TSHWANE ENERGY & ELECTRICITY DEPARTMENT
ENERGY BUSINESS DIVISION

TENDER REFERENCE: EEBU 07 -2025-26

CITY OF TSHWANE
IGNITING EXCELLENCE

TENDER FOR THE SUPPLY, DELIVERY, INSTALLATION, TESTING AND COMMISSIONING OF 1x300MVA POWER TRANSFORMER AT KWAGGA 275/132KV SUBSTATION WITH ASSOCIATED EQUIPMENT FOR A PERIOD OF THREE (3) YEARS

VOLUME 1

A Tender for Category 8EP or higher CIDB Registered Contractors

ISSUED BY:	**PREPARED BY:**
The Divisional Head **Energy & Electricity Department** **PO Box 423** **Pretoria** **0001**	**The Divisional Head** **Supply Chain Management Unit** Tshwane House 320 Madiba Street Pretoria CBD 0002

Registered Name of Tenderer:	
Trading Name of Tenderer:	
Registration No. of Entity:	
Contact Person:	CoT Vendor No:
Tel. No:	E-Mail Address:
Cell No:	Fax No:
CIDB CRS Number (s):	

Only bidders registered on the central supplier database and with CSD Number will be considered for this tender as it is a requirement from National Treasury.

Contents of Volume 1

PORTION 1: TENDER

PART T1: TENDER PROCEDURES

TABLE OF CONTENTS

T1.1 TENDER NOTICE AND INVITATION TO TENDER

EEBU 07- 2025/26

CITY OF TSHWANE
ENERGY AND ELECTRICTY BUSINESS UNIT

TENDER FOR THE SUPPLY, DELIVERY, INSTALLATION, TESTING AND COMMISSIONING OF 1x300MVA POWER TRANSFORMER AT KWAGGA 275/132KV SUBSTATION WITH ASSOCIATED EQUIPMENT FOR A PERIOD OF THREE (3) YEARS

Tenders are hereby invited for the above work.

Tenderers should have a Construction Industry Development Board (CIDB) contractor grading designation as **8EP or higher**

The tender documents will be obtainable for download on City of Tshwane public website (www.tshwane.gov.za) and National Treasury's e-tenders (www.etenders.gov.za).

Tenders will be evaluated based on awarding points specific goals of the tenderer.

The system comprises of the following two elements:

a)	Price	90 points
b)	Specific goals	10 points

TENDER BRIEFING SESSION
Compulsory tender site meeting will be held on:

Date & Time: 26 January 2026 at 10:00am

Venue: Kwagga 275/132kV Substation located in Pretoria West at Church Street

Prospective tenderers must already be in possession of the tender document and be familiarised with the contents. ONLY TWO or less representatives of each prospective tenderer will be allowed to attend the meeting and site inspection.
The Municipality reserves the right to accept any tender as a whole or in part or no tender.

The validity period for the tender after closure is 90 days.
City of Tshwane shall have right and power to extent any tender validity period beyond any initial validity period set and subsequent extensions. SCM shall ensure that an extension of validity is requested in writing from all bidders before the validity expiry date. Extension of validity shall be finalized while the quotations/bids are still valid.
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The closing time for receipt of tenders is the 19 February 2026 at **10H00am** Tenders will be received on the closing date and time shown, must be enclosed in sealed envelopes bearing the applicable tender heading and reference number, as well as the closing time and due date, and must be addressed to the Divisional Head, SUPPLY CHAIN MANAGEMENT, PRETORIA, 0002 and must be submitted in the tender box situated at Tshwane House, 320 Madiba Street, Pretoria CBD. Tenders will be opened at the latter address at the time indicated.

ENQUIRIES:

Employers Agent:	**John Hlongwani**
Tel (Office):	**012 358 6484**
E-Mail:	**johnhl@tshwane.gov.za**

SUPPLY CHAIN EQUIRIES:

Employer's Agent:	Mulondi Rasekgala
Telephone:	012 358 6636
E mail:	mulondin@tshwane.gov.za

Mr Johann Mettler
City Manager

NOTICE NO 09 of 2025-26

T1.2 TENDER DATA

The conditions of tender are the Standard Conditions of Tender as contained in **Annexure C** of **Standard for Uniformity in Construction Procurement (Board Notice Government Gazette No 42622 of 08 August 2019)**, bound into Section T1.3

The Standard Conditions of Tender makes several references to the Tender Data. The Tender Data shall have precedence in the interpretation of any ambiguity or inconsistency between it and the Standard Conditions of Tender to which it mainly applies.

CLAUSE NUMBER		TENDER DATA
C.1.1	Actions	The Employer is **City of Tshwane Metropolitan Municipality**
C.1.2	Tender Documents	Volume 1: Tender Document **THE TENDER** **Part T1: Tendering Procedures** T1.1 – Tender notice and invitation to tender T1.2 – Tender data T1.3 – Standard Conditions of Tender **Part T2: Returnable documents** T2.1 – List of returnable documents T2.2 – Returnable schedules **THE CONTRACT** **Part C1: Agreements and contract data** C1.1 – Form of offer and acceptance C1.2 – Contract data C1.3 – Form of Guarantee C1.4 - Example form of Guarantee C1.5 – Health and safety agreement **Part C2: Pricing data** C2.1 – Pricing instruction C2.2 – Pricing schedule **Part C3: Scope of work** C3.1 – Description of works C3.2 – Health and safety **Part C4: Site information** C4.1 – Locality plans and drawings
C.1.3 *C.1.3.4*	Interpretation	**Add** the following new clause: *The tender documents have been drafted in English. The contract arising from the invitation to tender shall be interpreted and construed in English*
C.1.4		Agent: **John Hlongwani**

CLAUSE NUMBER		TENDER DATA
	Communication and Employer's Agent	Tel: **012 358 6484** E-Mail: **johnhl@tshwane.gov.za**
C.2.1	Eligibility	This bid will be evaluated in four evaluation stages namely: • Stage 1: Administrative compliance • Stage 2: Mandatory Requirements • Stage 3: Functionality Criteria • Stage 4: Preference Points System (90/10) Only those tenderers who are registered with the CIDB, or are capable of being so prior to the closing of tender submissions, in a contract grading designation equal to or higher than a contractor grading designation determined in accordance with the sum tendered or a value determined in accordance with regulation **25(1B**) or **25 (7A)** of the Construction Industry Development Regulations for a 8**EP or higher** class of construction work, are eligible to submit tenders. **Award:** The contract will be awarded to one prospective bidder only
		Joint Ventures are eligible to submit tenders provided that: 1. The combined contractor grading designation calculated in accordance with the Construction Industry Development Regulations is equal to or higher than a contractor designation in accordance with the sum tendered for a 8**EP** class of construction work or a value determined in accordance with Regulation 25(1B) or 25(7A) of the Construction Industry Development Regulations. <u>Joint ventures are eligible to submit tenders provided that:</u> - • Every member of a joint venture must be registered with the CIDB Prior to the closing of tenders • Three contractors registered in contractor grading designation 7**EP.** • Any other joint venture will be acceptable if total is equal to 8**EP or higher.**
		STAGE 1: ADMINISTRATIVE COMPLIANCE All the bids will be evaluated against the administrative responsiveness requirements as set out in the list of returnable documents. A compulsory site meeting and briefing session to be held: **11.1 Stage 1: ADMINISTRATIVE COMPLIANCE.**

CLAUSE NUMBER	TENDER DATA
	All the bids will be evaluated against the administrative responsiveness requirements as set out in the list of returnable documents.

Compulsory Returnable Documentation (Submission of these are compulsory)	Submitted (YES or NO)	Checklist (Guide for Bidder and the Bid Evaluation Committee)
a) To enable The City to verify the bidder's tax compliance status, the bidder must provide; • Tax compliance status PIN. or • Central Supplier Database (CSD)		Tax status must be compliant before the award.
b) A copy of their Central Supplier Database (CSD) registration; or indicate their Master Registration Number / CSD Number;		CSD must be valid.
c) Confirmation that the bidding company's rates and taxes are up to date: Original or copy of Municipal Account Statement of the Bidder (bidding company) not older than 3 months and account must not be in arrears for more than ninety (90) days; or ,signed lease agreement or In case of bidders located in informal settlement, rural areas or areas where they are not required to pay Rates and Taxes a letter from the local councillor confirming they are operating in that area		Was a Municipal Account Statement, signed lease agreement or letter from the local councillor provided for the bidding company? The name and / or addresses of the bidder's statement correspond with CIPC document, Address on CSD or Company profile? Are all payment(s) up to date (i.e. not in arrears for more than 90 days?
d) In addition to the above, confirmation that all the bidding company's owners / members / directors / major shareholders rates and taxes are up to date: • Original or copy of Municipal Account Statement of all the South African based owners / members / directors / major shareholders not older than 3 months and the account/s may not be in arrears for more than ninety (90) days; or a signed lease agreement of owners / members / directors / major shareholders or In case of bidders located in informal settlement, rural areas or areas where they are not required to pay Rates and Taxes a letter from the local councillor confirming they are residing in that area		Was a Municipal Account Statement, signed lease agreement or letter from the local councillor provided for the bidding company? The name and / or addresses of the bidder's statement correspond with CIPC document, Address on CSD or Company profile? Are all payment(s) up to date (i.e. not in arrears for more than 90 days?
e) Duly Signed and completed MBD forms (MBD 1, 4, 5, 8 and 9) The person signing the bid documentation must be authorized to sign on behalf of the bidder. Where the signatory is not a Director / Member / Owner / Shareholder of the company, an official letter		All documents fully completed (i.e. no blank spaces)? All documents fully signed by (any director / member / trustee as indicated on the CIPC document, alternatively a delegation of authority would be required?

CLAUSE NUMBER	TENDER DATA		
	of authorization or delegation of authority should be submitted with the bid document. **NB: Bidders must ensure that the directors, trustees, managers, principal shareholders, or stakeholders of this company, declare any interest in any other related companies or business, whether or not they are bidding for this contract. *<u>See Question 3.14 of MBD 4.</u>* *<u>Failure to declare interest will result in a disqualification</u>***		Documents completed in black ink (i.e. no "Tippex" corrections, no pencil, no other colour ink, or **non-submission of the MBD forms**, will be considered)?
	f) Audited Financial Statements for the most recent three (3) years or Audited Financial Statements from date of existence for companies less than three years old. **NB**: The bidder must submit signed audited annual financial statements for the most recent three years, or if established for a shorter period, submit audited annual financial statements from date of establishment. If the bidder is not required by law to prepare signed annual financial statements for auditing purposes, then the bidder must submit proof that the bidder is not required by law to prepare audited financial statements.		Applicable for tenders above R10m in conjunction with MBD 5) Are Audited financial statements provided (Audited financials must be signed by auditor) Or proof that the bidder is not required by law to prepare audited financial statements.
	g) Joint Ventures (JV) – (Only applicable when the bidder tenders as a joint venture) Where the bidder bids as a joint venture (JV), the required or relevant documents as per (a) to (f) above must be provided for all JV parties. In addition to the above the bidder must submit a Joint Venture (JV) agreement signed by the relevant parties. **NB**: It is a condition of this bid that the successful bidder will continue with the same Joint Venture (JV) for the duration of the contract unless prior approval is obtained from the City.		If applicable. JV agreement provided? JV agreement complete and relevant? Agreement signed by all parties? All required documents as per (i.e. a to f) must be provided for all partners of the JV.
	h) Bidder attended a compulsory briefing session where applicable		A compulsory briefing register must be signed by the bidder. **Bidders will be disqualified should they fail to attend compulsory briefing session**
	i) Pricing schedule (All items must be quoted for in pricing schedule and if not, all items are quoted the bidder will be disqualified). Unless the tender is awarded per item or per section		Incomplete pricing schedule results in totals being incomparable. Bidder must be disqualified.

CLAUSE NUMBER	TENDER DATA

where the bidder only quoted the items or sections, they are interested in.		**Bidder will be disqualified should they make corrections on the price schedule without attaching a signature or initialising thereto.** **Bidder will be disqualified should they use tippex/ correction ink, on the price schedule.**

STAGE 2: MANDATORY AND TECHNICAL REQUIREMENTS

The tenderers must complete Schedule of Particulars and guarantees Part C2.1 Section 5.

The tenderers must offer and guarantee the specified requirement in the Schedule of Particulars.

The tenderer must complete Part C2.1 – Schedule of particulars and guarantee and submit type test certificates or reports (SABS/IEC) on all items indicated with (yes):

	Equipment	Certificate or Type test report(s)
C2.1.5.02.1.1	Circuit Breakers-132kV	yes
C2.1.5.02.1.2	Circuit Breakers-275kV	yes
C2.1.5.03.1.1	Disconnector Switches-132kV	yes
C2.1.5.03.1.2	Disconnector Switches-275kV	yes
C2.1.5.04.1.1	Surge Diverters-132kV	yes
C2.1.5.04.1.2	Surge Diverters-275kV	yes
C2.1.5.05.1.1	Voltage Transformers-132kV	yes
C2.1.5.05.1.2	Voltage Transformers-275kV	yes
C2.1.5.05.2.1	Current Transformers 132kV	yes
C2.1.5.05.2.2	Current Transformers 275kV	yes
C2.1.5.07.1.1	Insulators 132kV	yes
C2.1.5.07.1.2	Insulators 275kV	yes
C2.1.5.10.6.1	Transformer 300MVA (275/132kV)	yes
C2.1.5.10.6.1	275kV transformer bushings	Yes
C2.1.5.10.6.1	132kV transformer bushings	Yes

IF TEST CERTIFICATES TEST/ REPORTS ARE NOT SUBMITTED THEN THE BIDDER WILL BE AUTOMATICALLY DISQUALIFIED (CATALOGUE CERTIFICATES ARE NOT ACCEPTABLE).

The tenderers must offer and guarantee the specified requirements in the Schedule of Particulars and Guarantee.

Bids that do not meet these requirements will be disqualified.

CLAUSE NUMBER	TENDER DATA
	Form RD.D.1 Evaluation schedule (Test Certificates or reports for electrical equipment must be filled in full) Form RDE 6P Verification of Schedule of Particulars and Guarantees must be fully completed and signed.

FINANCIAL CAPABILITY

Tenderers to complete Form RDC 11 on T2

RD.C.11	The tenderer must provide bank rating not older than three months indicating their Bank Rating before closing of tender. (Note: Attach original copy of Bank Stamped Letter or original certified copy of Bank Stamped Letter)

Only tenders with bank ratings of A, B and C will be considered. Any bank rating below C shall be disqualified and will not be evaluated further

It is compulsory to complete Form RD.D.3 and attach certified copies of qualifications of engineer/s and attach ECSA registration/s as a professional	The bidder must have in his/her company a minimum of one or two engineer(s) or technologist(s) who possess qualifications in electrical and Civil or structural engineering. **Qualifications and experience requirements** • Electrical Engineer/ Technologist NQF 7 or higher with ECSA registration as Professional and minimum of 3 years' experience in electrical field of testing and commissioning on electrical equipment post registration • Civil or Structural engineer with ECSA registration as Professional and minimum of 3 years' experience in substation building or design after registration NB: Engineer who possesses Electrical and Civil/Structural qualifications with active registrations with Engineering Council of South Africa on both disciplines will be considered for both Electrical and Civil

STAGE 3: FUNCTIONALITY EVALUATION

The following criteria and weights will be applied when bids are assessed for functionality.

NO	CRITERIA	SUB-CRITERIA	SCALE	WEIGHT	HIGHEST POSSIBLE SCORE

CLAUSE NUMBER	TENDER DATA				
1	**TRACK RECORD OF THE COMPANY IN EXECUTING TURNKEY PROJECTS** Complete Form RD.D.2 and attach signed copies of contract appointment letters and project completion certificates for work successfully completed by the tenderer. Completed projects must be turnkey which includes (design, supply, delivery, installation, testing, and commissioning of electrical substation). Only completed projects of High/Medium Voltage substations will be considered. (i.e.132/11kV) or Higher NB The projects completed must be of building and/or refurbishment of Electrical Substations that includes the following as minimum (Power transformers, Circuit breakers, Isolators, Switchgear Panels, SCADA & Batteries) Complete Form RD.D.2 and attach signed copies of contract appointment letters and project completion certificates for work successfully completed by the tenderer (Failure to complete Form RD.D.2 and attachment of supporting documents will result in automatic disqualification) NB: Only projects with verifiable documentary proof in the form of appointment letter(s) and completion certificate(s) will be considered and awarded points.	Appointment letters and Completion certificates for at least three projects with accumulated value between R10 million and R30 million	1	5	35
		Appointment letters and Completion certificates for at least three projects with accumulated value between R31 million and R60 millions	3		
		Appointment letters and Completion certificates for at least three projects with accumulated value between R61 million and R90 million at least 2 projects)	5		
		Appointment letters and completion certificates for a minimum of three projects with	7		

CLAUSE NUMBER	TENDER DATA					
			accumulated value of R91 million and above			
	2	**KEY PERSONNEL EXPERIENCE** The tenderer must have in his employees, personnel engineers with experience in Electrical, Civil Engineering and Project Management in electrical turnkey projects: Years of experience as professional Electrical Engineer/Technologist/ Project Manager after registration from the professional body It is compulsory to complete Form RD.D.3 and attach <u>certified copies</u> of qualifications of key personnel, proof of registrations	ECSA Electrical and Structural or Civil Engineering registration and detailed CV indicating years of staff's experience in Electrical and Civil or Structural engineering**.** SACPCMP (South African Council for Project and Construction Management Professions) registration and detailed CV indicating years of experience in building and commissioning of electrical projects There must be a minimum of 1 key personnel for each discipline. • Professional Electrical Engineer or Professional technologist electrical • Professional Civil of Structural engineer Professional technologist • Professional project manager)			
			SUB-CRITERIA SCALE	SCALE	WEIGHT	HIGHEST POSSIBLE SCORE
		Total sum of years of experience as Professional Electrical Engineer(s) Technologist(s) post registration from Engineering Council of South Africa	3-5 Years 6-8 Years 9 Years or more	1 2 3	5	15

CLAUSE NUMBER	**TENDER DATA**

	Total sum of years of experience as Professional Civil or Structural Engineer(s) or Technologist(s) post registration from Engineering Council of South Africa	3-5 Years 6-8 Years 9 Years or more	1 2 3	5	15
	Total sum of years of experience in Construction Project Manager post registration to professional body	3-5 Years 6-8 Years 9 Years or more	1 2 3	5	15
	It is compulsory to complete Form RD.D.3 and attach certified copies of qualifications and registrations of key personnel as mentioned.				
3	**QUALITY MANAGEMENT SYSTEM** The tenderer must describe the construction quality system incorporated by the tenderer in his organisation and which will be applicable to this Contract (RD.D 4) Evaluation schedule: Quality Management System form to be filled by the tender	Provide company's ISO 9001 quality compliance certificate	1	10	10
		Provide company's ISO 14001 compliance certificate	1	10	10
	HIGHEST POSSIBLE SCORE				**100**

The maximum possible score that can be achieved for functionality is 100.

