall be Dyn 11.

Transformers will be low loss type

12.6.1 Standards

The Transformers shall be in compliance with the following standards:

- SANS/IEC 60076-11 Power Transformers – Dry Type transformers
- SANS/IEC 60076-1+5 Power Transformers
- SANS/IEC 60270 Partial discharge measurements
- SANS/IEC 60551 Determination of Transformer and reactor sound levels
- HD 538.1 S1 Three phase Dry Type Distribution Transformers, with highest voltage for equipment not exceeding 36kV
- SANS/IEC 60529 Degrees of protection provided by enclosures (IP code)

12.6.2 Description

[a] Magnetic Core

This will be made from laminations of grain oriented silicon steel, insulated with mineral oxide and will be protected against corrosion with a coat of varnish.

[b] LV Windings

These will be made from aluminium or copper foil (according to the manufacturer's preference) class F interlayer insulation by encapsulation (impregnation) with synthetic alkyl resin or equivalent.

At least the upper part of the LV coils will be covered with a coat of epoxy resin or equivalent and the foil will be protected everywhere with an insulation material even in the air ducts.

[c] HV Windings

These will be independent of the LV windings and will be made of aluminium or copper wire or foil (according to the manufacturer's preference) with class F insulation.

The HV windings will be vacuum cast in a class F fireproof epoxy resin casting system composed of:

- An epoxy resin
- An anhydride hardener with a flexibility additive
- A flame-retardant filler

The flame-retardant filler will be thoroughly mixed with the resin and hardener. It will be composed of tri-hydrated alumina power (or aluminium hydroxide) or other flame-retardant products to be specified, either mixed with silica or not.

The casting system will be of class F.

[d] HV Connections

The HV connections will be made from above on the top of the connection bars. Phases to be colour coded Red, White and Blue.

[e] LV Connections

The LV connections will be made from above onto bars located at the top of the coils on the opposite side to the HV connections.

[e] HV Tapping

The tapping which acts on the highest voltage adapting the Transformer to the real supply voltage value, will be off-circuit bolted links.

Tapping with connection cables are not allowed.

These bolted links will be attached to the HV coils.

[f] Thermal Protection

These Transformers will be equipped with a thermal protection device, which will comprise:

- 1 set of 3 PTC sensors, installed in the coils of the Transformer. They will be placed in a tube to enable them to be replaced if ever necessary. An electronic converter with two independent monitoring circuits equipped with a:
 - Alarm
 - Trip

The position of the relays will be indicated by coloured indicator lights.

These indicator lights will be on the front of the converter. The electronic converter will be installed away from the Transformer.

A terminal block for connection of the PTC sensors to the electronic converter.

The PTC sensors will be supplied, assembled and wired to the terminal block fixed on the upper part of the Transformer. The converter will be supplied loose with the Transformer, packaged complete with its wiring diagram.

[g] Metal Enclosure

The Transformers will be equipped with a metal enclosure for indoor installation comprising an integral IP23 enclosure.

- An anti-corrosion protection in the manufacturer's standard colour.
- Lifting lugs enabling the Transformer and enclosure assembly to be handled.
- A bolted access panel on the enclosure front to allow access to the HV connection and to the tapping. This will be fitted with handles; it will have one "Danger Electricity" warning label (T10 warning), a rating plate and a visible braid of earthing.
- Blanked off holes for fitting Ronis ELP1 or alternatively Profalux P1 type key locks on the bolted access panel to enable it to be locked.
- 2 Undrilled gland plates on the roof: one on the HV side, one on the LV side (drilling and cable gland not supplied).

[h] Climatic and Environmental Classifications

The Transformers will be of climatic class C2 and of environmental class E2.

[i] Fire Behaviour Classification

The Transformers will be class F1.

The manufacturer must produce a test report from an official laboratory for a Transformer of the same design as those produced.

12.7 **CONSTRUCTIONAL DETAILS AND FITTINGS**

The Transformers shall be fitted with the recommended standard fittings for Transformers as specified in Table 3 of SANS 780 and as specified below:

- Wheels

- Medium Voltage surge arrestors
- Earth terminals.
- Eyebolts for lifting by crane.
- 5 position OFF - load tap change switches [$\pm 2.5\%$, $\pm 5\%$].
- Padlocks for the tap change switches.
- Padlocks on all doors
- • Brass plates indicating the terminals and connections schematically.
- • Auxiliary terminal box for:
- Thermometer connections
- Rating plate

12.7.1 Cable Terminations

The Medium Voltage section of the Transformer shall be fitted with a cable box to accommodate a 70mm² x 3 core XLPE [armoured] 11000V grade cable. Cabling will be supplied, installed and terminated by the Electrical Sub Contractor.

The Low Voltage section of the Transformer shall be equipped to accept 3 000A Busbar.