Bids that do not achieve a minimum score of 70 (out of 100) for functionality will not be evaluated further.

CLAUSE NUMBER	TENDER DATA
	STAGE 4: PREFERENCIAL POINTS SYSTEM

The preferential point system used will be the 90/10 points system in terms of the Preferential Procurement Policy Framework Act, 2000 (Act 5 of 2000) Regulations 2022.

- 90 points for price
- 10 points for Specific goals

Specific Goals

- Bidders are required to submit supporting documents for their bids to claim the specific goal points.
- Non-compliance with specific goals will not lead to disqualification but bidders will not be allocated specific goal points. Bidders will score points out of 90 for price only and zero (0) points out of 10 for specific goals.
- City of Tshwane shall act against any bidder or person when it detects that the specific goals were claimed or obtained on a fraudulent basis.

The specific goal for this bid is outlined below.

Specific goals	90/10 preference point system	Proof of specific goals to be submitted
BB-BEE score of companies • Level 1 • Level 2 • Level 3 • Level 4 • Level 5 • Level 6 • Level 7 • Level 8 • Non-compliant	• 4 Points • 3.5 Points • 3 Points • 2.5 Points • 2 Points • 1.5 Points • 1 Point • 0.5 Points 0 Points	Valid Certified copy of BBBEE certificate Sworn Affidavit for B-BBEE qualifying small enterprise or Exempt Micro Enterprises or CIPC BBBEE certificate.
EME and/ or QSE	1 Point	Valid Sworn affidavit for B-BBEE qualifying small enterprise or Exempt Micro Enterprises or CIPC BBBEE certificate
At least 51% of Women-owned companies	1 Point	Certified copy of Identity Document/s **and** proof of ownership (Sworn affidavit for B-BBEE qualifying small enterprise or Exempt Micro Enterprises, CIPC

CLAUSE NUMBER		TENDER DATA

		registration or any other proof of ownership)
At least 51% owned companies by People with disability	1 Point	Medical Certificate with doctor's details (Practice Number, Physical Address, and contact numbers) and proof of ownership (Sworn affidavit for B-BBEE qualifying small enterprise or Exempt Micro Enterprises, CIPC registration or any other proof of ownership
At least 51% owned companies by Youth	1 Point	Certified copy of Identity Document/s **and** proof of ownership (Sworn affidavit for B-BBEE qualifying small enterprise or Exempt Micro Enterprises, CIPC registration or any other proof of ownership
Local Economic Participation • City of Tshwane • Gauteng • National	2 Points 1 Point 1 Point	Municipal Account statement/Lease agreement.

For points to be allocated as per above the tenderers will be required to submit proof of documentation as evidence for claims made. Any tenderer that does not submit evidence as stated in the bid document to claim applicable points will be allocated zero points.

i. The service provider must comply to the Occupational Health and Safety Act 85 of 1993 and its regulation. OHS plan must be submitted with tender documents

CLAUSE NUMBER		TENDER DATA
C.2.2	Cost of Tendering	The employer **will not** compensate the tenderer for any costs incurred in attending interviews or making any submissions in the office of the employer.
C.2.7	Clarification meeting	The arrangements for a **compulsory** clarification meeting are as stated in the tender notice and invitation to tender Confirmation of attendance will be recorded on site in the attendance register to be signed by all tenderers. Addenda will be issued to and tenders received from those tendering entities appearing on the attendance register. **Tender documents will not be made available at the clarification meeting**.
C.2.8	Seek clarification	*Request clarification of the tender documents, if necessary, by notifying the employer at least* ***5 (Five) working days*** ***before the closing time stated in the tender data.***
C.2.9	Insurance	*Accept that the submission of a tender shall be construed as an acknowledgement by the tenderer that he is satisfied with, where applicable, the insurance cover the employer will affect under the contract.*

CLAUSE NUMBER	TENDER DATA
C.2.12 Alternative offers C.2.12.3	Alternative offers will only be considered if tenderer(s) have submitted a fully completed main offer. For alternative offers a complete separate detailed activity, quantities and bill/price schedule must be submitted as a separate document. Alternative tender offer will only be considered if the main offer is the winning tender.
C2.13. Submitting a tender offer C2.13.1 C2.13.2 C2.13.3 C2.13.4 C2.13.5	Submit one tender offer only, either as a single tendering entity or as a member in a joint venture to provide the whole of the works, services or supply identified in the contract data described in the scope of work, unless stated otherwise in the tender data. Return all returnable documents to the employer after completing them in their entirety, by writing legibly in non- erasable ink. *Submit the parts of the tender offer communicated on paper as an original plus the number of copies stated in the tender data, with an English translation of any documentation in a language other than English, and the parts communicated electronically in the same format as they were issued by the employer.* *Sign the original and all copies of the tender offer where required in terms of the tender data. The employer will hold all authorized signatories liable on behalf of the tenderer signatories for tenderers proposing to contract as joint ventures shall state which of the signatories is the lead partner whom the employer shall hold liable for the purpose of the tender offer.* *Seal the original tender offer and each of the tender offer as separate packages marking the packages as ORIGINAL and COPY. Each package shall state on the outside of the employer's address and identification details stated in the tender data, as well as the tenderers name and contact address.* The identification details are: Tender Reference: **EEBU 07-2025/26** Tender Description*:* **TENDER FOR THE SUPPLY, DELIVERY, INSTALLATION, TESTING AND COMMISSIONING OF 1x300MVA POWER TRANSFORMER AT KWAGGA 275/132KV SUBSTATION FOR A PERIOD OF THREE (3) YEARS** *Closing Time:* 10 :00 AM *Closing Date:* *19 February 2026* *Each tender shall be enclosed in a sealed envelope, bearing the correct identification details and shall be placed in the tender box located at:* ***PROCUREMENT ADVICE CENTRE*** ***(TENDER BOX AT)*** ***Tshwane House*** ***320 Madiba Street*** ***PRETORIA CBD*** ***0002***

CLAUSE NUMBER	TENDER DATA
	This address is 24 hours available for delivery of tender offers.
C2.13.6	*Where a two-envelope system is required in terms of the tender data, place and seal the returnable documents listed in the tender data in an envelope marked —financial proposal‖ and place the remaining returnable documents in an envelope marked —technical proposal‖. Each envelope shall state on the outside the employer's address and identification details stated in the tender data, as well as the tenderer's name and contact address.*
C2.13.7	*Seal the original tender offer and copy packages together in an outer package that states on the outside only the employer's address and identification details as stated in the tender data.*
C2.13.8	*Accept that the employer will not assume any responsibility for the misplacement or premature opening of the tender offer if the outer package is not sealed and marked as stated* *Accept that tender offers submitted by facsimile or e-mail will be rejected by the employer, unless stated otherwise in the tender data.*
C2.13.9	*Only authorised signatories may sign the original and all copies of the tender offer where required.* *In the case of a ONE-PERSON CONCERN submitting a tender, this shall be clearly stated.* *In the case of a* ***COMPANY*** *submitting a tender, include a copy of a* ***resolution by its board of directors*** *authorising a director or other official of the company to sign the documents on behalf of the company.* *In the case of a* ***CLOSE CORPORATION*** *submitting a tender, include a copy of a* ***resolution by its members*** *authorising a member or other official of the corporation to sign the documents on each member's behalf.* *In the case of a* ***PARTNERSHIP*** *submitting a tender,* ***all the partners*** *shall sign the documents, unless one partner or a group of partners has been authorised to sign on behalf of each partner, in which case* ***proof of such authorisation*** *shall be included in the Tender.* *In the case of a* ***JOINT VENTURE/CONSORTIUM*** *submitting a tender, include* ***a resolution of each company*** *of the joint venture together with a* ***resolution by its members*** *authorising a member of the joint venture to sign the documents on behalf of the joint venture.* ***Accept that failure to submit proof of authorisation to sign the tender shall result in the tender offer being regarded as non-responsive.***
C.2.14 Information and data to be completed in all respects	Accept that tender offers, which do not provide all the data or information requested completely and in the form required, may be regarded by the employer as non-responsive.
C.2.15 Closing time	The closing time for submission of tender offers is stated in the tender notice and invitation to tender.

CLAUSE NUMBER		TENDER DATA
C.2.16 *C.2.16.5*	Tender offer validity	The tender offer validity period is **90 days**. **<u>Add</u>** the following new clause *In the case of a Joint Venture/Consortium/Sub-contractors each party must submit a separate original Tax Clearance Certificate.*
C.2.18	Provide other material	The tenderer shall, when requested by the employer to do so, submit the names of all management and supervisory staff that will be employed to supervise the labour-intensive portion of the works together with satisfactory evidence that such staff members satisfy the eligibility requirements.
C.2.19	Inspection, tests and analysis	The tenderer shall, when requested provide access during working hours to premises for inspections, tests and analysis as provided for in the tender data.
C2.20	Submit securities, bonds, policies, etc.	The tenderer is required to submit with his tender a letter of intent from an approved insurer undertaking to provide the performance bond to the format included in Section C1.3 of this procurement document.
C2.23	Certificates	Refer to part T2 of this procurement document for a list of the documents that are to be returned with the tender.
C2.24	Conditions Associated with the Granting of Preferences	**<u>Add</u>** the following new clause The Tenderer, undertakes to: a) engage one or more Targeted Enterprises / Targeted Labour in accordance with the provisions of the SANS 1914 as varied in the Procurement Section of the Scope of Works; b) deliver to the Employer, within 5 working days of being requested in writing to do so, a Targeted Enterprise Declaration Affidavit in respect of all Targeted Enterprises engaged at prime contract level to satisfy Contract Participation Goal requirements; c) Accept the sanctions set out in the Scope of Works should such conditions be breached.
C2.25	*Canvassing and obtaining of additional information by tenderers*	**<u>Add</u>** the following new clause *The Tenderer shall not make any attempt either directly or indirectly to canvass any of the Employer's officials or the Employer's agent in respect of his tender, after the opening of the tenders but prior to the Employer arriving at a decision thereon.* *The Tenderer shall not make any attempt to obtain particulars of any relevant information, other than that disclosed at the opening of tenders.*
C2.26	*Prohibitions on awards to persons in service of the state*	**<u>Add</u>** the following new clause *The Employer is prohibited to award a tender to a person -* *a) who is in the service of the state; or* *b) if that person is not a natural person, of which any director, manager, principal shareholder or stakeholder is a person in the service of the state; or* *c) a person who is an advisor or consultant contracted with the municipality or municipal entity.* ***In the service of the state*** *means to be -*

CLAUSE NUMBER		TENDER DATA
		a) a member of:- *• any municipal council;* *• any provincial legislature; or* *• the National Assembly or the National Council of Provinces;* *b) a member of the board of directors of any municipal entity;* *c) an official of any municipality or municipal entity;* *d) an employee of any national or provincial department;* *e) provincial public entity or constitutional institution within the meaning of the Public Finance Management Act, 1999 (Act No.1 of 1999);* *f) a member of the accounting authority of any national or provincial public entity; or* *g) an employee of Parliament or a provincial legislature.* In order to give effect to the above, the questionnaire for the declaration of interests in the tender of persons in service of state in part T2 of this procurement document must be completed.
C2.27	*Awards to close family members of persons in the service of the state*	**Add** the following new clause *Accept that the notes to the Employer's annual financial statements must disclose particulars of any award of more than R2000 to a person who is a spouse, child or parent of a person in the service of the state (defined in clause C2.25), or has been in the service of the state in the previous twelve months, including -* *a) the name of that person;* *b) the capacity in which that person is in the service of the state; and* *c) the amount of the award.* In order to give effect to the above, the questionnaire for the declaration of interests in the tender of persons in service of state in part T2 of this procurement document must be completed.
C2.28	*Vendor registration*	**Add** the following new clause *The contractor will required registering as a supplier/ service provider on the City of Tshwane's vendor register before any payment can be done.* *If the tenderer is already registered as a vendor, it is required to record the vendor number in space provided on the cover page of this Tender document.* *Vendor registration documents and support is available from the Procurement Advice Centre or from https://vendorportal.tshwane.gov.za/ All parties of a joint venture or consortium submitting a tender shall comply with the requirements of this clause.*
C2.29	*Tax*	**Add** the following new clause *An original tax clearance certificate must be submitted with this tender document.* *In the case of a Joint Venture/Consortium the tax clearance certificates must be individual original tax clearance certificates for the members of the Joint Venture/Consortium are not acceptable.*
C.3.1	Respond to requests from the tenderer	
C.3.1.1		The employer will respond to requests for clarification up to 5 **(seven) working days** before the tender closing time.

CLAUSE NUMBER		TENDER DATA
C.3.4	Opening of tender submissions	Tenders will be opened immediately after the closing time for tenders.
C3.11.3	Scoring	The following criteria and weights will be applied when bids are assessed for functionality Quality shall be scored by not less than three evaluators in accordance with the following schedules contained in T2.2 Returnable Schedules: RD.D.2 Evaluation Schedule: Schedule of tenderer's experience RD.D.3 Evaluation Schedule: Key personnel experience RD.D.4 Evaluation Schedule: Quality Management System
C.3.13	Acceptance of Tender Offer	Tender offers will only be accepted if: a.) the tenderer has complied in full with the all eligibility criteria b.) the tenderer is able to produce an original Tax Clearance Certificate issued by the South African Revenue Service; c.) the tenderer submits a letter of intent from an approved insurer undertaking to provide to provide the Performance Bond to the format included in Section C1.3 of this procurement document; d.) the tenderer is registered with the Construction Industry Development Board in an appropriate contractor grading designation. e.) the tenderer is not in arrears for more than 3 months with municipal rates and taxes and municipal service charges; f.) the tenderer or any of its directors is not listed on the Register of Tender Defaulters in terms of the Prevention and Combating of Corrupt Activities Act of 2004 as a person prohibited from doing business with the public sector; g.) the tenderer has not: i) abused the Employer's Supply Chain Management System; or ii) failed to perform on any previous contract and has been given a written notice to this effect. h.) the tenderer has completed the Compulsory Enterprise Questionnaire and there are no conflicts of interest which may impact on the tenderer's ability to perform the contract in the best interests of the employer or potentially compromise the tender process and persons in the employ of the state are permitted to submit tenders or participate in the contract; i.) the tenderer is registered and in good standing with the compensation fund or with a licensed compensation insurer; j.) the employer is reasonably satisfied that the tenderer has in terms of the Construction Regulations, 2003, issued in terms of the Occupational Health and Safety Act, 1993, the necessary competencies and resources to carry out the work safely.
C.3.17	Copies of Contract	**One** signed copy of contract shall be provided by the Employer to the successful Tenderer.

T1.3 STANDARD CONDITIONS OF TENDER

TABLE OF CONTENTS

C.1 General

C.1.1 Actions

C.1.1.1 The Employer and each tenderer submitting a tender offer shall comply with these conditions of tender. In their dealings with each other, they shall discharge their duties and obligations as set out in C.2 and C.3, timeously and with integrity, and behave equitably, honestly and transparently, comply with all legal obligations and not engage in anticompetitive practices.

C.1.1.2 The Employer and the tenderer and all their agents and employees involved in the tender process shall avoid conflicts of interest and where a conflict of interest is perceived or known, declare any such conflict of interest, indicating the nature of such conflict. Tenderers shall declare any potential conflict of interest in their tender submissions. Employees, agents and advisors of the Employer shall declare any conflict of interest to whoever is responsible for overseeing the procurement process at the start of any deliberations relating to the procurement process or as soon as they become aware of such conflict, and abstain from any decisions where such conflict exists or recuse themselves from the procurement process, as appropriate.