12.7.2 Terminals

Three terminals shall be provided on the primary side. Each terminal shall be fitted with the correct size and quantities of lugs, bolts, nuts, washers, etc. to accept cables as specified. Bolted connections only are acceptable.

Four terminals shall be provided on the secondary side i.e. three phases and an insulated neutral. Each terminal shall be fitted with the correct size and quantities of lugs, bolts, nuts, washers, etc. to accept the cables as specified. Where parallel cables are specified bushing stud clamps or similar connectors shall be provided of adequate size to accommodate the cable bolted lugs without overlapping of the lugs.

Where busbars are specified on the secondary side, provision shall be made for the busbar enclosure to be made off on the transformer. Busbars rated at the Transformer's full load current shall be accommodated. Terminals shall be colour coded Red, White and Blue. Adequate space shall also be allowed for busbar protection current Transformers and allowance shall be made for the neutral to be brought out of the enclosure for external earthing.

12.7.3 Corrosion Protection

Corrosion protection shall comply strictly with SANS 780, Clause 8.2.3.

12.7.4 Method of Cooling

The Transformers enclosure shall be supplied with adequate cooling openings to prevent ingress of rodents and still allow adequate cooling.

12.7.5 Technical Information

All relevant technical information i.e. outline drawings, test cards, drawings of rating plate etc., as specified in SANS 780 shall be submitted with the tender.

12.7.6 Visit to the Site

Tenderers are to acquaint themselves with local site conditions such as access to the site, location of the site, supply of labour, work space, tackles, tools, transport, loading, unloading and storage space. Additional claims which may arise from ignorance of site conditions will not be considered.

12.7.7 Information and Technical Details

All tenderers shall include in the tenders descriptive catalogues, brochures and illustrations pertaining to the equipment offered for the installation.

All technical information schedules shall be completed before submitting of the tender.

Should the equipment offered in any way differ from the type specified, the differences shall be explicitly stated in detail. This information shall be submitted in detail in a covering letter with the tender stating the paragraph of the specification where the requirements of the particular equipment specified are deviated from.

Extent of emergency spares and service available shall be included for the equipment offered and whether the tenderers will be in a position to attend to emergency calls at short notice.

12.7.8 Rating plate

Rating plate to comply with SANS 60076-11: 2005, details to be included are:

- dry-type transformer;
- number and year of this part of IEC 60076;
- manufacturer's name;
- manufacturer's serial number;
- year of manufacture;
- insulation system temperature for each winding. The first letter shall refer to the high voltage winding, the second letter shall refer to the low voltage winding. \
- When more than two windings are present, the letters shall be placed in the order of the windings from the high voltage to the low voltage;
- number of phases;
- rated power for each kind of cooling;
- rated frequency;
- rated voltages, including tapping voltages, if any;
- rated currents for each kind of cooling;
- connection symbol;
- short-circuit impedance at rated current and at the appropriate referenced temperature;
- type of cooling;
- total mass;
- insulation levels;
- degree of protection;
- environmental class;
- climatic class;
- fire behavior class.

12.8 DETAILS TO BE SUBMITTED WITH TENDERS

The attention of the Tenderer is drawn to the fact a tender is subject to disqualification if all information called for is not submitted with the tender.

Should the Tenderer in any way differ from the specification, the differences shall be stated in detail. This information shall be submitted in a covering letter accompanying the tender, stating the paragraph of the specification where the requirements of the specification are deviated from.

It should be noted information entered in the schedules shall not relieve the Tenderer of his obligations to comply with the specification.

12.9 MAINTENANCE AND GUARANTEE

The installation and equipment supplied under this contract shall be maintained by the supplier for a period of twelve months from practical completion. Exact dates of when practical completion has been programmed for shall be obtained from the main contractor. The tender price shall include the above.

12.10 INSURANCE

Tenderers shall ensure their insurance policies provide adequate cover for the installation activities as the construction work progresses. Should insurance have to be extended to cover eventualities that may arise from the construction activities, these additional premiums may be included in the tender price and shall be enumerated in the covering letter.

12.11 REGULATIONS

The total installation shall conform to SABS Code of Practice SANS 10142 as amended for the Wiring of Premises as well as all the regulations and by-laws of the Local and Supply Authority.

12.12 LV CABLE INSTALLATION

All LV Cabling will be supplied and installed by the Electrical Sub Contractor.

12.13 EARTHING AND BONDING

The complete installation shall be earthed and bonded as required by the SABS Code of Practice.

12.14 TESTING

Pre delivery testing shall be done in accordance with the test sheet included with this tender specification. Testing to be witnessed by the Engineer.

It shall be expected of the transformer supplier/manufacturer to attend the testing of the transformer and associated installation prior to them being energized by the electrical sub contractor.

12.15 "AS BUILT" DRAWINGS

The Supplier/Manufacturer shall provide "As Built" drawings comprising of three [3] complete sets of the drawings, showing final details, circuit configurations and sizes of circuit wiring.

All terminal blocks in the system shall be identified and listed on a schedule of drawings.

12.16 MAINTENANCE MANUALS

The Supplier shall provide three [3] sets and one [1] CD of maintenance manuals which shall contain the following:

- Test certificates.
- Sets of Operating and Maintenance manuals.
- The Operating and Maintenance manuals shall include the following:
 - i. Completion date.
 - ii. Supplier.
 - iii. Installer.
 - iv. Contact details.
 - v. Guarantee period.
 - vi. Preventative as well as Corrective maintenance procedures and intervals.
 - vii. Alarms and Indicators.
 - viii. Items (i) and (v) indicated on the transformer.
 - ix. Parts & Accessories.
- Training manuals with a complete list of fault finding and operation.

- Training with certification of trainees upon completion.
- As built drawings of the installation

NOTE

The installation shall not be considered complete until the above has been done.

PART 13

TRANSFORMER TENDER

TECHNICAL DATA

For each requested transformer, the Supplier will provide the following data:

	Required	Offered
Rated Power	kVA	kVA
Cooling		
Quantity		
Rated frequency	Hz	Hz
Rated primary voltage	kV	kV
Rated primary insulation level	kV	kV
Applied voltage to industrial frequency	kV	kV
Basic Insulation Level (BIL) or impulse	kV	kV
Off-circuit tapping	%	%
Secondary voltage at no load	V	V
Between phases		
Phase to neutral	V	V
Rated secondary insulation level	kV	kV
Applied secondary voltage to industrial frequency	kV	kV
Vector group		
Conductor Material MV winding	AV	AV
Conductor Material LV winding	AV	AV
No load losses	W	W
Load losses at 75°C	W	W
Load losses at 120°C	W	W
Rated impedance voltage at 120°C	%	%
Acoustic power Lw(A)	dB(A)	dB(A)
Acoustic pressure at 1 metre Lp(A)	dB(A)	dB(A)
Impedance Voltage at the principle tapping at 75°C	%	%
Maximum ambient temperature	°C	°C
Daily average ambient temperature	°C	°C
Yearly average ambient temperature	°C	°C
Maximum altitude	m	m
HV winding temperature class	F	
LV winding temperature class	F	
Temperature of insulation system	155°C	°C
Climatic classification (HD 464 S1)	C2	
Environmental classification (HD 464 S1)	E2	
Fire behaviour classification (HD 464 S1)	F1	
Enclosure	Yes	
Protection degree	IP23	
Length	mm	mm
Width	mm	mm
Height	mm	mm
Total weight	kg	kg
Measurement circuit supply for the thermal protection electronic converter	DC	V
	AC	V

PART 13B

TRANSFORMER TENDER

TRANSFORMER TEST REPORT

13.1 TRANSFORMER SPECIFICATIONS

- KVA: _____ kVA
- Voltage: HV – _____ V
LV – _____ V (No-Load)
- Current: HV – _____ A
LV – _____ A
- Impedance: _____ % (Refer to SANS 780 for compliance)
- Frequency: _____ Hz
- Phases: _____ Ph
- Type Cooling: _____
- Total Mass: _____ Kg
- Core Windings: _____ Kg
- Oil: _____ l
- Manufactured: _____ month/year
- Serial Number: _____

Notes, Test and calibration certificates.

[illegible]

13.2 Tests as specified in SANS 780 & SANS 60076-1

13.2.1 General requirements for routine, type and special tests

- Transformers shall be subjected to tests as specified below.
- Tests shall be made at any ambient temperature between 10 °C and 40 °C and with cooling water (if required) at any temperature not exceeding 25 °C.
- Tests shall be made at the manufacturer's works, unless otherwise agreed between the manufacturer and the purchaser.
- All external components and fittings that are likely to affect the performance of the transformer during the test shall be in place.
- Tapped windings shall be connected on their principal tapping, unless the relevant test clause requires otherwise or unless the manufacturer and the purchaser agree otherwise.
- The test basis for all characteristics other than insulation is the rated condition, unless the test clause states otherwise.
- All measuring systems used for the tests shall have certified, traceable accuracy and be subjected to periodic calibration, according to the rules of 4.11 of ISO 9001.

NOTE

Specific requirements on the accuracy and verification of the measuring systems are under consideration (see IEC 60606).

Where it is required that test results are to be corrected to a reference temperature, this shall be:

- for oil-immersed transformers: 75 °C;
- for dry-type transformers: according to the general requirements for tests in IEC 60726.

13.2.2 Routine tests

- Measurement of winding resistance
- Measurement of voltage ratio and check of phase displacement.
- Measurement of short-circuit impedance and load loss.
- Measurement of no-load loss and current.
- Measurement of the harmonics of the no-load current.
- Measurement of zero-sequence impedance(s) on three-phase transformers
- Tests on on-load tap-changers, where appropriate.
- Measurement of Paint thickness.
- Transformer pressure testing.
- Dielectric routine tests (IEC 60076-3).