Note:

1) *A conflict of interest may arise due to a conflict of roles which might provide an incentive for improper acts in some circumstances. A conflict of interest can create an appearance of impropriety that can undermine confidence in the ability of that person to act properly in his or her position even if no improper acts result.*

2) *Conflicts of interest in respect of those engaged in the procurement process include direct, indirect or family interests in the tender or outcome of the procurement process and any personal bias, inclination, obligation, allegiance or loyalty which would in any way affect any decisions taken.*

C.1.1.3 The Employer shall not seek and a tenderer shall not submit a tender without having a firm intention and the capacity to proceed with the contract.

C.1.2 Tender Documents

The documents issued by the Employer for the purpose of a tender offer are listed in the tender data.

C.1.3 Interpretation

C.1.3.1 The tender data and additional requirements contained in the tender schedules that are included in the returnable documents are deemed to be part of these conditions of tender.

C.1.3.2 These conditions of tender, the tender data and tender schedules which are only required for tender evaluation purposes, shall not form part of any contract arising from the invitation to tender.

C.1.3.3 For the purposes of these conditions of tender, the following definitions apply:

a) **conflict of interest** means any situation which:

i) someone in a position of trust has competing professional or personal interests which make it difficult to fulfil his or her duties impartially;

ii) an individual or organisation is in a position to exploit a professional or official capacity in some way for their personal or corporate benefit; or

iii) incompatibility or contradictory interests exist between an employee and the organisation which employs that employee.

b) **comparative price** means the price after the factors of a non-firm price and all unconditional discounts it can be utilised to have been taken into consideration;

c) **corrupt practice** means the offering, giving, receiving or soliciting of anything of value to influence the action of the Employer or his staff or agents in the tender process;

d) **fraudulent practice** means the misrepresentation of the facts in order to influence the tender process or the award of a contract arising from a tender offer to the detriment of the Employer, including collusive practices intended to establish prices at artificial levels;

e) **organization** means a company, firm, enterprise, association or other legal entity, whether incorporated or not, or a public body;

f) **functionality** means the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs

C.1.4 Communication and Employer's agent

Each communication between the Employer and a tenderer shall be to or from the Employer's agent only, and in a form that can be readily read, copied and recorded. Communications shall be in the English language. The Employer shall not take any responsibility for non-receipt of communications from or by a tenderer. The name and contact details of the Employer's agent are stated in the tender data.

C.1.5 Cancellation and re-invitation of tenders

C.1.5.1 An organ of state may, prior to the award of the tender, cancel the tender if-

(a) due to changed circumstances, there is no longer a need for the services, works or goods requested; or

(b) funds are no longer available to cover the total envisaged expenditure; or

(c) no acceptable tenders are received.

C.1.5.2 The decision to cancel the tender must be published in the CIDB website and in the Tender Bulletin for the media in which the original tender invitation as advertised.

C.1.6 Procurement procedures

C.1.6.1 General

Unless otherwise stated in the tender data, a contract will, subject to C.3.13, be concluded with the tenderer who in terms of C.3.11 is the highest ranked or the tenderer scoring the highest number of tender evaluation points, as relevant, based on the tender submissions that are received at the closing time for tenders.

C.1.6.2 Competitive negotiation procedure

C.1.6.2.1 Where the tender data require that the competitive negotiation procedure is to be followed, tenderers shall submit tender offers in response to the proposed contract in the first round of submissions. Notwithstanding the requirements of C.3.4, the Employer shall announce only the names of the tenderers who make a submission. The requirements of C.3.8 relating to the material deviations or qualifications which affect the competitive position of tenderers shall not apply.

C.1.6.2.2 All responsive tenderers, or not less than three responsive tenderers that are highest ranked in terms of the evaluation method and evaluation criteria stated in the tender data, shall be invited in each round to enter competitive negotiations, based on the principle of equal treatment and keeping confidential the proposed solutions and associated information. Notwithstanding the provisions of C.2.17, the Employer may request that tenders be clarified, specified, and fine-tuned in order to improve a tenderer's competitive position provided that such clarification, specification, fine-tuning or additional information does not alter any fundamental aspects of the offers or impose substantial new requirements which restrict or distort competition or have a discriminatory effect.

C.1.6.2.3 At the conclusion of each round of negotiations, tenderers shall be invited by the Employer to make a fresh tender offer, based on the same evaluation criteria, with or without adjusted weightings. Tenderers shall be advised when they are to submit their best and final offer.

C.1.6.2.4 The contract shall be awarded in accordance with the provisions of C.3.11 and C.3.13 after tenderers have been requested to submit their best and final offer.

C.1.6.3 Proposal procedure using the two stage-system

C.1.6.3.1 Option 1

Tenderers shall in the first stage submit technical proposals and, if required, cost parameters around which a contract may be negotiated. The Employer shall evaluate each responsive submission in terms of the method of evaluation stated in the tender data, and in the second stage negotiate a contract with the tenderer scoring the highest number of evaluation points and award the contract in terms of these conditions of tender.

C.1.6.3.2 Option 2

C.1.6.3.2.1 Tenderers shall submit in the first stage only technical proposals. The Employer shall invite all responsive tenderers to submit tender offers in the second stage, following the issuing of procurement documents.

C.1.6.3.2.2 The Employer shall evaluate tenders received during the second stage in terms of the method of evaluation stated in the tender data and award the contract in terms of these conditions of tender.

C.2 Tenderer's obligations

C.2.1 Eligibility

C.2.1.1 Submit a tender offer only if the tenderer satisfies the criteria stated in the tender data and the tenderer, or any of his principals, is not under any restriction to do business with Employer.

C.2.1.2 Notify the Employer of any proposed material change in the capabilities or formation of the tendering entity (or both) or any other criteria which formed part of the qualifying requirements used by the Employer as the basis in a prior process to invite the tenderer to submit a tender offer and obtain the Employer's written approval to do so prior to the closing time for tenders.

C.2.2 Cost of tendering

C.2.2.1 Accept that, unless otherwise stated in the tender data, the Employer will not compensate the tenderer for any costs incurred in the preparation and submission of a tender offer, including the costs of any testing necessary to demonstrate that aspects of the offer complies with requirements.

C.2.2.2 The cost of the tender documents charged by the Employer shall be limited to the actual cost incurred by the Employer for printing the documents. Employers must attempt to make available the tender documents on its website so as not to incur any costs pertaining to the printing of the tender documents.

C.2.3 Check documents

Check the tender documents on receipt for completeness and notify the Employer of any discrepancy or omission.

C.2.4 Confidentiality and copyright of documents

Treat as confidential all matters arising in connection with the tender. Use and copy the documents issued by the Employer only for the purpose of preparing and submitting a tender offer in response to the invitation.

C.2.5 Reference documents

Obtain, as necessary for submitting a tender offer, copies of the latest versions of standards, specifications, conditions of contract and other publications, which are not attached but which are incorporated into the tender documents by reference.

C.2.6 Acknowledge addenda

Acknowledge receipt of addenda to the tender documents, which the Employer may issue, and if necessary, apply for an extension to the closing time stated in the tender data, in order to take the addenda into account.

C.2.7 Clarification meeting

Attend, where required, a clarification meeting at which tenderers may familiarize themselves with aspects of the proposed work, services or supply and raise questions. Details of the meeting(s) are stated in the tender data.

C.2.8 Seek clarification

Request clarification of the tender documents, if necessary, by notifying the Employer at least five working days before the closing time stated in the tender data.

C.2.9 Insurance

Be aware that the extent of insurance to be provided by the Employer (if any) might not be for the full cover required in terms of the conditions of contract identified in the contract data. The tenderer is advised to seek qualified advice regarding insurance.

C.2.10 Pricing the tender offer

C.2.10.1 Include in the rates, prices, and the tendered total of the prices (if any) all duties, taxes (except Value Added Tax (VAT), and other levies payable by the successful tenderer, such duties, taxes and levies being those applicable 14 days before the closing time stated in the tender data.

C.2.10.2 Show VAT payable by the Employer separately as an addition to the tendered total of the prices.

C.2.10.3 Provide rates and prices that are fixed for the duration of the contract and not subject to adjustment except as provided for in the conditions of contract identified in the contract data.

C.2.10.4 State the rates and prices in Rand unless instructed otherwise in the tender data. The conditions of contract identified in the contract data may provide for part payment in other currencies.

C.2.11 Alterations to documents

Do not make any alterations or additions to the tender documents, except to comply with instructions issued by the Employer, or necessary to correct errors made by the tenderer. All signatories to the tender offer shall initial all such alterations.

C.2.12 Alternative tender offers

C.2.12.1 Unless otherwise stated in the tender data, submit alternative tender offers only if a main tender offer, strictly in accordance with all the requirements of the tender documents, is also submitted as well as a schedule that compares the requirements of the tender documents with the alternative requirements that are proposed.

C.2.12.2 Accept that an alternative tender offer may be based only on the criteria stated in the tender data or criteria otherwise acceptable to the Employer.

C.2.12.3 An alternative tender offer may only be considered if the main tender is the winning tender.

C.2.13 Submitting a tender offer

C.2.13.1 Submit one tender offer only, either as a single tendering entity or as a member in a joint venture to provide the whole of the works, services or supply identified in the contract data and described in the scope of works, unless stated otherwise in the tender data.

C.2.13.2 Return all returnable documents to the Employer after completing them in their entirety, either electronically (if they were issued in electronic format) or by writing legibly in non-erasable ink.

C.2.13.3 Submit the parts of the tender offer communicated on paper as an original plus the number of copies stated in the tender data, with an English translation of any documentation in a language other than English, and the parts communicated electronically in the same format as they were issued by the Employer.

C.2.13.4 Sign the original and all copies of the tender offer where required in terms of the tender data. The Employer will hold all authorized signatories liable on behalf of the tenderer. Signatories for tenderers proposing to contract as joint ventures shall state which of the signatories is the lead partner whom the Employer shall hold liable for the purpose of the tender offer.

C.2.13.5 Seal the original and each copy of the tender offer as separate packages marking the packages as "ORIGINAL" and "COPY". Each package shall state on the outside the Employer's address and identification details stated in the tender data, as well as the tenderer's name and contact address.

C.2.13.6 Where a two-envelope system is required in terms of the tender data, place and seal the returnable documents listed in the tender data in an envelope marked "financial proposal" and place the remaining returnable documents in an envelope marked "technical proposal". Each envelope shall state on the outside the Employer's address and identification details stated in the tender data, as well as the tenderer's name and contact address.

C.2.13.7 Seal the original tender offer and copy packages together in an outer package that states on the outside only the Employer's address and identification details as stated in the tender data.

C.2.13.8 Accept that the Employer will not assume any responsibility for the misplacement or premature opening of the tender offer if the outer package is not sealed and marked as stated.

C.2.13.9 Accept that tender offers submitted by facsimile or e-mail will be rejected by the Employer, unless stated otherwise in the tender data.

C.2.14 Information and data to be completed in all respects

Accept that tender offers, which do not provide all the data or information requested completely and in the form required, may be regarded by the Employer as non-responsive.

C.2.15 Closing time

C.2.15.1 Ensure that the Employer receives the tender offer at the address specified in the tender data not later than the closing time stated in the tender data. Accept that proof of posting shall not be accepted as proof of delivery.

C.2.15.2 Accept that, if the Employer extends the closing time stated in the tender data for any reason, the requirements of these conditions of tender apply equally to the extended deadline.

C.2.16 Tender offer validity

C.2.16.1 Hold the tender offer(s) valid for acceptance by the Employer at any time during the validity period stated in the tender data after the closing time stated in the tender data.

C.2.16.2 If requested by the Employer, consider extending the validity period stated in the tender data for an agreed additional period, but no longer than 12 weeks.

C.2.16.3 Accept that a tender submission that has been submitted to the Employer may only be withdrawn or substituted by giving the Employer's agent written notice before the closing time for tenders that a tender is to be withdrawn or substituted.

C.2.16.4 Where a tender submission is to be substituted, submit a substitute tender in accordance with the requirements of C.2.13 with the packages clearly marked as "SUBSTITUTE".

C.2.17 Clarification of tender offer after submission

Provide clarification of a tender offer in response to a request to do so from the Employer during the evaluation of tender offers. This may include providing a breakdown of rates or prices and correction of arithmetical errors by the adjustment of certain rates or item prices (or both). No change in the competitive position of tenderers or substance of the tender offer is sought, offered, or permitted.

Note: *Sub-clause C.2.17 does not preclude the negotiation of the final terms of the contract with a preferred tenderer following a competitive selection process, should the Employer elect to do so.*

C.2.18 Provide other material

C.2.18.1 Provide, on request by the Employer, any other material that has a bearing on the tender offer, the tenderer's commercial position (including notarized joint venture agreements), preferencing arrangements, or samples of materials, considered necessary by the Employer for the purpose of a full and fair risk assessment. Should the tenderer not provide the material, or a satisfactory reason as to why it cannot be provided, by the time for submission stated in the Employer's request, the Employer may regard the tender offer as non-responsive.

C.2.18.2 Dispose of samples of materials provided for evaluation by the Employer, where required.

C.2.19 Inspections, test and analysis

Provide access during working hours to premises for inspections, tests and analysis as provided for in the tender data.

C.2.20 Submit securities, bonds and policies

If requested, submit for the Employer's acceptance before formation of the contract, all securities, bonds, guarantees, policies and certificates of insurance required in terms of the conditions of contract identified in the contract data.

C.2.21 Check final draft

Check the final draft of the contract provided by the Employer within the time available for the Employer to issue the contract.

C.2.22 Return of other tender documents

If so instructed by the Employer, return all retained tender documents within 28 days after the expiry of the validity period stated in the tender data.

C.2.23 Certificates

Include in the tender submission or provide the Employer with any certificates as stated in the tender data.

C.3 The Employer's undertakings

C.3.1 Respond to requests from the tenderer

C.3.1.1 Unless otherwise stated in the tender data respond to a request for clarification received up to five working days before the tender closing time stated in the Tender Data and notify all tenderers who drew procurement documents.

C.3.1.2 Consider any request to make a material change in the capabilities or formation of the tendering entity (or both) or any other criteria which formed part of the qualifying requirements used to prequalify a tenderer to submit a tender offer in terms of a previous procurement process and deny any such request if as a consequence:

a) an individual firm, or a joint venture as a whole, or any individual member of the joint venture fails to meet any of the collective or individual qualifying requirements.

b) the new partners to a joint venture were not prequalified in the first instance, either as individual firms or as another joint venture; or

c) in the opinion of the Employer, acceptance of the material change would compromise the outcome of the prequalification process.

C.3.2 Issue addenda

If necessary, issue addenda that may amend or amplify the tender documents to each tenderer during the period from the date that tender documents are available until three days before the tender closing time stated in the Tender Data. If, as a result a tenderer applies for an extension to the closing time stated in the Tender Data, the Employer may grant such extension and, shall then notify all tenderers who drew documents.

C.3.3 Return late tender offers

Return tender offers received after the closing time stated in the Tender Data, unopened, (unless it is necessary to open a tender submission to obtain a forwarding address), to the tenderer concerned.

C.3.4 Opening of tender submissions

C.3.4.1 Unless the two-envelope system is to be followed, open valid tender submissions in the presence of tenderers’ agents who choose to attend at the time and place stated in the tender data. Tender submissions for which acceptable reasons for withdrawal have been submitted will not be opened.

C.3.4.2 Announce at the meeting held immediately after the opening of tender submissions, at a venue indicated in the tender data, the name of each tenderer whose tender offer is opened and, where applicable, the total of his prices, and time for completion for the main tender offer only.

C.3.4.3 Make available the record outlined in C.3.4.2 to all interested persons upon request.

C.3.5 Two-envelope system

C.3.5.1 Where stated in the tender data that a two-envelope system is to be followed, open only the technical proposal of valid tenders in the presence of tenderers’ agents who choose to attend at the time and place stated in the tender data and announce the name of each tenderer whose technical proposal is opened.

C.3.5.2 Evaluate functionality of the technical proposals offered by tenderers, then advise tenderers who remain in contention for the award of the contract of the time and place when the financial proposals will be opened. Open only the financial proposals of tenderers, who score in the functionality evaluation more than the minimum number of points for functionality stated in the tender data, and announce the score obtained for the technical proposals and the total price and any points claimed on BBBEE status level. Return unopened financial proposals to tenderers whose technical proposals failed to achieve the minimum number of points for functionality

C.3.6 Non-disclosure

Not disclose to tenderers, or to any other person not officially concerned with such processes, information relating to the evaluation and comparison of tender offers, the final evaluation price and recommendations for the award of a contract, until after the award of the contract to the successful tenderer.

C.3.7 Grounds for rejection and disqualification

Determine whether there has been any effort by a tenderer to influence the processing of tender offers and instantly disqualify a tenderer (and his tender offer) if it is established that he engaged in corrupt or fraudulent practices.

C.3.8 Test for responsiveness

C.3.8.1 Determine, after opening and before detailed evaluation, whether each tender offer properly received:

a) complies with the requirements of these Conditions of Tender,

b) has been properly and fully completed and signed, and

c) is responsive to the other requirements of the tender documents.

C.3.8.2 A responsive tender is one that conforms to all the terms, conditions, and specifications of the tender documents without material deviation or qualification. A material deviation or qualification is one which, in the Employer's opinion, would:

a) detrimentally affect the scope, quality, or performance of the works, services or supply identified in the Scope of Work,
b) significantly change the Employer's or the tenderer's risks and responsibilities under the contract, or

c) affect the competitive position of other tenderers presenting responsive tenders, if it were to be rectified.

Reject a non-responsive tender offer, and not allow it to be subsequently made responsive by correction or withdrawal of the non-conforming deviation or reservation.

C.3.9 Arithmetical errors, omissions and discrepancies

C.3.9.1 Check the highest ranked tender or tenderer with the highest number of tender evaluation points after the evaluation of tender offers in accordance with C.3.11 for:

a) the gross misplacement of the decimal point in any unit rate;

b) omissions made in completing the pricing schedule or bills of quantities; or

c) arithmetic errors in:

   i) line item totals resulting from the product of a unit rate and a quantity in bills of quantities or schedules of prices; or

   ii) the summation of the prices.

C.3.9.2 The Employer must correct the arithmetical errors in the following manner:

a) Where there is a discrepancy between the amounts in words and amounts in figures, the amount in words shall govern.

b) If bills of quantities or pricing schedules apply and there is an error in the line item total resulting from the product of the unit rate and the quantity, the line item total shall govern and the rate shall be corrected. Where there is an obviously gross misplacement of the decimal point in the unit rate, the line item total as quoted shall govern, and the unit rate shall be corrected.

c) Where there is an error in the total of the prices either as a result of other corrections required by this checking process or in the tenderer's addition of prices, the total of the prices shall govern and the tenderer will be asked to revise selected item prices (and their rates if bills of quantities apply) to achieve the tendered total of the prices.

Consider the rejection of a tender offer if the tenderer does not correct or accept the correction of the arithmetical error in the manner described above.

C.3.10 Clarification of a tender offer

Obtain clarification from a tenderer on any matter that could give rise to ambiguity in a contract arising from the tender offer.

C.3.11 Evaluation of tender offers

C.3.11.1 General

Appoint an evaluation panel of not less than three persons. Reduce each responsive tender offer to a comparative offer and evaluate them using the tender evaluation methods and associated evaluation criteria and weightings that are specified in the tender data.

C.3.11.2 Method 1: Price and Preference

In the case of a price and preference:

1) Score tender evaluation points for price
2) Score points for BBBEE contribution
3) Add the points score for price and BBBEE

C.3.11.3 Method 2: Functionality, Price and Preference

The procedure for the evaluation of responsive tender is Method 2.

- Stage 1: Administrative compliance
- Stage 2: Mandatory requirements
- Stage 3: Functionality Criteria
- Stage 4: Preference Points System

In the case of a functionality, price and preference:

1) Score functionality, rejecting all tender offers that fail to achieve the minimum number of points for functionality as stated in the Tender Data.
2) No tender must be regarded as an acceptable tender if it fails to achieve the minimum qualifying score for functionality as indicated in the tender invitation.
3) Tenders that have achieved the minimum qualification score for functionality must be evaluated further in terms of the preference points system prescribed in paragraphs 4 and 4 and 5 below.

4) **The 80/20 preference point system for acquisition of services, works or goods up to Rand value of R1 million:**

(a) The following formula must be used to calculate the points for price in respect of tenders (including price quotation) with a Rand value equal to, or above R 30 000 and up to Rand value of R 1 000 000 (all applicable taxes included):

(i) $P_s = 80 \times \left[1 - \left(\frac{P_t - P_{min}}{P_{min}}\right)\right]$

Where

P_s = Points scored for comparative price of tender or offer under consideration;
P_t = Comparative price of tender of offer under consideration; and
P_{min} = Comparative price of lowest acceptable tender or offer.

(ii) An Employer of state may apply the formula in paragraph (i) for price quotations with a value less than R 30 000, if and when appropriate.

(b) Subject to subparagraph 4)(c), points must be awarded to a tender for attaining the B-BBEE status level of contributor in accordance with the table below:

B-BBEE Status Level of Contributor	Number of Points
1	20
2	18
3	16
4	12
5	8
6	6
7	4
8	2
Non-compliant Contributor	0

(c) A maximum of 20 points may be allocated in accordance with subparagraph 4)(b)

(d) The points scored by tender in respect of B-BBEE contribution contemplated in subparagraph 4)(b) must be added to the points scored for price a calculated in accordance with subparagraph 4)(a).

(e) Subject to paragraph C.4.3.8 the contract must be awarded to the tender who scores the highest total number of points.

5) **The 90/10 preference points system for acquisition of services, works or goods with a Rand value above R1 million:**

(a) The following formula must be used to calculate the points for price in respect of tenders with a Rand value above R 1 000 000 (all applicable taxes included):

$$P_s = 90 \times \left[1 - \left(\frac{P_t - P_{min}}{P_{min}}\right)\right]$$

Where

P_s = Points scored for comparative price of tender or offer under consideration;
P_t = Comparative price of tender of offer under consideration; and
P_{min} = Comparative price of lowest acceptable tender or offer.

(b) Subject to subparagraph 5)(c), points must be awarded to a tender for attaining the B- BBEE status level of contributor in accordance with the table below:

B-BBEE Status Level of Contributor	Number of Points
1	10
2	9
3	8
4	5
5	4
6	3
7	2
8	1
Non-compliant Contributor	0

(c) A maximum of 20 points may be allocated in accordance with subparagraph 5)(b)

(d) The points scored by tender in respect of B-BBEE contribution contemplated in subparagraph 5)(b) must be added to the points scored for price a calculated in accordance with subparagraph 5)(a).

(e) Subject to paragraph C.4.3.8 the contract must be awarded to the tender who scores the highest total number of points.

C.3.11.6 Decimal places

Score financial offers, preferences and quality, as relevant, to two decimal places.

C.3.11.7 Scoring financial offers

Score the financial offers of remaining responsive tender offers using the following formula:

$$N_{FO} = W_1 \times A$$

Where N_{FO} is the number of tender evaluation points awarded for the financial offer

W_1 is the maximum possible number of tender evaluation points awarded for the financial offer as stated in the tender data.

A is a number calculated using the formula and option described in Table C.1 as stated in the tender data.

Table C.1: Formulae for calculating the value of A

Formula	Comparison aimed at achieving	Option 1[a]	Option 2[a]
1	Highest price or discount	$A = \left(1 + \frac{(P - P_m)}{P_m}\right)$	$A = {P}/{P_m}$
2	Lowest price or percentage commission / fee	$A = \left(1 - \frac{(P - P_m)}{P_m}\right)$	$A = {P_m}/{P}$
a	P_m is the comparative offer of the most favourable comparative offer. P is the comparative offer of the tender offer under consideration.		

C.3.11.8 Scoring preferences

Confirm that tenderers are eligible for the preferences claimed in accordance with the provisions of the tender data and reject all claims for preferences where tenderers are not eligible for such preferences. Calculate the total number of tender evaluation points for preferences claimed in accordance with the provisions of the tender data.

C.3.11.9 Scoring functionality

Score each of the criteria and sub criteria for quality in accordance with the provisions of the Tender Data.

Calculate the total number of tender evaluation points for quality using the following formula:

$$N_Q = W_2 \times {S_O}/{M_S}$$

Where S_O is the score for quality allocated to the submission under consideration;

M_S is the maximum possible score for quality in respect of a submission; and

W_2 is the maximum possible number of tender evaluation points awarded for the quality as stated in the tender data.

C.3.12 Insurance provided by the Employer

If requested by the proposed successful tenderer, submit for the tenderer's information the policies and / or certificates of insurance which the conditions of contract identified in the contract data, require the Employer to provide.

C.3.13 Acceptance of tender offer

Accept the tender offer, if in the opinion of the Employer, it does not present any unacceptable commercial risk and only if the tenderer:

a) is not under restrictions, or has principals who are under restrictions, preventing participating in the Employer’s procurement,

b) can, as necessary and in relation to the proposed contract, demonstrate that he or she possesses the professional and technical qualifications, professional and technical competence, financial resources, equipment and other physical facilities, managerial capability, reliability, experience and reputation, expertise and the personnel, to perform the contract,

c) has the legal capacity to enter into the contract,

d) is not insolvent, in receivership, under Business Rescue as provided for in chapter 6 of the Companies Act, 2008, bankrupt or being wound up, has his affairs administered by a court or a judicial officer, has suspended his business activities, or is subject to legal proceedings in respect of any of the foregoing,

e) complies with the legal requirements, if any, stated in the tender data, and

f) is able, in the opinion of the Employer, to perform the contract free of conflicts of interest.

C.3.14 Prepare contract documents

C.3.14.1 If necessary, revise documents that shall form part of the contract and that were issued by the Employer as part of the tender documents to take account of:

a) addenda issued during the tender period,

b) inclusion of some of the returnable documents, and

c) other revisions agreed between the Employer and the successful tenderer.

C.3.14.2 Complete the schedule of deviations attached to the form of offer and acceptance, if any.

C.3.15 Complete adjudicator’s contract

Unless alternative arrangements have been agreed or otherwise provided for in the contract, arrange for both parties to complete formalities for appointing the selected adjudicator at the same time as the main contract is signed.

C.3.16 Notice to unsuccessful tenderers

C.3.16.1 Notify the successful tenderer of the Employer's acceptance of his tender offer by completing and returning one copy of the form of offer and acceptance before the expiry of the validity period stated in the tender data, or agreed additional period.

C.3.16.2 After the successful tenderer has been notified of the Employer's acceptance of the tender, notify other tenderers that their tender offers have not been accepted.

C.3.17 Provide copies of the contracts

Provide to the successful tenderer the number of copies stated in the tender data of the signed copy of the contract as soon as possible after completion and signing of the form of offer and acceptance.

C.3.18 Provide written reasons for actions taken

Provide upon request written reasons to tenderers for any action that is taken in applying these conditions of tender, but withhold information which is not in the public interest to be divulged, which is considered to prejudice the legitimate commercial interests of tenderers or might prejudice fair competition between tenderers.

C.3.19 Transparency in the procurement process

C.3.19.1 The CIDB prescripts require that tenders must be advertised and be registered on the CIDB i.Tender system.

C.3.19.2 The Employer must adopt a transparency model that incorporates the disclosure and accountability as transparency requirements in the procurement process.

C.3.19.3 The transparency model must identify the criteria for selection of projects, project information template and the threshold value of the projects to be disclosed in the public domain at various intervals of delivery of infrastructure projects.

C.3.19.4 The client must publish the information on a quarterly basis which contains the following information:

- Procurement planning process
- Procurement method and evaluation process
- Contract type
- Contract status
- Number of firms tendering
- Cost estimate
- Contract title
- Contract firm(s)
- Contract price
- Contract scope of work
- Contract start date and duration
- Contract evaluation reports

C.3.19.5 The employer must establish a Consultative Forum which will conduct a random audit in the implementation of the transparency requirements in the procurement process.

C.3.19.6 Consultative Forum must be an independent structure from the bid committees.

C.3.19.7 The information must be published on the employer's website.

C.3.19.8 Records of such disclosed information must be retained for audit purposes.

PART T2: RETURNABLE DOCUMENTS

TABLE OF CONTENTS

T2.1 LIST OF RETURNABLE DOCUMENTS

RD.A RETURNABLE DOCUMENTS FOR TENDER EVALUATION PURPOSES

Note: ***Failure to submit the applicable documents will result in the tender offer being disqualified from further consideration***

Document Name	Reference	**Confirmation of Document Included** (Tenders may use this column to confirm documents have been completed and included in the tender)
Form of offer and acceptance	**Section C1.1**	
MBD 4: Declaration of interest	Form RD.A.1	
MBD 5: Declaration for procurement above R10 million (all applicable taxes included)	Form RD.A.2	
MBD 8: Declaration of tenderer's past supply chain management practises	Form RD.A.3	
MBD 9: Certificate of independent tender determination	Form RD.A.4	

RD.B RETURNABLE DOCUMENTS REQUIRED FOR PREFERENTIAL PROCUREMENT EVALUATION PURPOSES

Note: ***Failure to submit the applicable documents will result in the tender offer being awarded 0 (zero) preference points***

Document Name	Reference	**Confirmation of Document Included** (Tenders may use this column to confirm documents have been completed and included in the tender)
MBD 6.1: Preference Points Claim Form in terms of the Preferential Procurement Regulations 2022	Form RD.B.1	
Valid B-BBEE Status Level of Contributor Certificate	Form RD.B.2	
B-BBEE Exempted Micro Enterprise – Sworn Affidavit	Form RD.B.3	
Promotion of local enterprises (Local Economic Participation)	Form RD.B.4	
Certified copy of Identity Document/s	Form RD.B.5	
Medical Certificate with doctor's details (Practice Number, Physical Address and contact numbers)	Form RD.B.6	

RD.C ADDITIONAL RETURNABLE DOCUMENTS REQUIRED FOR TENDER EVALUATION PURPOSES

Document Name	Reference	Confirmation of Document Included (Tenders may use this column to confirm documents have been completed and included in the tender)
Tax compliance status	RD.C.1	
Proof of registration with the CIDB	RD.C.2	
Compliance with OHSA (Act 85 of 1993	RD.C.3	
Record of services provided to organs of state	RD.C.4	
Schedule of plant and equipment	RD.C.5	
EPWP Staff for labour intensive construction works	RD.C.6	
Status of concern submitting tender	RD.C.7	
Classification of business	RD.C.8	
Certificate of authority of signatory	RD.C.9	
Certificate of authority of signatory for joint ventures and consortia	RD.C.10	
Letter of intent to provide a performance bond	RD.C.11	
Bank Rating Report	RD.C.12	

RD.D RETURNABLE DOCUMENTS REQUIRED FOR QUALITY EVALUATION PURPOSES

Document Name	Reference	Confirmation of Document Included (Tenders may use this column to confirm documents have been completed and included in the tender)
Terms of reference for Quality Evaluation:		
Evaluation Schedule: Tenderer's experience	RD.D.2	
Evaluation Schedule: Key personnel	RD.D.3	
Evaluation Schedule: Quality Management System	RD.D.4	
Evaluation Schedule: Construction health and safety officer	Attach SACPCMP certificate	

RD.E OTHER DOCUMENTS THAT WILL FORM PART OF THE CONTRACT

Note: ***Failure to submit or fully complete the applicable documents will result in the tender offer being disqualified from further consideration***

Document Name	Reference	**Confirmation of Document Included** (Tenders may use this column to confirm documents have been completed and included in the tender)
Test certificates for electrical equipment	RD.D. 1	
Form of offer and acceptance	Section C1.1	
Data provided by the contractor	Section C1.2	
Record of addenda to tender documents	RD.E.1	
Proposed amendments	RD.E.2	
Cost price adjustment (CPA) Local contents (SEIFSA)	RD.E.3	
Cost price adjustment (CPA) imported content (FOREX)	RD.E.4	
Verification on schedule of particulars & guarantees	RD.E. 6P	

T2.2 RETURNABLE SCHEDULES

TABLE OF CONTENTS

MBD 4 DECLARATION OF INTEREST

1. No bid will be accepted from persons in the service of the state[1].

2. Any person, having a kinship with persons in the service of the state, including a blood relationship, may make an offer or offers in terms of this invitation to bid. In view of possible allegations of favouritism, should the resulting bid, or part thereof, be awarded to persons connected with or related to persons in service of the state, it is required that the bidder or their authorised representative declare their position in relation to the evaluating/adjudicating authority.

3. **In order to give effect to the above, the following questionnaire must be completed and submitted with the bid.**

3.1 Full Name of bidder or his or her representative: ………………………………….

3.2 Identity Number: ………………………………………………………………………

3.3 Position occupied in the Company (director, trustee, hareholder[2]) ……………

3.4 Company Registration Number: ……………………………………………………….

3.5 Tax Reference Number: ……………………………………………………………..

3.6 VAT Registration Number: …………………………………………………………..

3.7 The names of all directors / trustees / shareholders members, their individual identity numbers and state employee numbers must be indicated in paragraph 4 below.

3.8 Are you presently in the service of the state? **YES / NO**

3.8.1 If yes, furnish particulars. ……………………………………………………………

……………………………………………………………………………………………..

[1] MSCM Regulations: "in the service of the state" means to be –
(a) a member of –
(i) any municipal council;
(ii) any provincial legislature; or
(iii) the national Assembly or the national Council of provinces;
(b) a member of the board of directors of any municipal entity;
(c) an official of any municipality or municipal entity;
(d) an employee of any national or provincial department, national or provincial public entity or constitutional institution within the meaning of the Public Finance Management Act, 1999 (Act No.1 of 1999);
(e) a member of the accounting authority of any national or provincial public entity; or
(f) an employee of Parliament or a provincial legislature.

[2] Shareholder" means a person who owns shares in the company and is actively involved in the management of the company or business and exercises control over the company.

3.9 Have you been in the service of the state for the past twelve months? **YES/NO**

3.9.1 If yes, furnish particulars. …………………………………………………………

………………………………………………………………………………………..

3.10 Do you have any relationship (family, friend, other) with persons in the service of the state and who may be involved with the evaluation and or adjudication of this bid? **YES / NO**

3.10.1 If yes, furnish particulars. ……………………………………………………….....

………………………………………………………………………………………..