Routine tests and inspections shall be performed before the transformer leaves the factory, and reported in accordance with annex B (SANS 780). Type Tests and Special Tests will be conducted and reported in accordance with annex B (SANS 780)

13.2.3 Type tests

- Temperature-rise test (IEC 60076-2).
- Dielectric type tests (IEC 60076-3).

13.2.4 Special tests

- Dielectric special tests (IEC 60076-3).
- Determination of capacitances windings-to-earth, and between windings.
- Determination of transient voltage transfer characteristics.
- Measurement of zero-sequence impedance(s) on three-phase transformers.
- Short-circuit withstand test (IEC 60076-5).
- Determination of sound levels (IEC 60551).
- Measurement of the harmonics of the no-load current.
- Measurement of the power taken by the fan and oil pump motors.
- Measurement of insulation resistance to earth of the windings, and/or measurement of dissipation factor ($\tan \delta$) of the insulation system capacitances. (These are reference values for comparison with later measurement in the field. No limitations for the values are given here.)

13.3 Measurement of winding resistance

13.3.1 General

The resistance of each winding, the terminals between which it is measured and the temperature of the windings shall be recorded. Direct current shall be used for the measurement.

In all resistance measurements, care shall be taken that the effects of self-induction are minimized.

13.3.2 Dry-type transformers

Before measurement the transformer shall be at rest in a constant ambient temperature for at least 3 hours.

Winding resistance and winding temperature shall be measured at the same time. The winding temperature shall be measured by sensors placed at representative positions, preferably inside the set of windings, for example, in a duct between the high-voltage and low voltage windings.

Measurement of winding resistance			
Primary Voltage	Winding Resistance(Ω)	Winding Temperature ($^{\circ}\text{C}$)	DC Current (Adc)

13.3.3 Oil-immersed type transformers

After the transformer has been under oil without excitation for at least 3 h, the average oil temperature shall be determined and the temperature of the winding shall be deemed to be the same as the average oil temperature. The average oil temperature is taken as the mean of the top and bottom oil temperatures.

In measuring the cold resistance for the purpose of temperature-rise determination, special efforts shall be made to determine the average winding temperature accurately. Thus, the difference in temperature between the top and bottom oil should be small. To obtain this result more rapidly, the oil may be circulated by a pump.

Measurement of winding resistance			
Primary Voltage	Winding Resistance(Ω)	Winding Temperature ($^{\circ}\text{C}$)	DC Current (Adc)

13.4 Measurement of voltage ratio and check of phase displacement

The voltage ratio shall be measured on each tapping. The polarity of single-phase transformers and the connection symbol of three-phase transformers shall be checked.

Measurement of voltage ratio and check of phase displacement		
Primary Voltage	Tap Setting (%)	Voltage Ratio
Polarity or Vector Symbol		

13.5 Measurement of short-circuit impedance and load loss

The short-circuit impedance and load loss for a pair of windings shall be measured at rated frequency with approximately sinusoidal voltage applied to the terminals of one winding, with the terminals of the other winding short-circuited, and with possible other windings open circuited. (For selection of tapping for the test, see 5.5 and 5.6 of SANS 60076-1). The supplied current should be equal to the relevant rated current (tapping current) but shall not be less than 50 % thereof. The measurements shall be performed quickly so that temperature rises do not cause significant errors. The difference in temperature between the top oil and the bottom oil shall be small enough to enable the mean temperature to be determined accurately. If the cooling system is OF or OD, the pump may be used to mix the oil.

The measured value of load loss shall be multiplied with the square of the ratio of rated current (tapping current) to test current. The resulting figure shall then be corrected to reference temperature (1.1). The I²R loss (R being d.c. resistance) is taken as varying directly with the winding resistance and all other losses inversely with the winding resistance.

The measurement of winding resistance shall be made according to 1.2. The temperature correction procedure is detailed in annex E of SANS 60076-1.

The short-circuit impedance is represented as reactance and a.c. resistance in series. The impedance is corrected to reference temperature assuming that the reactance is constant and that the a.c. resistance derived from the load loss varies as described above.

On transformers having a tapped winding with tapping range exceeding $\pm 5\%$, the short-circuit impedance shall be measured on the principal tapping and the two extreme tapings.

On a three-winding transformer, measurements are performed on the three different two winding combinations. The results are re-calculated, allocating impedances and losses to individual windings (see IEC 60606). Total losses for specified loading cases involving all these windings are determined accordingly.

NOTE 1

For transformers with two secondary windings having the same rated power and rated voltage and equal impedance to the primary (sometimes referred to as 'dual-secondary transformers'), it may be agreed to investigate the symmetrical loading case by an extra test with both secondary windings short-circuited simultaneously.