3.11 Are you, aware of any relationship (family, friend, other) between any other bidder and any persons in the service of the state who may be involved with the evaluation and or adjudication of this bid? **YES / NO**

3.11.1 If yes, furnish particulars. …………………………………………………………

………………………………………………………………………………………..

3.12 Are any of the company's directors, trustees, managers, principle shareholders or stakeholders in service of the state? **YES / NO**

3.12.1 If yes, furnish particulars. …………………………………………………………

………………………………………………………………………………………..

3.13 Are any spouse, child or parent of the company's directors trustees, managers, principle shareholders or stakeholders in service of the state? **YES / NO**

3.13.1 If yes, furnish particulars. …………………………………………………………

………………………………………………………………………………………..

3.14 Do you or any of the directors, trustees, managers, principle shareholders, or stakeholders of this company have any interest in any other related companies or business whether or not they are bidding for this contract. **YES / NO**

3.14.1 If yes, furnish particulars: …………………………………………………………

……………………………………………………………………………………….

4. Full details of directors / trustees / members / shareholders.

Full Name	**Identity Number**	**State Employee Number**

……………………………………………… ………………………………………..

Signature **Date**

……………………………………………… ………………………………………..

Capacity **Name of Bidder**

FORM RD.A.2 MBD 5: DECLARATION FOR PROCUREMENT ABOVE R10 MILLION (ALL APPLICABLE TAXES INCLUDED)

For all procurement expected to exceed R10 million (all applicable taxes included), bidders must complete the following questionnaire:

1 Are you by law required to prepare annual financial statements for auditing? ***YES / NO**

1.1 If yes, submit audited annual financial statements for the past three years or since the date of establishment if established during the past three years.

……………………………………………………………………………

…………………………………………………………………………….

2 Do you have any outstanding undisputed commitments for municipal services towards any municipality for more than three months or any other service provider in respect of which payment is overdue for more than 30 days? ***YES / NO**

2.1 If no, this serves to certify that the bidder has no undisputed commitments for municipal services towards any municipality for more than three months or other service provider in respect of which payment is overdue for more than 30 days.

2.2 If yes, provide particulars.

……………………………………………………………………

…………………………………………………………………….

…………………………………………………………………….

…………………………………………………………………..

3 Has any contract been awarded to you by an organ of state during the past five years, including particulars of any material non-compliance or dispute concerning the execution of such contract? ***YES / NO**

3.1 If yes, furnish particulars

…………………………………………………………………….

…………………………………………………………………………

4. Will any portion of goods or services be sourced from outside the Republic, and, if so, what portion and whether any portion of payment from the municipality / municipal entity is expected to be transferred out of the Republic? ***YES/NO**

4.1 If yes, furnish particulars

…………………………………………………………..

…………………………………………………………..

CERTIFICATION

I, THE UNDERSIGNED (NAME) ………………………………………………………………………………
CERTIFY THAT THE INFORMATION FURNISHED ON THIS DECLARATION FORM IS CORRECT. I ACCEPT THAT THE STATE MAY ACT AGAINST ME SHOULD THIS DECLARATION PROVE TO BE FALSE.

…………………………………..	……………………………………..
Signature	Date
……………………................	…………………………………….
Position	Name of Bidder

FORM RD.A.3 MBD 8: DECLARATION OF TENDER'S PAST SUPPLY CHAIN MANAGEMENT PRACTISES

1. This municipal tender document must form part of all tenders invited.
2. It serves as a declaration to be used by municipalities and municipal entities in ensuring that when goods and services are being procured, all reasonable steps are taken to combat the abuse of the supply chain management system.
3. The tender of any tenderer may be rejected if that tenderer, or any of it's directors have:

   a. abused the municipality's/municipal entity's supply management system or committed any improper conduct I n relation to such system;
   b. been convicted for fraud or corruption during the past five years;
   c. wilfully neglected, reneged on or failed to comply with any government, Municipal or other public sector contract during the past five years; or
   d. been listed in the Register for Tender Defaulters in terms of Section 29 of the Prevention and Combating of Corrupt Activities Act, 2004 (Act 12 of 2004).

4. In order to give effect to the above, the following questionnaire must be completed and submitted with the tender:

Item	Question	Response	
4.1	Is the tenderer, any of it's directors listed on the National Treasurer's database as a company or persons prohibited from doing business with the public sector? **(Companies for persons who are listed on this database were informed in writing of this restriction by the National Treasury after the audi alteram partem rule was applied)**	**YES**	**NO**
	If so, furnish particulars:		
4.2	Is the tenderer or any of it's directors listed on the Register for Tender Defaulters in terms of Section 29 of the Prevention and Combating of Corrupt Activities Act, 2004 (Act 12 of 2004)? (**To access this register enter the National Treasury's website, www.treasury.gov.za , click on the icon "Register for Tender Defaulters" or submit your written request for a hard copy of the Register to facsimile number 012-326-5445**).	**YES**	**NO**
	If so, furnish particulars:		
4.3	Was the tenderer or any of its directors convicted by a court of law (including a court of law outside the Republic of South Africa) for fraud or corruption during the past five years?	**YES**	**NO**
	If so, furnish particulars:		

Item	Question	Response	
4.4	Does the tenderer or any of its directors owe any municipal rates and taxes or municipal charges to the municipality/municipal entity, or to any other municipality/municipal entity, that is in arrears for more than three months?	**YES**	**NO**
	If so, furnish particulars:		
4.5	Was any contract between the tenderer and the municipality/municipal entity or any other organ of state terminated during the past five years on account of failure to perform on or comply with the contract?	**YES**	**NO**
	If so, furnish particulars:		

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

<u>Person authorized to sign the tender:</u>

Full name (in BLOCK letters): ______________________

Signature: ______________________

Date: ______________________

FORM RD.A.4 MBD 9: CERTIFICATION OF INDEPENDENT TENDER DETERMINATION

1. This Municipal Bidding Document (MBD) must form part of all tenders[1] invited.

2. Section 4 (1) (b) (iii) of the Competition Act Nol. 89 of 1998, as amended, prohibits an agreement between, or concerted practice by, firms, or a decision by an association of firms, if it is between parties in a horizontal relationship and if it involves collusive tendering (or tender rigging)[2]. Collusive tendering is a *per se* prohibition meaning that it cannot be justified under any grounds.

3. Municipal Supply Regulation 38 (1) prescribes that a supply chain management policy must provide measures for the combating of abuse of the supply chain management system, and must enable the accounting officer, among others, to:

   a. Take all reasonable steps to prevent such abuse;
   b. Reject the tender of any tenderer if that tenderer or any of its directors has abused the supply chain management system of the municipality or municipal entity or has committed any improper conduct in relation to such system; and
   c. Cancel a contract awarded to a person if the person committed any corrupt or fraudulent act during the tendering process or the execution of the contract.

4. This will serve as a certificate of declaration that would be used by institutions to ensure that, when tenders are considered, reasonable steps are taken to prevent any form of tender-rigging.

5. In order to give effect to the above, the attached Certificate of Tender Determination must be completed and submitted with the tender.

[1] Includes price quotations, advertised competitive tenders, limited tenders and proposals.

[2] Tender rigging (or collusive tendering) occurs when businesses, that would otherwise be expected to compete, secretly conspire to raise prices or lower the quality of goods and/or services for purchasers who wish to acquire goods and/or services through a tender process. Tender rigging is, therefore, an agreement between competitors not to compete.

CERTIFICATE OF INDEPENDENT TENDER DETERMINATION

I, the undersigned, in submitting the accompanying tender:

Contract: EEBU 07-2025.26 TENDER FOR THE SUPPLY, DELIVERY, INSTALLATION, TESTING AND COMMISSIONING OF 1x300MVA POWER TRANSFORMER AT KWAGGA 275/132KV SUBSTATION WITH ASSOCIATED EQUIPMENT FOR A PERIOD OF THREE (3) YEARS

in response to the invitation for the tender made by

<u>City of Tshwane Metropolitan Municipality</u>

do hereby make the following statement that I certify to be true and complete in every respect:

I certify, on behalf of ____ that:
(Name of tenderer)

1. I have read and understand the contents of this certificate;

2. I understand that the accompanying tender will be disqualified if this certificate is found not to be true and complete in every aspect;

3. I am authorised by the tenderer to sign this certificate, and to submit the accompanying tender, on behalf of the tenderer;

4. Each person whose signature appears on the accompanying tender has been authorised by the tenderer to determine the terms of, and to sign, the tender, on behalf of the tenderer;

5. For the purposes of this Certificate and the accompanying tender, I understand that the word "competitor"" shall include any individual or organization, other that the tenderer, whether or not affiliated with the tenderer who:

    a. Has been requested to submit a tender in response to this tender invitation, based on their qualifications, abilities or experience; and
    b. Could potentially submit a tender in response to this tender invitation, based on their qualifications, abilities or experience; and provides the same goods and services as the tenderer and/or is in the same line of business as the tenderer.

6. The tenderer has arrived at the accompanying tender independently form, and without consultation, communication, agreement or arrangement with any competitor. However, communication between partners in a joint venture or consortium[33] will not be construed as collusive tendering.

7. In particular, without limiting the generality of paragraphs 6 above, there has been no consultation, communication, agreement of arrangement with any competitor regarding:

    a. Prices;
    b. Geographical area where product of services will be rendered (market allocation);
    c. Methods, factors of formulas used to calculate prices;
    d. The intention or decision to submit or not to submit, a tender;
    e. The submission of a tender which does not meet the specifications and conditions of the tender; or
    f. Tendering with the intention not to win the tender.

[3] Joint venture or consortium means an association of persons for the purpose of combining their expertise, property, capital, efforts, skill and knowledge in an activity for the execution of a contract.

8. In addition, there have been no consultations, communications, agreements or arrangement with any competitor regarding the quality, quantity, specifications and conditions or delivery particulars of the products or services to which this tender invitation relates.

9. The terms of the accompanying tender have not been, and will not be, disclosed by the tenderer, directly or indirectly, to any competitor, prior to the date and time of the official tender opening or to the awarding of the contract.

10. I am aware that, in addition and without prejudice to any other remedy provided to combat any restrictive practises related to tenders and contracts, tenders that are suspicious will be reported to the Competition Commission for investigation and possible imposition of administrative penalties in terms of section 59 of the Competition Act No. 89 of 1998 and or may be reported to the National Prosecuting Authority (NPA) for criminal investigation and or may be restricted form conduction business with the public sector for a period not exceeding ten (10) years in terms of the Prevention and combating of Corrupt Activities Act No. 12 of 2004 or any other applicable legislation.

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Person authorized to sign the tender:

Full name (in BLOCK letters):	
Signature:	
Date:	

FORM RD.B.1 MBD 6.1: PREFERENCE POINTS CLAIM FORM IN TERMS OF THE PREFERENTIAL PROCUREMENT REGULATIONS 2022

This preference form must form part of all tenders invited. It contains general information and serves as a claim form for preference points for specific goals.

NB: BEFORE COMPLETING THIS FORM, TENDERERS MUST STUDY THE GENERAL CONDITIONS, DEFINITIONS AND DIRECTIVES APPLICABLE IN RESPECT OF THE TENDER AND PREFERENTIAL PROCUREMENT REGULATIONS, 2022

1. GENERAL CONDITIONS

1.1 The following preference point systems are applicable to invitations to tender:

- the 80/20 system for requirements with a Rand value of up to R50 000 000 (all applicable taxes included); and
- the 90/10 system for requirements with a Rand value above R50 000 000 (all applicable taxes included).

1.2 To be completed by the organ of state

(delete whichever is not applicable for this tender).

a) The applicable preference point system for this tender is the 90/10 preference point system.

1.3 Points for this tender (even in the case of a tender for income-generating contracts) shall be awarded for:

(a) Price; and

(b) Specific Goals.

1.4 To be completed by the organ of state:

The maximum points for this tender are allocated as follows:

	POINTS
PRICE	90
SPECIFIC GOALS	10
TOTAL POINTS FOR PRICE AND SPECIFIC GOALS	100

1.5 Failure on the part of a tenderer to submit proof or documentation required in terms of this tender to claim points for specific goals with the tender, will be interpreted to mean that preference points for specific goals are not claimed.

1.6 The organ of state reserves the right to require of a tenderer, either before a tender is adjudicated or at any time subsequently, to substantiate any claim in regard to preferences, in any manner required by the organ of state.

2. DEFINITIONS

(a) "tender" means a written offer in the form determined by an organ of state in response to an invitation to provide goods or services through price quotations, competitive tendering process or any other method envisaged in legislation;

(b) "price" means an amount of money tendered for goods or services, and includes all applicable taxes less all unconditional discounts;

(c) "rand value" means the total estimated value of a contract in Rand, calculated at the time of bid invitation, and includes all applicable taxes;

(d) "tender for income-generating contracts" means a written offer in the form determined by an organ of state in response to an invitation for the origination of income-generating contracts through any method envisaged in legislation that will result in a legal agreement between the organ of state and a third party that produces revenue for the organ of state, and includes, but is not limited to, leasing and disposal of assets and concession contracts, excluding direct sales and disposal of assets through public auctions; and

(e) "the Act" means the Preferential Procurement Policy Framework Act, 2000 (Act No. 5 of 2000).

3. FORMULAE FOR PROCUREMENT OF GOODS AND SERVICES

3.1. POINTS AWARDED FOR PRICE

3.1.1 THE 80/20 OR 90/10 PREFERENCE POINT SYSTEMS

A maximum of 80 or 90 points is allocated for price on the following basis:

80/20 or 90/10

$$\boldsymbol{Ps = 80\left(1 - \frac{Pt - P\,min}{P\,min}\right)} \quad \text{or} \quad \boldsymbol{Ps = 90\left(1 - \frac{Pt - P\,min}{P\,min}\right)}$$

Where

Ps = Points scored for price of tender under consideration

Pt = Price of tender under consideration

Pmin = Price of lowest acceptable tender

3.2. FORMULAE FOR DISPOSAL OR LEASING OF STATE ASSETS AND INCOME GENERATING PROCUREMENT

3.2.1. POINTS AWARDED FOR PRICE

A maximum of 80 or 90 points is allocated for price on the following basis:

90/10

$$Ps = 90\left(1 + \frac{Pt - P\,max}{Pmax}\right)$$

Where

Ps = Points scored for price of tender under consideration

Pt = Price of tender under consideration

Pmax = Price of highest acceptable tender

4. POINTS AWARDED FOR SPECIFIC GOALS

4.1. In terms of Regulation 4(2); 5(2); 6(2) and 7(2) of the Preferential Procurement Regulations, preference points must be awarded for specific goals stated in the tender. For the purposes of this tender the tenderer will be allocated points based on the goals stated in table 1 below as may be supported by proof/ documentation stated in the conditions of this tender:

4.2. In cases where organs of state intend to use Regulation 3(2) of the Regulations, which states that, if it is unclear whether the 80/20 or 90/10 preference point system applies, an organ of state must, in the tender documents, stipulate in the case of—

(a) an invitation for tender for income-generating contracts, that either the 80/20 or 90/10 preference point system will apply and that the highest acceptable tender will be used to determine the applicable preference point system; or

(b) any other invitation for tender, that either the 80/20 or 90/10 preference point system will apply and that the lowest acceptable tender will be used to determine the applicable preference point system,

then the organ of state must indicate the points allocated for specific goals for both the 90/10 and 80/20 preference point system.

Table 1: Specific goals for the tender and points claimed are indicated per the table below.

(Note to organs of state: Where either the 90/10 or 80/20 preference point system is applicable, corresponding points must also be indicated as such.

Note to tenderers: The tenderer must indicate how they claim points for each preference point system.)

Specific goals	**90/10 preference point system**	**Number of points claimed (90/10 system) (To be completed by the tenderer)**
BB-BEE score of companies • Level 1 • Level 2 • Level 3 • Level 4	• 4 Points • 3.5 Points • 3 Points • 2.5 Points	

Specific goals	**90/10 preference point system**	**Number of points claimed (90/10 system) (To be completed by the tenderer)**
• Level 5 • Level 6 • Level 7 • Level 8 • Non-compliant	• 2 Points • 1.5 Points • 1 Point • 0.5 Points • 0 Points	
EME and/ or QSE	1 Point	
At least 51% of Women-owned companies	1 Point	
At least 51% owned companies by People with disability	1 Point	
At least 51% owned companies by Youth	1 Point	
Local Economic Participation • City of Tshwane • Gauteng • National	 2 Points 1 Point 1 Point	

N.B For points to be allocated as per above the tenderers will be required to submit proof of documentation as evidence for claims made. Any tenderer that does not submit evidence as stated in the bid document to claim applicable points will be allocated zero points.

DECLARATION WITH REGARD TO COMPANY/FIRM

4.3. Name of company/firm……………………………………………………………………….

4.4. Company registration number: ……………………………………………………….....

4.5. TYPE OF COMPANY/ FIRM

☐ Partnership/Joint Venture / Consortium
☐ One-person business/sole propriety
☐ Close corporation
☐ Public Company
☐ Personal Liability Company
☐ (Pty) Limited
☐ Non-Profit Company
☐ State Owned Company

[TICK APPLICABLE BOX]

4.6. I, the undersigned, who is duly authorised to do so on behalf of the company/firm, certify that the points claimed, based on the specific goals as advised in the tender, qualifies the company/ firm for the preference(s) shown and I acknowledge that:

i) The information furnished is true and correct;

ii) The preference points claimed are in accordance with the General Conditions as indicated in paragraph 1 of this form;

iii) In the event of a contract being awarded as a result of points claimed as shown in paragraphs 1.4 and 4.2, the contractor may be required to furnish documentary proof to the satisfaction of the organ of state that the claims are correct;

iv) If the specific goals have been claimed or obtained on a fraudulent basis or any of the conditions of contract have not been fulfilled, the organ of state may, in addition to any other remedy it may have –

(a) disqualify the person from the tendering process;

(b) recover costs, losses or damages it has incurred or suffered as a result of that person's conduct;

(c) cancel the contract and claim any damages which it has suffered as a result of having to make less favourable arrangements due to such cancellation;

(d) recommend that the tenderer or contractor, its shareholders and directors, or only the shareholders and directors who acted on a fraudulent basis, be restricted from obtaining business from any organ of state for a period not exceeding 10 years, after the *audi alteram partem* (hear the other side) rule has been applied; and

(e) forward the matter for criminal prosecution, if deemed necessary.

	....
	SIGNATURE(S) OF TENDERER(S)
SURNAME AND NAME:	....
DATE:	....
ADDRESS:	....
	....
	....
	....

FORM RD.B.2 VALID B-BBEE STATUS LEVEL OF CONTRIBUTOR CERTIFICATE

Submit B-BBEE Verification Certificate from a Verification Agency accredited by the South African Accreditation System (SANAS) or a Registered Auditor approved by the Independent Regulatory Board of Auditors (IRBA) or an Accounting Officer as contemplated in the Close Corporation Act (CCA).

NOTE:

1. Attach original copy of B-BBEE Verification Certificate to this page.

2. In the case of a joint venture / consortium parties must each attach original copy of their B-BBEE Verification Certificates.

FORM RD.B.3 B-BBEE EXEMPTED MICRO ENTERPRISE – SWORN AFFIDAVIT

I, the undersigned

Full Name & Surname	
Identity Number	- - -

Hereby declare under oath as follow:

1. The contents of this statement are to the best of my knowledge a true reflection of the facts.
2. I am a member / director / owner of the following enterprise and am duly authorised to act on its behalf.

Enterprise Name	
Trading Name	
Registration Number	
Enterprise Address	

3. I hereby declare under oath that:

- The enterprise is __________ % black owned;
- The enterprise is __________ % woman owned;
- The enterprise is __________ % owned companies by People with disability;
- The enterprise is __________ % owned companies by Youth;
- Based on the audited management accounts and other information available on the __________ financial year, the income did not exceed R 10,000,000 (ten million rands);
- Please confirm on the below the B-BBEE level contributor, by ticking the applicable box.

100% Black owned	**Level One** (135% B-BBEE procurement recognition)	
More than 51% Black owned	**Level Two** (125% B-BBEE procurement recognition)	
Less than 51% Black owned	**Level Four** (100% B-BBEE procurement recognition)	

4. The entity is an empowering supplier in terms of the dti Codes of Good Practice
5. I know and understand the contents of the contents of this affidavit and I have no objection to take the prescribed oath and consider the oath binding on my conscience and on the owners of the enterprise which I represent in this matter.
6. The sworn affidavit will be valid for a period of 12 (twelve) month from the date signed by the commissioner.

Deponent Signature: Date:

Commissioner of oaths

(Signature and stamp)

1. Attach original or certified copy of CSD registration certificate to this page.

2. In the case of a joint venture / consortium (excluding consulting engineering partners) the joint venture / consortium must attach original or certified copy of their CSD registration certificate to this page.

FORM RD.B.4 PROMOTION OF LOCAL ENTERPRISES

The City of Tshwane has mandated the promotion of local enterprises. To comply with this the tenderer must provide proof of the type of business unit and whether the unit resides within the Tshwane and will be scored as follow:

If 90/10 preference point system applies:

	Promotion of local enterprises
No Response (score 0)	The tenderer did not respond or comply with this evaluation schedule. A score of 0 will also be awarded for any misrepresentation made in this regard,
Satisfactory (score 1)	The tenderer operates a head office or fully staffed office or his sole office outside the boundaries of Gauteng Province. (I.e. no business unit or office resides within the boundaries of Tshwane Metropolitan Municipality)
Good (score 1)	The tenderer's office resides within the boundaries of Gauteng Province. (I.e. no business unit or office resides within the boundaries of Tshwane Metropolitan Municipality)
Very good (score 2)	The tenderer's office resides within the boundaries of the Tshwane Metropolitan Municipality.

Municipal Rates & Taxes not older than three months from tender advertisement date or Valid Lease Agreement should be attached as evidence.

(If necessary the tenderer will be requested to present the office / business unit to officials of the City)

The undersigned, who warrants that he / she is duly authorized to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.	
<u>Person authorized to sign the tender:</u>	
Full name (in BLOCK letters):	______________________
Signature:	______________________
Date:	

FORM RD.B.5 At least 51% Women owned companies and At least 51% owned companies by Youth

The City of Tshwane has mandate for the promotion At least 51% Women owned companies and At least 51% owned companies by youth. To comply with this the tenderer must provide Certified copy of Identity Document/s that proof that company is 51% owend by Women or youth

	promotion At least 51% Women owned companies and At least 51% owned companies by youth
No Response (score 0)	The tenderer did not respond or comply with this evaluation schedule. A score of 0 will also be awarded for any misrepresentation made in this regard,
Good (score 1	Certified copy of Identity Document/s that proof that company is 51% owned by Women and proof of ownership (Sworn affidavit for B-BBEE qualifying small enterprise or Exempt Micro Enterprises, CIPC registration or any other proof of ownership
Good (score 1)	Certified copy of Identity Document/s that proof that company is 51% owned by youth and proof of ownership (Sworn affidavit for B-BBEE qualifying small enterprise or Exempt Micro Enterprises, CIPC registration or any other proof of ownership

(If necessary the tenderer will be requested to present the office / business unit to officials of the City)

The undersigned, who warrants that he / she is duly authorized to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Person authorized to sign the tender:

Full name (in BLOCK letters): ______________________

Signature: ______________________

Date:

FORM RD.B.6 At least 51% owned companies by People with disability

The City of Tshwane has mandate for the promotion of At least 51% owned companies by People with disability. To comply with this the tenderer must provide Medical Certificate with doctor's details (Practice Number, Physical Address and contact numbers that proof that company is 51% owned by People with disability

	Promotion of At least 51% owned companies by People with disability
No Response (score 0)	The tenderer did not respond or comply with this evaluation schedule. A score of 0 will also be awarded for any misrepresentation made in this regard,
Good (score 1)	Medical Certificate with doctor's details (Practice Number, Physical Address and contact numbers and proof of ownership (Sworn affidavit for B-BBEE qualifying small enterprise or Exempt Micro Enterprises, CIPC registration or any other proof of ownership

(If necessary the tenderer will be requested to present the office / business unit to officials of the City)

The undersigned, who warrants that he / she is duly authorized to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

<u>Person authorized to sign the tender:</u>

Full name (in BLOCK letters): ______________________

Signature: ______________________

Date:

FORM RD.C.1 TAX COMPLIANCE STATUS: TAX CLEARANCE CERTIFICATE REQUIREMENTS

a) To enable The City to verify the bidder's tax compliance status, the bidder must provide;

- A copy of their Tax Clearance Certificate (TCS);or Indicate their tax compliance status PIN or A copy of their Central Supplier Database (CSD) registration; or indicate their Master Registration Number / CSD Number

FORM RD.C.2 PROOF OF REGISTRATION WITH THE CIDB

3. Attach original or certified copy of CIDB registration certificate to this page.

4. In the case of a joint venture / consortium (excluding consulting engineering partners) parties must each attach original or certified copy of their CIDB registration certificate.

Firm	**CRS Number**	**CIDB Grading**	**Lead Partner** (Indicate with X)
Combined CIDB Grading for Joint Venture / Consortium:			

(Calculator is available at https://registers.cidb.org.za/common/jvcalc.asp)

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Person authorized to sign the tender:

Full name (in BLOCK letters): ______________________

Signature: ______________________

Date: ______________________

FORM RD.C.3 COMPLIANCE WITH OHSA (ACT 85 OF 1993)

Tenderers are required to satisfy the employer and the engineer as to their ability and available resources to comply with the above by answering the following questions and providing the relevant information required below.

(Tick applicable box)

1. Are your company familiar with the OHSA (ACT 85 of 1993) and its Regulations?	**YES**	**NO**
2. Who will prepare your company's Health and Safety Plan? Provide a copy of the person/s curriculum vitae/s or company profile.		
3. Do your company have a health and safety policy? If **YES** provide a copy.	**YES**	**NO**
4. How is this policy communicated to your employees? Provide supporting documentation.	**YES**	**NO**
5. Do your company keep record of safety aspects of each site where work is performed? If **YES** what records are kept?	**YES**	**NO**
6. Do your company conduct monthly safety meetings? If **YES**, who is the chairperson of the meeting, and attend these meetings?	**YES**	**NO**
7. Do your company have a safety officer in its employment, responsible for overall safety of your company? If **YES**, explain his duties and provide a copy of his CV	**YES**	**NO**
8. Do your company have trained first aid employees? If **YES**, indicate who.	**YES**	**NO**
9. Do your company have a safety induction training programme in place? If **YES**, provide a copy.	**YES**	**NO**
10. Do your company conduct medical surveillance for its employees?	**YES**	**NO**

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Person authorized to sign the tender:

Full name (in BLOCK letters): ____________________

Signature: ____________________

Date: ____________________

FORM RD.C.4 RECORD OF SERVICES PROVIDED TO ORGANS OF STATE

Tenderers are required to complete this record in terms of the Supply Chain Management Regulations issued in terms of the Municipal Finance Management Act of 2003.

Include only those contracts where the tenderer identified in the signature block below was directly contracted by the employer. Tenderers must not include services provided in terms of a sub-contract agreement.

Where contracts were awarded in the name of a joint venture and the tenderer formed part of that joint venture, indicate in the column entitled "Title of the contract for the service" that was in joint venture and provide the name of the joint venture that contracted with the employer. In the column for the value of the contract for the service, record the value of the portion of the contract performed (or to be performed) by the tender.

Complete the record or attach the required information in the prescribed tabulation

	ALL SERVICES COMMENCED OR COMPLETED TO AN ORGAN OF STATE IN THE LAST FIVE YEARS			
	Organ of state, i.e. national or provincial department, public entity, municipality or municipal entity.	**Title of contract for the service**	**Value of contract for service incl. VAT (Rand)**	**Date completed (State current if not yet completed)**
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				

(Attach additional pages if more space is required.)

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Person authorized to sign the tender:

Full name (in BLOCK letters): ______________________

Signature: ______________________

Date: ______________________

FORM RD.C.5 SCHEDULE OF PLANT AND EQUIPMENT

The following are lists of the major items of relevant equipment that I/we presently own/lease and will have available for this contract or will hire/acquire for this contract as proof of the requirements for Clause F.3.13 b) of the Conditions of Tender

Major equipment owned/leased that is immediately available for the execution of the works	
Quantity	**Description, size, capacity etc.**

(Attach additional pages if more space is required)

Major equipment that will be hired or acquired for the execution of the works	
Quantity	**Description, size, capacity etc.**

FORM RD.C.6 EPWP STAFF FOR LABOUR INTENSIVE CONSTRUCTION WORKS

The tenderer shall, submit the names of all management, design and supervisory staff that will be employed to design and supervise the labour intensive portion of the works together with satisfactory documentary evidence that such staff members satisfy the eligibility requirements.

CATEGORY OF EMPLOYEE	NAME OF EMPLOYEE	NQF LEVEL	LABOUR INTENSIVE SKILLS PROGRAM UNIT STANDARD TITLES	DATE COMPLETED	YEARS EXPERIENCE
Designer					
NQF 7 Unit Standard Required: Develop and Promote Labour Intensive Construction Strategies					

Administrator/ Site supervisor					
NQF 5 Unit Standard Required: Manage Labour Intensive Construction Projects					

(Attach documentary proof to this page)

FORM RD.C.7 STATUS OF CONCERN SUBMITTING TENDER

1. General

State whether the tenderer is a company, a closed corporation, a partnership, a sole practitioner, a joint venture/consortium or a co-operative

Public Company	
Private Company	
Closed Corporation	
Partnership	
Sole Proprietary	
Joint Venture / Consortium	
Co-operative	

(Mark the appropriate option)

2. Information to be provided

If the Tendering Entity is a:		**Documentation to be submitted with the tender**
1	Closed Corporation, incorporated under the Close Corporation Act,1984, Act 69 of 1984	CIPRO CK1 or CK2 (Certified copies of the founding statement) and list of members
2	Private Company incorporated with share capital, under the companies Act, 1973, Act 61of 1973 (Including Companies incorporated under Art 53 (b))	Certified copies of: a) CIPRO CM 1 - Certificate of Incorporation b) CIPRO CM 29 – Contents of Register of Directors, Auditors and Officers c) Shareholders Certificates of all Members of the Company, plus a signed statement of the Company's Auditor, certifying each Member's ownership/shareholding percentage relative to the total.
3	Private Company incorporated with share capital, under the companies Act, 1973, Act 61of 1973 in which any, or all, shares are held by another Closed Corporation or company with, or without, share capital.	Certified copies of documents referred to in 1 and/or 2 above in respect of all such Closed Corporations and/or Companies
4	Public Company incorporated with share capital, under the companies Act, 1973, Act 61of 1973 (Including Companies incorporated under Art 21)	A signed statement of the Company's Secretary confirming that the Company is a public Company.
5	Sole Proprietary or a Partnership	Certified copy of the Identity Document of: a) such Sole Proprietary, or b) Each of the Partners in the Partnership Certified copy of the Partnership agreement.
6	Co-operative	CIPRO CR2 - Certified copies of Company registration document.
7	Joint Venture / Consortium	All the documents (as described above) as applicable to each partner in the joint venture / consortium as well as a certified copy of the joint venture / consortium agreement.

Note:

1. If the shares are held in trust provide a copy of the Deed of Trust (only the front page and pages listing the trustees and beneficiaries are required) as well as the Letter of Authority as issued by the Master of the Supreme Court wherein trustees have been duly appointed and authorised
2. Include a certified copy of the Certificate of Change of Name (CM9) if applicable.

3. Registered for VAT proposes in terms of the Value-Added Tax Act (89 of 1991)

Yes	
No	

(Make an X in the appropriate space)

REGISTRATION NO: ________________________________

FORM RD.C.8 CLASSIFICATION OF BUSINESS

1. The Small Businesses are defined in the National Small Business Act, 1996 (Act 102 of 1996).

2. Information furnished with regard to the classification of Small businesses

   (a.) Indicate whether the company/entity is defined as a <u>small, medium or micro enterprise</u> by the National Small Business Act.

YES	NO

(Tick appropriate box)

   (b.) If the response to 2.(a.) is **YES**, the following must be completed:

      i. Sector/sub-sector in accordance with the Standard Industrial classification:

      ____

      ii. Size or class:

      ____

      iii. Total full-time equivalent of paid employees:

      ____

      iv. Total annual turnover:

      ____

      v. Total gross asset value (fixed property excluded):

      ____

(A schedule indicating the different sectors is attached to this form.)

   (c.) The tenderer should substantiate the information provided by submitting the following documentation:

      i. A letter from the tenderer’s auditor or an affidavit from the South African Police Services confirming the correctness of the abovementioned information,

      ii. Company profile indicating the tenderer’s staff compliment, and

      iii. 3 year financial statement or since their establishment if established during the past 3 years.