NOTE 2

The measurement of load loss on a large transformer requires considerable care and good measuring equipment because of the low power factor and the often large test currents. Correction for measuring transformer errors and for resistance of the test connections should be applied unless they are obviously negligible (see IEC 60606).

Measurement of short-circuit impedance and load loss		
	Primary Voltage	
	V	V
Load (Copper) Loss (W) – Measured		
Load (Copper) Loss (W) – SANS 780 Table 1		
Short Circuit Impedance (%) – Measured		
Short Circuit Impedance (%) – SANS 60076-1 Table 1		

13.6 Measurement of no-load loss and current

The no-load loss and the no-load current shall be measured on one of the windings at rated frequency and at a voltage corresponding to rated voltage if the test is performed on the principal tapping or to the appropriate tapping voltage if the test is performed on another tapping. The remaining winding or windings shall be left open-circuited and any windings which can be connected in open delta shall have the delta closed.

The transformer shall be approximately at factory ambient temperature.

For a three-phase transformer the selection of the winding and the connection to the test power source shall be made to provide, as far as possible, symmetrical and sinusoidal voltages across the three wound limbs.

The test voltage shall be adjusted according to a voltmeter responsive to mean value of voltage but scaled to read the r.m.s. voltage of a sinusoidal wave having the same mean value. The reading of this voltmeter is U' .

At the same time, a voltmeter responsive to the r.m.s. value of voltage shall be connected in parallel with the mean-value voltmeter and its indicated voltage U shall be recorded.

When a three-phase transformer is tested, the voltages shall be measured between line terminals, if a delta-connected winding is energized, and between phase and neutral terminals if a YN or ZN connected winding is energized.

The test voltage wave shape is satisfactory if the readings U' and U are equal within 3 %.

NOTE

It is recognized that the most severe loading conditions for test voltage source accuracy are usually imposed by large single-phase transformers.

The measured no-load loss is P_m , and the corrected no load loss is taken as:

$$P_o = P_m(1 + d)$$

$$d = \frac{U' - U}{U'} (\text{usually negative})$$

If the difference between voltmeter readings is larger than 3 %, the validity of the test is subject to agreement.

The r.m.s. value of no-load current is measured at the same time as the loss. For a three phase transformer, the mean value of readings in the three phases is taken.

NOTE

In deciding the place of the no-load test in the complete test sequence, it should be borne in mind that no-load loss measurements performed before impulse tests and/or temperature rise tests are, in general, representative of the average loss level over long time in service. Measurements after other tests sometimes show higher values caused by spitting between laminate edges during the impulse tests, etc. Such measurements may be less representative of losses in service.

Measurement of no-load loss and current		
	Primary Voltage	
	V	V
No Load (Iron) Loss (W) – Measured		
No Load (Iron) Loss (W) – SANS 780 Table 1 & SANS 60076-1 Table		
No Load Current (A) – Measured		
No Load Current (A) – SANS 60076-1 Table 1		

13.7 Measurement of the harmonics of the no-load current

The harmonics of the no-load current in the three phases are measured and the magnitude of the harmonics is expressed as a percentage of the fundamental component.

Measurement of the harmonics of the no-load current		
Primary Voltage	THD (% of fundamental)	No Load Current (A) – Measured

13.8 Measurement of zero-sequence impedance(s) on three-phase transformers

The zero-sequence impedance is measured at rated frequency between the line terminals of a star-connected or zigzag-connected winding connected together, and its neutral terminal. It is expressed in ohms per phase and is given by $3 U/I$, where U is the test voltage and I is the test current.

The test current per phase $\frac{I}{3}$ shall be stated

It shall be ensured that the current in the neutral connection is compatible with its current carrying capability.

In the case of a transformer with an additional delta-connected winding, the value of the test current shall be such that the current in the delta-connected winding is not excessive, taking into account the duration of application.

If winding balancing ampere-turns are missing in the zero-sequence system, for example, in a star-star-connected transformer without delta winding, the applied voltage shall not exceed the phase-to-neutral voltage at normal operation. The current in the neutral and the duration of application should be limited to avoid excessive temperatures of metallic constructional parts.

In the case of transformers having more than one star-connected winding with neutral terminal, the zero-sequence impedance is dependent upon the connection (see 3.7.3) and the tests to be made shall be subject to agreement between the manufacturer and the purchaser.

Auto-transformers with a neutral terminal intended to be permanently connected to earth shall be treated as normal transformers with two star-connected windings. Thereby, the series winding and the common winding together form one measuring circuit, and the common winding alone forms the other. The measurements are carried out with a current not exceeding the difference between the rated currents on the low-voltage side and the high-voltage side.

NOTE 1

In conditions where winding balancing ampere-turns are missing, the relation between voltage and current is generally not linear. In that case several measurements at different values of current may give useful information.

NOTE 2

The zero-sequence impedance is dependent upon the physical disposition of the windings and the magnetic parts and measurements on different windings may not, therefore, agree.