SCHEDULE OF SECTORS

SIZE OF CLASS	THE TOTAL FULL-TIME EQUIVALENT OF PAID EMPLOYEES	TOTAL TURNOVER	TOTAL GROSS ASSET VALUE (FIXED PROPERTY EXCLUDED)
AGRICULTURE			
Medium	100	R 5 mil	R 5 mil
Small	50	R 3 mil	R 3 mil
Very Small	10	R 500 000	R 500 000
Micro	5	R 200 000	R 100 000
MINING AND QUARRYING			
Medium	200	R 39 mil	R 23 mil
Small	50	R 10 mil	R 6 mil
Very Small	20	R 4 mil	R 2 mil
Micro	5	R 200 000	R 100 000
MANUFACTURING			
Medium	200	R 51 mil	R 19 mil
Small	50	R 13 mil	R 5 mil
Very Small	20	R 5 mil	R 2 mil
Micro	5	R 200 000	R 100 000
ELECTRICITY, GAS & WATER			
Medium	200	R 51 mil	R 19 mil
Small	50	R 13 mil	R 5 mil
Very Small	20	R 5.1 mil	R 1.9 mil
Micro	5	R 200 000	R 100 000
CONSTRUCTION			
Medium	200	R 26 mil	R 5 mil
Small	50	R 6 mil	R 1 mil
Very Small	20	R 3	R 500 000
Micro	5	R 200 000	R 100 000
RETAIL AND MOTOR TRADE & REPAIR SERVICES			
Medium	200	R 39 mil	R 6 mil
Small	50	R 19 mil	R 3 mil
Very Small	20	R 4 mil	R 600 000
Micro	5	R 200 000	R 100 000
WHOLESALE TRADE, COMMERCIAL AGENTS AND ALLIED SERVICES			
Medium	200	R 64 mil	R 10 mil
Small	50	R 32 mil	R 5 mil
Very Small	20	R 6 mil	R 600 000
Micro	5	R 200 000	R 100 000
CATERING, ACCOMMODATION AND OTHER TRADE			
Medium	200	R 13 mil	R 3 mil
Small	50	R 6 mil	R 1 mil
Very Small	20	R 5.1 mil	R 1.9 mil
Micro	5	R 200 000	R 100 000
TRANSPORT, STORAGE & COMMUNICATIONS			
Medium	200	R 26 mil	R 6 mil
Small	50	R 13 mil	R 3 mil
Very Small	20	R 3 mil	R 600 000
Micro	5	R 200 000	R 100 000
FINANCE & BUSINESS SERVICES			
Medium	200	R 26 mil	R 5 mil
Small	50	R 13 mil	R 3 mil
Very Small	20	R 3 mil	R 500 000
Micro	5	R 200 000	R 100 000
COMMUNITY, SOCIAL AND PERSONAL SERVICES			
Medium	200	R 13 mil	R 6 mil
Small	50	R 6 mil	R 3 mil
Very Small	20	R 1mil	R 600 000
Micro	5	R 200 000	R 100 000

FORM RD.C.9 CERTIFICATE OF AUTHORITY OF SIGNATORY

RESOLUTION of a meeting of the *Board of Directors/Members/Partners of

____

____

(Legally correct full name and registration number, if applicable, of the enterprise)

Held at: ______________________________ (place)

On: ______________________________ (date)

RESOLVED that:

1. The enterprise submits a tender to the Tshwane Metro Municipality in respect of the following project:

Tender Number:	**EEBU 07-2025.26**
Tender Description:	**TENDER FOR THE SUPPLY, DELIVERY, INSTALLATION, TESTING AND COMMISSIONING OF 1x300MVA POWER TRANSFORMER AT KWAGGA 275/132KV SUBSTATION WITH ASSOCIATED EQUIPMENT FOR A PERIOD OF THREE (3) YEARS**

2. *Mr/Ms:

*Mr/Ms:	
in *his/her capacity as	

and who will sign as follow:

Proof signature	Proof signature

be, and is hereby authorised to sign the tender, and any and all other documents and/or correspondence in connection with and relating to the tender for the enterprise mentioned above

NAME	CAPACITY	SIGNATURE

Note: 1. *Delete which is not applicable. 2. IMPORTANT: This resolution <u>must</u> be signed by all the directors/members/ partners of the tendering enterprise. 3. Should the number of directors/members/partners exceed the space available above, additional names and signatures must be supplied on a separate page.	Enterprise stamp

FORM RD.C.10 CERTIFICATE OF AUTHORITY OF SIGNATORY FOR JOINT VENTURES AND CONSORTIA

*Joint venture/consortium name: ______________________________

We, the undersigned, are submitting this tender in a *joint venture/consortium and hereby authorise *Mr/Ms

______________________________ authorised signatory of the enterprise

______________________________ acting in the capacity of lead partner

to sign the tender, and any and all other documents and/or correspondence in connection with and relating to the tender for the *joint venture/consortium mentioned above.

Registered name of enterprise	Registration number	% of contract value	Address	Duly authorised signatory	Mark with (x) for lead partner

Note:

1. *Delete which is not applicable.
2. IMPORTANT: This resolution <u>must</u> be signed by all the parties of the joint venture/consortium and every duly authorised signatory for each party to the joint venture/consortium <u>must</u> complete a Form RD.C.15.
3. Should the number of directors/members/partners exceed the space available above, additional names and signatures must be supplied on a separate page.

FORM RD.C.11 LETTER OF INTENT TO PROVIDE A PERFORMANCE BOND

It is hereby agreed that a Performance Bond drafted **exactly** as set out in the attached examples (See Section C1.3: Form of Guarantee) will be provided by the Surety named below:

Name of Surety (Bank or Insurer) ____________________

Address: ____________________

____

____

Signed:

____

Name: ____________________

Capacity: ____________________

On behalf of Tenderer (name of tenderer) ____________________

Date: ____________________

CONFIRMED BY Surety's Authorised representative

Signature(s):

____

Name (print): ____________________

Capacity ____________________

On behalf of Surety (Bank or Insurer) ____________________

Date: ____________________

Note: Refer to the Annexure to **C1.3 Form of Guarantee** for the List of Institutions from who Contract/Deposit Guarantees will be accepted.

FORM RD.C.12

BANK RATING REPORT

Banking Details:

Bank: ______________________________

Branch:

Name of Account: ______________________________

Account No: ______________________________

Type of Account: ______________________________

The Tenderer shall affix a Bank Rating Report, stamped and verified by the bank, to this page.

FORM RD.D.1 EVALUATION SCHEDULE: TEST CERTIFICATES FOR ELECTRICAL EQUIPMENT
The letter must bear the name of the bidder

Equipment	Submitted Type Test Report or Certificate. State YES/NO	Test Laboratory / Institution	Date of Testing
Item C2.1.5.02.1.1 Circuit Breakers-132kV			
Item C2.1.5.02.1.2 Circuit Breakers-275kV			
Item C2.1.5.03.1.1 Disconnector Switches-132kV			
Item C2.1.5.03.1.2 Disconnector Switches-275kV			
Item C2.1.5.04.1.1 Surge Diverters-132kV			
Item C2.1.5.04.1.2 Surge Diverters-275kV			
Item C2.1.5.05.1.1 Voltage Transformers-132kV			
Item C2.1.5.05.1.2 Voltage Transformers-275kV			
Item C2.1.5.05.2.1 Current Transformers 132kV			
Item C2.1.5.05.2.2 Current Transformers 275kV			
Item C2.1.5.07.1.1 Insulators 132kV			

Item C2.1.5.07.1.2 Insulators 275kV			
Item C2.1.5.10.6.1 TRF 300MVA (275/132kV) including 275kV and 132kV bushings			
Item C2.1.5.10.6.1 275kV transformer bushings			
Item C2.1.5.10.6.1 132kV transformer bushings			

FORM RD.D.2: SCHEDULE OF TENDERER'S EXPERIENCE

The following is a statement of similar work successfully executed by myself/ourselves.

Employer, contact person and telephone number	Description of contract	Value of work	*Date of appointment	**Date of completion

* Attach signed copies of contract appointment letters
** Attach signed copies of contract completion certificates

(Attach additional pages if more space is required)

FORM RD.D.2 EVALUATION SCHEDULE: SCHEDULE OF TENDERER'S EXPERIENCE

<table>
<tr>
<td rowspan="5">TENDERER'S EXPERIENCE

Complete Form RD.D.2 and attach <u>signed</u> copies of contract appointment letters and project completion certificates for work successfully completed by the tenderer. Completed projects must be turnkey which includes (design, supply, delivery, installation, testing, and commissioning of electrical equipment). Only completed projects of High/Medium Voltage substations will be considered. (i.e.132/11Kv) or Higher

NB The projects completed must be of building and refurbishment of Electrical Substations that includes the following as minimum (Power transformers, Circuit breakers, Isolators, Switchgear Panels, SCADA & Batteries)

(Failure to complete Form RD.D.2 will result in automatic disqualification)
TENDERER'S EXPERIENCE</td>
<td colspan="4">Only projects with verifiable documentary proof in the form of both appointment letter(s) and completion certificate(s) will be considered and awarded points.</td>
</tr>
<tr>
<td>Appointment letters and Completion certificates for a minimum of three projects with accumulated value of between R10 million and R30 million</td>
<td>1</td>
<td rowspan="4">5</td>
<td rowspan="4">35</td>
</tr>
<tr>
<td>Appointment letters and Completion certificates for a minimum of three projects with accumulated value of between R30 million and R60 million</td>
<td>3</td>
</tr>
<tr>
<td>Appointment letters and Completion certificates for a minimum of three projects with accumulated value of between R61 million and R90 million</td>
<td>5</td>
</tr>
<tr>
<td>Appointment letters and completion certificates for a minimum of three projects with accumulated value of R91 million and above</td>
<td>7</td>
</tr>
</table>

FORM RD.D.3: KEY PERSONNEL EXPERIENCE - MANAGEMENT AND SUPERVISORY STAFF

The tenderer shall list in the table below the key personnel to be engaged for this project.

Note: Form RD.D.3 must be complete for each person listed below.

	NAME	CATEGORY [4]	LOCAL / NON LOCAL
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

(Attach additional pages if more space is required)

[4] The Contractor shall fill in the various categories, e.g. Site, Agent, Foreman, Trainers, Plant Operators, Clerks, Technicians, Laboratory Assistants, etc. as required.

FORM RD.D.3: CURRICULUM VITAE OF KEY PERSONNEL

Note: This form should be completed for each key person listed in Form RD.D.3

Name:	**Date of birth:**
Profession:	**Nationality:**
Qualifications:	
Professional membership:	
Name of employer (firm):	
Current position:	**Years with firm:**
Employment record: (list in chronological order starting with earliest work experience)	
Experience record pertinent to required service:	
Certification: **I, the undersigned, certify that to the best of my knowledge and belief, this data correctly describes me, my qualifications and my experience.** _______________________________ *(Signature of person named in schedule)*	 _______________________ Date:

RD.D. 3 Evaluation Schedule: Key personnel experience and health and safety officer – Management, Supervisory staff and Safety Officer

<table>
<tr><td>KEY PERSONNEL EXPERIENCE

The tenderer must have in his employees, personnel engineers with experience in Electrical, Civil Engineering and Project Management in electrical turnkey projects:

Years of experience as professional Electrical Engineer/Technologist/ Project Manager after registration from the professional body</td><td colspan="4">ECSA Electrical and Structural or Civil Engineering registration and detailed CV indicating years of staff's experience in Electrical and Civil or Structural engineering.

SACPCMP (South African Council for Project and Construction Management Professions) registration and detailed CV indicating years of experience in building and commissioning of electrical projects

There must be a minimum of 1 key personnel for each discipline.

Professional Electrical Engineer or
Professional technologist electrical
Professional Civil of Structural engineer
Professional technologist
Professional project manager)</td></tr>
<tr><td></td><td>SUB-CRITERIA SCALE</td><td>SCALE</td><td>WEIGHT</td><td>HIGHEST POSSIBLE SCORE</td></tr>
<tr><td>Total sum of years' experience of Professional Electrical Engineer/s Technologist post registration from Engineering Council of South Africa</td><td>3-5 Years
6-8 Years
9 Years or more</td><td>1
2
3</td><td>5</td><td>15</td></tr>
<tr><td>Total sum of years' experience of Professional Civil or Structural Engineer or Technologists post registration from Engineering Council of South Africa</td><td>3-5 Years
6-8 Years
9 Years or more</td><td>1
2
3</td><td>5</td><td>15</td></tr>
<tr><td>Total sum of years' experience of Construction Project Manager post registration to professional body</td><td>3-5 Years
6-8 Years
9 Years or more</td><td>1
2
3</td><td>5</td><td>15</td></tr>
</table>

FORM RD.D.4 QUALITY MANAGEMENT SYSTEM

Briefly describe the construction quality system incorporated by the tenderer in his organisation and which will be applicable to this Contract.

	Internal	**External**	**Name of responsible Company /or Person (In case of Person give years' experience and qualification)**
Survey: Setting out of the works and control			
Testing Laboratory			
Additional quality systems			

RD.D. 4 Evaluation Schedule: Quality Management System

CRITERIA	SUB-CRITERIA	SCALE	WEIGHT	HIGH POSSIBLE SCORE
Quality Management System	Provide company's ISO 9001 compliance certificate	1	10	10
	Provide company's ISO 14001 compliance certificate	1	10	10

FORM RD.E.1 RECORD OF ADDENDA TO TENDER DOCUMENTS

We confirm that the following communications received from the Employer before submission of this tender, amending or amplifying the tender documents, have been taken in account in this tender offer:

	DATE	REFERENCE	TITLE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Person authorized to sign the tender:

Full name (in BLOCK letters): ______________________

Signature: ______________________

Date:

FORM RD.E. 2 PROPOSED AMENDMENTS

The Tenderer should record any deviations or qualifications he may wish to make to the tender documents in this Returnable Schedule. Alternatively, a tenderer may state such deviations and qualifications in **a covering letter to his tender and reference such letter in this schedule.**

The Tenderer's attention is drawn to clause 3.8 of the Standard Conditions of Tender referenced in the Tender Data regarding the Employer's handling of material deviations and qualifications.

PAGE	CLAUSE OR ITEM	PROPOSAL

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Person Authorized to sign Tender: ....

FULL NAME (BLOCK LETTERS): ....

SIGNATURE: ....

DATE:

FORM RD.E. 3

COST PRICE ADJUSTMENT (CPA) LOCAL CONTENT (SEIFSA)

Is/Are the tender price/s firm until the end of contract period? ***(YES/NO)***
If not: ....

....

....

LOCAL CONTENT:

Submit the cost factors which will be taken into account in the event of price increase/decrease, as well as the compilation of the tender price/s, i.e. cost price, transport cost, margin of profit, etc.

		INDEX FIGURE AND BASE DATE (E.G., SEIFSA TABLE E1)
Fixed	a= 0.1	
Material	b=	
Labour	c=	
Transport	d=	
Profit	e=	
Other		
Total	1	

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Person Authorized to sign Tender: ....

FULL NAME (BLOCK LETTERS): ....

SIGNATURE: ....

DATE:

FORM RD.E. 4 COST PRICE ADJUSTMENT (CPA) IMPORTED CONTENT (FOREX)

Is/Are the tender price/s firm until the end of contract period? ***YES/NO):***
If not:

IMPORTED CONTENT:

When the price/s is/are subject to the rate of exchange, submit the price basis on which the exchange rate will be based (e.g. F.O.B. value, fixed value in respect of foreign exchange, etc.)

(i) exchange rate upon which the bid price is based

....

....

....

....

(ii) What portion of the bid price (percentage or amount) will be affected by variations in the exchange rate?

....

....

....

....

<u>NB</u>: ***Tenderers are also required to submit a bank statement or an auditor's report regarding the actual exchange rate in respect of the transaction value paid to the overseas supplier.***

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

<u>Person Authorized to sign Tender:</u> ....

FULL NAME (BLOCK LETTERS): ....

SIGNATURE: ....

DATE:

FORM RDE 6P VERIFICATION ON SCHEDULE OF PARTICULARS & GUARANTEES
(The letter must bear the name of the bidder)

All bidders must complete the form in full. Failure to provide the required detailed information called for in the schedules will result in the bidders to be disqualified.
CONTENTS

PART	DESCRIPTION	Verify if the requirements that are specified in the following schedules of particulars and guarantees 1. Are the schedules completed in full? State YES or NO 2. Do all items comply fully to the specifications required? State YES or NO 3. Do all items stated comply with IEC and SABS specifications? State YES or NO		
		1.	2.	3.
1	Circuit breakers 132kV			
2	Circuit breakers 275kV			
3	Disconnectors Switches 132kV			
4	Disconnectors Switches 275kV			
5	Surge diverts 132kV			
6	Surge diverts 275kV			
7	Voltage Transformers 132kV			
8	Voltage Transformers 275kV			
9	Current Transformers 132kV			
10	Current Transformers 275kV			
11	Insulators 132kV			
12	Insulators 275kV			
13	TRF 300MVA (275/132kV)			
14	275kV transformer bushings			
15	132kV transformer bushings			

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Person Authorized to sign Tender:

FULL NAME (BLOCK LETTERS): ……………………………………………………………………

SIGNATURE: ……………………………………………………………………

DATE: ……………………………………………………………………

C1.1 FORM OF OFFER AND ACCEPTANCE

STAMP

OFFER

The Employer, identified in the Acceptance signature block, has solicited offers to enter into a contract in respect of the following works:

EEBU 07-2025.26 TENDER FOR THE SUPPLY, DELIVERY, INSTALLATION, TESTING AND COMMISSIONING OF 1x300MVA POWER TRANSFORMER AT KWAGGA 275/132KV SUBSTATION WITH ASSOCIATED EQUIPMENT FOR A PERIOD OF THREE (3) YEARS

The Tenderer, identified in the Offer signature block below, has examined the documents listed in the Tender Data and addenda thereto as listed in the Returnable Schedules, and by submitting this Offer has accepted the Conditions of Tender.

By the representative of the Tenderer, deemed to be duly authorised, signing this part of this Form of Offer and Acceptance, the Tenderer offers to perform all of the obligations and liabilities of the Contractor under the contract including compliance with all its terms and conditions according to their true intent and meaning for an amount to be determined in accordance with the conditions of contract identified in the Contract Data.

THE OFFERED TOTAL OF PRICES INCLUSIVE OF VALUE ADDED TAX IS

R _______________ *(in figures)*

_______________ *(in words)*

This Offer may be accepted by the Employer by signing the Acceptance part of this Form of Offer and Acceptance and returning one copy of this document including the Schedule of Deviations (if any) to the Tenderer before the end of the period of validity stated in the Tender Data, whereupon the Tenderer becomes the party named as the Contractor in the conditions of contract identified in the Contract Data.