Measurement of zero-sequence impedance(s) on three-phase transformers at rated frequency			
Primary Voltage	Z_0 (Z)- Measured	Test Current (A)	Test Voltage (V)

13.9 Tests on on-load tap-changers

13.9.1 Operation test

With the tap-changer fully assembled on the transformer the following sequence of operations shall be performed without failure:

- with the transformer un-energized, eight complete cycles of operation (a cycle of operation goes from one end of the tapping range to the other, and back again).
- with the transformer un-energized, and with the auxiliary voltage reduced to 85 % of its rated value, one complete cycle of operation.

- with the transformer energized at rated voltage and frequency at no load, one complete cycle of operation.
- with one winding short-circuited and, as far as practicable, rated current in the tapped winding, 10 tap-change operations across the range of two steps on each side from where a coarse or reversing changeover selector operates, or otherwise from the middle tapping.

Tests on on-load tap-changers – Operational Test	
Test	Passed (Sign)
1.8.1 a)	
1.8.1 b)	
1.8.1 c)	
1.8.1 d)	

13.9.2 Auxiliary circuits insulation test

After the tap-changer is assembled on the transformer, a power frequency test shall be applied to the auxiliary circuits as specified in IEC 60076-3.

Tests on on-load tap-changers – Auxiliary circuits insulation test	
Test	Passed (Sign)
1.8.2	

13.10 Measurement of paint thickness

Measurement of paint thickness shall be performed in accordance with SANS 2808 to determine the dry film thickness of the coatings at several points around the perimeter of the tank, the conservator (if any), cable boxes, terminal boxes, radiator headers and radiator tubes (if provided), preferably where the surface is exposed to airborne moisture and pollution or where it is likely to come into contact with soil or vegetation.

Measurement of paint thickness	
Thickness as per SANS 780	Passed (Sign)

13.11 Transformer pressure testing

Effectiveness of sealing shall be verified by applying a pressure of 20 kPa for a period of 6 h in the case of transformers that have a rating of 500 kVA or less, and 12 h in the case of transformers that have a rating exceeding 500 kVA. Examine the transformer for oil, air or gas leaks.

Transformer pressure testing		Passed(Sign)
End Pressure (kPa)		
No Visible Oil Leaks		

Type and special tests as required in this standard should be done by the manufacturer on each design. To avoid the costs incurred by the repetition of type and special tests on every lot of transformers offered for test, a certified record of the results of such tests conducted on a transformer from a previous lot may be submitted and, if acceptable, one or more of these tests may be omitted, provided that the certified record gives the date and method of testing, the serial number, the year of manufacture (if different from the year of test), and all relevant details of the transformer tested.

Details of any differences in construction and rating between the transformer to which the record applies and the transformers in the lot offered for test should be made available.

13.12 Type tests

3.12.1 Temperature-rise test

Fit a pressure gauge to the transformer to measure the pressure build-up during the temperature-rise test.

3.12.2 Dielectric type tests

The dielectric type tests in SANS 60076-3 apply, with the addition of the procedures in 10.3.2.2 and 10.3.2.3.

Apply impulses to all the medium-voltage line terminals simultaneously. Earth low-voltage terminals, the neutral terminal and the tank of the transformer through a shunt to ground. Insulate the tank from the ground. The test sequence consists of one impulse at 60 % of the full test voltage and two impulses at 100 % of the full test voltage. Measure the currents between the tank and earth return circuit. The results from the impulse tests completed at 100 % and 60 % of the full test voltage shall have the same wave shape.

Apply impulses to all the low-voltage and neutral terminals simultaneously. Earth medium voltage terminals and the tank of the transformer through a shunt to ground. Insulate the tank from the ground. The test sequence consists of one impulse at 60 % of the full test voltage and two impulses at 100 % of the full test voltage. Measure currents between the tank and earth return circuit. The results from the impulse tests completed at 100 % and 60 % of the full test voltage shall have the same wave shape.

NOTE

Deviations in the two tests might be due to flashovers somewhere in the winding to ground. This constitutes a failure

3.12.3 Corrugated tank fatigue test

Apply 11 000 pressure cycles by raising the internal pressure of the transformer to the value specified below, followed by a total release of pressure to complete one cycle. In the case of panels of depth less than 260 mm, the required sequence is as follows:

- 4 000 cycles at 15 kPa;

- 4 000 cycles at 20 kPa; and
- 3 000 cycles at 25 kPa.

In the case of larger panels, the sequence shall be agreed upon with the basis for acceptance being:

- a variation of less than 20 % in the distance between the panels when subjected to the last 3 000 cycles at 25 kPa (this measurement is taken with the tank pressurized at 25 kPa), and
- no trace whatsoever of an oil leak.

3.12.4 Thermal trip test (CSP transformers)

SANS 60076-13 apply, with the addition of the following: Ensure that the circuit-breaker under test is in the closed position and immersed in a container filled with transformer oil. Gradually heat the container and its contents from ambient temperature. Install a thermometer as close as possible to the circuit-breaker contacts to measure the oil temperature. Increase the temperature until the circuit-breaker trips. Check whether the circuit-breaker trips when the oil temperature exceeds a temperature that corresponds with a calculated winding hot-spot temperature of 140 °C and taking into account the tolerances specified by the circuit-breaker manufacturer.

NOTE

The oil should be stirred frequently to ensure a uniform temperature throughout.

3.12.5 Short-circuit trip test and transformer short-circuit withstand test (CSP transformers)

With the transformer (as equipped for service) at ambient temperature and with the circuit-breaker closed, apply an appropriate voltage such that when a short-circuit is applied to the LV terminals, the following values of current and tripping are achieved:

- at 10 times the rated current in the LV windings, the circuit-breaker trips within 1,50 s $\pm 0,15s$
- at 20 times the rated current in the LV windings, the circuit-breaker trips within 0,30 s $\pm 0,03s$

NOTE

The maximum current circulation time will be determined by the time it takes the circuit-breaker to trip, and could be shorter than required in terms of SANS 60076-5.

13.13 Additional modifications — Special tests

13.13.1 Short-circuit withstand test

In the case of transformers of rating 500 kVA and below (excluding transformers with metal foil windings) the additional requirements and acceptance criteria given in (a) to (j) with respect to the value of the symmetrical short-circuit current given in 3.1.2 of SANS 60076-5:2006 apply.

- Use the resistance value at 20 °C to calculate the short-circuit currents to be applied to the transformer.
- Use a voltage of 115 % of U_n (i.e. 5 % above U_m and 15 % above U_e) to calculate the short-circuit currents to be applied to the transformer.
- Only pre-set short-circuit testing is allowed.

NOTE:

It is a “normal” condition for a transformer to have a short circuit on its terminals when power is closed to the transformer or when auto-reclose operations occur. This test is aimed at emulating this condition.) Where preset testing is not possible, alternatives might be discussed with the purchaser before testing. The aim of the

discussion would be to find an equivalent alternative means of testing.

- A single-phase transformer will be required to withstand at least three short circuits on low, middle and high tap settings with not less than nine short-circuit tests per transformer. Test a three-phase transformer in accordance with SANS 60076-5 (use a minimum of nine short-circuit tests).

NOTE:

A transformer is subject to many short circuits in its operational life, especially a transformer used for electrification with long feeders and many customers. A single customer transformer has fewer faults but the fault most of the time will be close to the transformer terminals i.e. high fault currents.

- Inspect all transformers after testing, and report any mechanical deformation of the windings, winding supports, LV and HV leads or any other part of the transformer in the test report. Deformation due to short-circuit mechanical forces is not acceptable unless it could be shown that the deformation is minimal and would not cause increased electrical, mechanical, thermal or any other stresses.
- A total change in the inductance per phase (from the first to the last test) shall not exceed 2,0 %. Repeat testing on a particular tap setting until the change in inductance after each successive test stabilizes to less than 0,25 % of the inductance of the winding. (This implies that more than nine tests would be applied in such a case.) The supplier has to demonstrate that a change greater than 1,0 % is of a non-detrimental self limiting nature.
- A limited number of radial dimensional changes in non-circular concentric winding transformers are recognized as potentially acceptable. The total change in the inductance per phase (from the first to the last test) shall not exceed 4,0 %. Testing on a particular tap setting shall be repeated until the change after each successive test (on this tap setting) stabilizes to less than 0,25 % of the inductance of the winding. (This implies that more than nine tests would be applied in such a case.)

13.13.2 Determination of sound levels

If so required, determination of sound levels to prove compliance with table 6 shall be performed in accordance with SANS 60076-10.

13.13.3 Tank stiffness test

Measure the tank stiffness in relation to a reference point, the permanent deflection of tank panels or stiffeners (or both) of the transformer tank and, where relevant, the conservator, caused (in each case) by the vacuum and pressure applications described below. If the deflection exceeds the relevant limit given in table 7, repeat the test and verify whether the excess was caused only by relieving of fabrication stresses.

Perform vacuum application with the tank and the conservator (where relevant) empty of oil, the internal pressure reduced to 10 kPa below ambient pressure or, when relevant, the pressure at which the manufacturer requires the transformer to be filled if this pressure is lower than 10 kPa below ambient pressure. Gradually increase the pressure to ambient level.

Apply pressure where all the fittings that are normally in contact with oil are in place (including pressure limiting devices made inoperative) and with disconnecting chambers, where fitted, empty of oil and open for inspection. Subject the interior of the transformer, complete with its normal complement of oil, to a pressure of 35 kPa measured at the top of the conservator or, if no conservator is fitted, at the top of the tank. Gradually decrease the pressure to ambient level.

SITE INSPECTION CHECKLIST FOR POWER TRANSFORMERS

SITE INSPECTION CHECKLIST FOR POWER TRANSFORMERS			
DRAWING NUMBER		CONTRACT NUMBER	
PROJECT DESCRIPTION		PROJECT NUMBER	
ITEM	ITEMS TO CHECK	CHECKED BY	DATE
1.	Check tag no., KVA size & voltage to drawings & data sheets		
2.	Check maker's nameplate to purchase order & data sheets.		
3.	Location & orientation to design and drawing.		
4.	Enclosure as per hazardous area classification.		
5.	Visual inspection for damage or missing parts.		
6.	Check mountings and supports as per design & drawing.		
7.	Oil filled transformer. Check oil level & for oil leaks.		
8.	Air-cooled transformer. Check for total vermin proofing		
9.	Check proper mounting and support of transformer.		
10.	Check both primary and secondary cable sizes, numbers and termination conform to design and drawing.		
11.	Check tap changer is lockable and selecting positions.		
12.	Check insulation resistance, primary & secondary cables.		
13.	Check insulation resistance, test transformer and record readings		
14.	Check terminations and glanding prior to sealing compartments.		
15.	Check earthing connecting to transformer and record earthing tests.		
16.	All deviations revisions or changes recorded for 'As-built' drawings.		
17.	Copy of SABS Approval / Vendor test certificate received.		
18.	Certificate of compliance received.		
REMARKS:			
ACCEPTED BY	DATE	COMPANY NAME	SIGNATURE

PART 14

SANSA MATJIESFONTEIN

SCHEDULE OF DRAWINGS

ELECTRICAL INSTALLATION

DRAWING DESCRIPTION	ACC DRAWING NUMBER
<u>Earthing & Lightning Protection Layouts</u>	
Earthing & Lightning Protection Layout	SMFN-CAI-EE-DR-001_01
<u>Power Layouts</u>	
Site Plan Layout	SMFN-CAI-EE-DR-002_00
Generator Building Equipment & Diesel Reticulation Layout	SMFN-CAI-EE-DR-002_01
Main Building Power Layout	SMFN-CAI-EE-DR-002_03
<u>Cable Tray Layouts</u>	
Main Building Cable Trays & Trunking Layout	SMFN-CAI-EE-DR-002_04
Generator Bldg Cable Tray Layout	SMFN-CAI-EE-DR-002_05
<u>Mechanical Power Layouts</u>	
Main Building Mechanical Power Layout	SMFN-CAI-EE-DR-014_01
<u>Lighting Layouts</u>	
Main Building Lighting Layout	SMFN-CAI-EE-DR-003_01
<u>Detail Layouts</u>	
Gatehouse Electrical Layouts	SMFN-CAI-EE-DR-008_01
Generator Building Electrical Layouts	SMFN-CAI-EE-DR-008_02
NASA Electrical Layouts	SMFN-CAI-EE-DR-008_03
Typical Trench Details	SMFN-CAI-EE-DR-008_04
NASA Antenna Electrical Layout	SMFN-CAI-EE-DR-008_05
<u>Single Line Diagrams</u>	
Reticulation Single Line Diagram	SMFN-CAI-EE-DR-005_00
MLV Single Line Diagram	SMFN-CAI-EE-DR-005_01
SMD1 Single Line Diagram	SMFN-CAI-EE-DR-005_02
SD1 Single Line Diagram (Operations Building Local DB)	SMFN-CAI-EE-DR-005_03
SD2 Single Line Diagram	SMFN-CAI-EE-DR-005_04
DSANSA Single Line Diagram	SMFN-CAI-EE-DR-005_05
DUPS-A Single Line Diagram	SMFN-CAI-EE-DR-005_07
DUPS-B Single Line Diagram	SMFN-CAI-EE-DR-005_08
DGH Single Line Diagram	SMFN-CAI-EE-DR-005_09
Kiosk 1 Single Line Diagram	SMFN-CAI-EE-DR-005_10
DSER Single Line Diagram	SMFN-CAI-EE-DR-005_14
DNER Single Line Diagram	SMFN-CAI-EE-DR-005_15
NASA MDP-A Single Line Diagram	SMFN-CAI-EE-DR-005_16
NASA MDP-B Single Line Diagram	SMFN-CAI-EE-DR-005_17
ATS 1 Single Line Diagram	SMFN-CAI-EE-DR-005_18
ATS 2 Single Line Diagram	SMFN-CAI-EE-DR-005_19
ATS 3 Single Line Diagram	SMFN-CAI-EE-DR-005_20
DDSL Single Line Diagram	SMFN-CAI-EE-DR-005_21
<u>Electronic Services Layouts</u>	
Access Control Wireway Layout	SMFN-CAI-EE-DR-006_01
Fire Detection Wireway Layout	SMFN-CAI-EE-DR-009_01