FOR AND ON BEHALF OF THE TENDERER:

NAME:
(In BLOCK letters) _______________

CAPACITY:
(Of authorized agent) _______________

SIGNATURE:
(Of authorized agent) _______________

SIGNED at _______________ on this _______ day of _______________

WITNESSES:
(Full name in BLOCK letters and signature)

1. _______________ _______________

2. _______________ _______________

ACCEPTANCE

By signing this part of this Form of Offer and Acceptance, the Employer identified below accepts the Tenderer's Offer. In consideration thereof, the Employer shall pay the Contractor the amount due in accordance with the, conditions of contract identified in the Contract Data. Acceptance of the Tenderer's Offer shall form an agreement, between the Employer and the Tenderer upon the terms and conditions contained in this agreement and in the contract that is the subject of this agreement.

The terms of the contract, are contained in:

Part C1 Agreements and Contract Data
Part C2 Pricing Data
Part C3 Scope of Work
Part C4 Site Information

and drawings and documents or parts thereof, which may be incorporated by reference into the above listed Parts.

Deviations from and amendments to the documents listed in the Tender Data and any addenda thereto listed in the Returnable Schedules as well as any changes to the terms of the Offer agreed by the Tenderer and the Employer during this process of offer and acceptance, are contained in the Schedule of Deviations attached to and forming part of this Form of Offer and Acceptance. No amendments to or deviations from said documents are valid unless contained in this Schedule.

The Tenderer shall within two weeks of receiving a completed copy of this agreement, including the Schedule of Deviations (if any), contact the Employer's agent (whose details are given in the Contract Data) to arrange the delivery of any securities, bonds, guarantees, proof of insurance and any other documentation to be provided in terms of the conditions of contract identified in the Contract Data. Failure to fulfil any of these obligations in accordance with those terms shall constitute a repudiation of this agreement.

Notwithstanding anything contained herein, this agreement comes into effect on the date when the Tenderer receives one fully completed original copy of this document, including the Schedule of Deviations (if any). Unless the Tenderer (now Contractor) within five days of the date of such receipt notifies the Employer in writing of any reason why he cannot accept the contents of this agreement, this agreement shall constitute a binding contract between the parties.

FOR AND ON BEHALF OF THE EMPLOYER:

NAME:
(In BLOCK letters) ______________________________

CAPACITY:
(Of authorized agent) ______________________________

SIGNATURE:
(Of authorized agent) ______________________________

SIGNED at ____________________ on this __________ day of ____________________

WITNESSES:
(Full name in BLOCK letters and signature)

1. ____________________ ____________________

2. ____________________ ____________________

SCHEDULE OF DEVIATIONS

Notes:

1. The extent of deviations from the tender documents issued by the employer prior to the tender closing date is limited to those permitted in terms of the conditions of tender;
2. A tenderer's covering letter shall not be included in the final contract document. Should any matter in such, letter, which constitutes a deviation as aforesaid become the subject of agreements reached during the process of, offer and acceptance, the outcome of such agreement shall be recorded here;
3. Any other matter arising from the process of offer and acceptance either as a confirmation, clarification or change to the tender documents and which it is agreed by the parties becomes an obligation of the contract shall also be recorded here;
4. Any change or addition to the tender documents arising from the above agreements and recorded here shall also be incorporated into the final draft of the contract.

4.1 Subject: ____________________

____

Details: ____________________

____

4.2 Subject: ____________________

____

Details: ____________________

____

4.3 Subject: ____________________

____

Details: ____________________

____

4.4 Subject: ____________________

____

Details: ____________________

____

4.5 Subject: ____________________

____

Details: ____________________

____

By the duly authorised representatives signing this agreement, the employer and the Tenderer agree to and accept the foregoing Schedule of Deviations as the only deviations from the amendments to the documents listed in the Tender Data and addenda thereto as listed in the Tender Schedules, as well as any confirmation, clarification or change to the terms of the offer agreed by the Tenderer and the Employer during this process of offer and acceptance.

It is expressly agreed that no other matter whether, oral communication or implied during the period between the issue of the tender documents and the receipt by the Tenderer of a completed signed copy of this Agreement shall have any meaning or effect in the contract between the parties arising from this Agreement.

FOR AND ON BEHALF OF THE TENDERER:

NAME:
(In BLOCK letters) ______________________________

CAPACITY:
(Of authorized agent) ______________________________

SIGNATURE:
(Of authorized agent) ______________________________

SIGNED at ____________________ on this __________ day of ____________________

WITNESSES:
(Full name in BLOCK letters and signature)

1. ____________________ ____________________

2. ____________________ ____________________

FOR AND ON BEHALF OF THE EMPLOYER:

NAME:
(In BLOCK letters) ______________________________

CAPACITY:
(Of authorized agent) ______________________________

SIGNATURE:
(Of authorized agent) ______________________________

SIGNED at ____________________ on this __________ day of ____________________

WITNESSES:
(Full name in BLOCK letters and signature)

1. ____________________ ____________________

2. ____________________ ____________________

CONFIRMATION OF RECEIPT

The Tenderer, (now Contractor), identified in the Offer part of this Agreement hereby confirms receipt from the Employer, identified in the Acceptance part of this Agreement, of one fully completed original copy of this Agreement, including the Schedule of Deviations (if any) today the _________________________ (day) of _________________________ (month) _____________ (year) at ____ (place).

FOR AND ON BEHALF OF THE CONTRACTOR:

NAME:
(In BLOCK letters) ______________________________

CAPACITY:
(Of authorized agent) ______________________________

SIGNATURE:
(Of authorized agent) ______________________________

SIGNED at ______________________ on this ________ day of ______________________

WITNESSES:
(Full name in BLOCK letters and signature)

1. ______________________ ______________________

2. ______________________ ______________________

C1.2 CONTRACT DATA

TABLE OF CONTENTS

C.1.2.1 GENERAL CONDITIONS OF CONTRACT

The general conditions of contract applicable to this contract shall be **General Conditions of Contract for Construction Works, Third Edition (2015)** of the South African Institution of Civil Engineering (SAICE), read together with the Variations and Additions to the Conditions of Contract as well as the Data provided by Employer.

Tenderers, contractors and subcontractors shall obtain their own copies of the document **General Conditions of Contract for Construction Works, Third Edition (2015)** for tendering purposes and for use for the duration of the contract from the Secretary of the South African Institution of Civil Engineering, Private Bag X200, Halfway House, Midrand, 1685 and shall bear all expenses in this regard:

South African Institution of Civil Engineering (SAICE)
Telephone: 011 80505947 / 48 / 53
E-Mail: civilinfo@saice.org.za
Web: www.saice.org.za

C1.2.2 VARIATIONS AND ADDITIONS TO THE CONDITIONS OF CONTRACT

The following variations and additions to the **General Conditions of Contract for Construction Works, Third Edition (2015)**, shall apply to this contract:

CLAUSE / SUB-CLAUSE	DESCRIPTION	VARIATION / ADDITION
1.1.1	Definitions	**1.1.1.3 Certificate of Completion** **<u>Add</u>** the following to the clause: *Unless specified otherwise in the Contract Data, separate Certificates of Completion will not be issued for portions or phases of the Works.*
		1.1.1.24 Practical Completion **<u>Add</u>** the following to the clause: *This clause shall apply mutatis mutandis to any portion or phase of the Works that may be described in the Scope of Works or in the Contract Data, or agreed subsequently between the Contractor and the Employer, and committed to in writing.*
		<u>Add</u> the following new clause: *1.1.1.35 Construction Work Permit* *Construction Work Permit" means a statutory permit as defined in the Construction Regulations 2014.*
1.2.1	Delivery of notices	**<u>Add</u>** the following to the clause: *1.2.1.3 Sent by facsimile, electronic or any like communication irrespective of time of transmission;* *1.2.1.4 posted to the Contractor's address, and delivered by the postal authorities; or* *1.2.1.5 delivered by a courier service or messenger, and signed for by the recipient or his representative.*
1.2.3	Authority of representatives	**<u>Add</u>** the following to the clause: *1.2.3.1 The Employer has authorised the **Divisional Head: Transport Infrastructure Design & Construction** to act on his behalf in respect of this Contract, save for such duties or functions:* *1.2.3.1.1 which other holders of office ex officio execute on behalf of the Employer; or* *1.2.3.1.2 for which the **Divisional Head: Transport Infrastructure Design & Construction** has no authority and the Employer's approval is required before execution thereof.*
2.4.1	Ambiguity or Discrepancy	**<u>Delete</u>** the contents of the clause and insert the following:

		The documents forming the Contract are to be taken as mutually explanatory of one another. For the purposes of interpretation, the priority of the documents shall be in accordance with the following sequence, listed from highest to lowest priority: *a) Form of Offer and Acceptance* *b) Contract Data* *c) General Conditions of Contract* *d) Drawings* *e) Scope of Work* *f) Standard Specifications* *g) Bill of Quantities* *h) any other documents forming part of the Contract* *Upon finding any ambiguity in, or discrepancy between, or otherwise any error in the documents, the Contractor shall forthwith advise the Employer's Agent thereof before applying an interpretation in accordance with the above priority. If, after applying the above priority, an ambiguity in, or discrepancy between, or otherwise any remaining error in the documents remains, the Employer's Agent shall provide the necessary clarification or instruction.*
3.2.3	Specific approval of the Employer required	**Replace** clause 3.2.3 with the following: *In addition to the functions or duties set out in the Contract Data under Data Provided By The Employer, the Employer's Agent is required to obtain the specific prior approval of the Employer for:* *3.2.3.1 certification of expenditure that exceeds the Contract Price in terms of Clause 1.1.1.10;* *3.2.3.2 issuing of an order to suspend the progress of the Works in terms of Clause 5.11.2, the extra cost resulting from which order is to be borne by the Employer or the effect of which is liable to give rise to a claim by the Contractor for an extension of time under Clause 5.12 of these conditions;* *3.2.3.3 issuing of an instruction or order to vary the nature or quantity of the Works in terms of Clause 6.3, the estimated effect of which will be to increase the Contract Price by an amount exceeding R100 000, the evaluation of all variation orders in terms of Clause 6.4 and the adjustment of the sum(s) tendered for General Items in terms of Clause 6.11; or* *3.2.3.4 approval of any claim submitted by the Contractor in terms of Clause 10.1.*
4.1.2	Contractor's liability for own design errors	**Add** the following to the clause: *The Contractor shall provide the following to the Employer's Agent for retention by the Employer or his assignee in respect of all works designed by the Contractor:*

		4.1.2.1 A Certificate of Stability of the Works signed by a registered Professional Engineer confirming that all such works have been designed in accordance with the appropriate codes of practice. *4.1.2.2 Proof of registration and of adequate and current professional indemnity insurance cover held by the designer(s).* *4.1.2.3 Design calculations should the Employer's Agent request a copy thereof.* *4.1.2.4 Engineering drawings and workshop details (both signed by the relevant professional engineer), in order to allow the Employer's Agent to compare the design with the specified requirements and to record any comments he may have with respect thereto.* *4.1.2.5 "As-Built" drawings in DXF electronic format after completion of the Works.* *The Contractor shall be responsible for the design of the Temporary Works.*
4.3	Legal Provisions	**Add** the following new sub-clause: *4.3.3 Wages and conditions of work:* *i. For conventional construction works the Basic Conditions of Employment Act of 1997 (Act No 75 of 1997) shall apply and the minimum employment conditions which will apply shall be guided by the Bargaining Council for the Civil Engineering Industry Collective Agreement as published from time to time.* *ii. Basic Conditions of Employment Act of 1997 (Act No 75 of 1997) as per Government Notice R63 of 25 January 2002, shall apply to works described in the Scope of Work as being labour intensive and which are undertaken by unskilled or semi-skilled workers.*
		Add the following new sub-clause: *4.3.4 Notwithstanding any actions which the Employer may take, the Contractor accepts sole liability for due compliance with the relevant duties, obligations, prohibitions, arrangements and procedures imposed by the Occupational Health and Safety Act, 1993 (Act 85 of 1993), and all its regulations, including the Construction Regulations, 2014, for which he is liable as mandatory. By entering into this Contract it shall be deemed that the parties have agreed in writing to the above provisions in terms of Section 37(2) of the Act. The Contractor shall sign the Occupational Health and Safety Agreement for Contract Work in the City of Tshwane Metropolitan Municipality included in section C1.5.*
		Add the following new sub-clause: *4.3.5 The Employer retains an interest in all inquiries conducted under this Contract in terms of Section 31 and/or 32 of the Occupational Health*

		and Safety Act, 1993 (Act 85 of 1993) and its Regulations following any incident involving the Contractor and/or Sub-Contractor and/or their employees. The Contractor shall notify the Employer in writing of all investigations, complaints or criminal charges which may arise pursuant to work performed under this Contract in terms of the Occupational Health and Safety Act, 1993 (Act 85 of 1993) and Regulations.
		Add the following new sub-clause: *4.3.6 Contractor's Designer* *The Contractor and his designer shall accept full responsibility and liability to comply with the Occupational Health and Safety Act, 1993 (Act 85 of 1993) and the Construction Regulations, 2014 for the design of the Temporary Works and those part of the Permanent Works which the Contractor is responsible to design in terms of the Contract*
		Add the following new sub-clause: *4.3.7 Construction Work Permit* *Unless duly exempted or otherwise duly agreed with the Contractor, the Employer shall forthwith, where a Construction Work Permit in terms of Regulation 3(1) of the Construction Regulations 2014 is required to be obtained by the Employer without derogation from the Employer's duties, the Employer or his duly appointed Construction Health and Safety Agent in terms of Regulation 5(6) or otherwise, upon the Construction Work Permit becoming available, issue it to the Employer's Agent, who, in turn, shall forthwith issue it to the Contractor.* *Notwithstanding anything stipulated to the contrary in these Conditions, the Contractor shall not be entitled to any claim or extension of time arising from any delay in obtaining a Construction Work Permit which has been duly applied for, unless such delay exceeds 84 consecutive days.*
5.3.3	Time to instruct the commencement of the works	**Replace** both periods of "*7 days*" in Clause 5.3.3 with "*14 days*".
5.6.1	Programme of works	**Add** the following to the clause: *The Contractor shall have regard for the phases and sub-phases (if applicable) for the Works, which shall also be the order in which the Permanent Works shall be constructed, unless otherwise agreed between the parties and committed to writing. If phased construction is applicable, the phases and sub-phases will be described in the Scope of Works and/or will be indicated on the Phasing Plan which forms part of the Drawings.*
5.7.1	Rate of progress	**Delete** the last paragraph of the clause and replace with the following: *No instruction by the Employer's Agent to the Contractor to improve his rate of progress in this regard will qualify for additional compensation, unless the instruction explicitly states that the Contractor is entitled to additional*

		compensation and cites the amount of such compensation or the basis upon which it is to be determined.
5.9.2	Further drawings and instructions	**Add** the following to the clause: *All instructions shall be in writing*
5.12	Extension of time for Practical Completion	**Add** the following new sub-clause *5.12.5 Critical path provision* *A delay in so far as extension of time is concerned, will be regarded as a delay only if, on a claim by the Contractor in accordance with the General Conditions of Contract, the Employer's Agent rules that all progress on an item or items of work on the critical path of the approved programme for the execution of the Works by the Contractor, has been brought to a halt. Delays on normal working days only, based on a working week, of five normal working days, will be taken in account for the extension of time.*
		Add the following new sub-clause *5.12.6 Extension of time due to abnormal rainfall* *Extension of time due to abnormal rainfall shall be determined by means of Method 1, if rainfall records and/or values derived from rainfall records are supplied in the Scope of Work, otherwise Method 2 shall apply.* *Method 1: Rainfall formula method* *The rainfall records and/or values derived from rainfall records from a suitable rainfall station near the Site, which are supplied in the Project Specifications, shall be considered suitable for the determination of extension of time due to abnormal rainfall in accordance with this method.* *Extension of time arising from abnormal rainfall, shall be calculated separately for each calendar month or part thereof for the full period of completion of the Contract, including any extension thereof, in accordance with the rainfall formula given below:* $$V = (N_w - N_n) + \frac{(R_w - R_n)}{X}$$ *If V is negative and its absolute value exceeds N_n, then V shall be equal to minus N_n.* *If V is positive and greater than the number of calendar days in the calendar month under consideration, V shall be taken as equal to the number of calendar days in the relevant calendar month.* *The symbols shall have the following meaning:*

		V = *Extension of time in calendar days in respect of the calendar month under consideration* N_w = *Actual number of days during the calendar month on which a rainfall of Y mm or more has been recorded.* R_w = *Actual rainfall in mm for the calendar month under consideration.* N_n = *Average number of days as derived from existing rainfall records, on which a rainfall or Y mm or more has been recorded for the calendar month. Rainfall records and/or the derived values of N_n will be provided in the Specifications.* R_n = *Average rainfall in mm for the calendar month, as derived from existing rainfall records. Rainfall records and/or the derived values of R_n will be provided in the Project Specifications.* X = *20 unless otherwise provided in the Project Specifications* Y = *10 unless otherwise provided in the Project Specifications* *The total extension of time shall be the algebraic sum of the monthly totals for the period under consideration. However, if the grand total is negative the time for completion shall not be reduced on account of abnormal rainfall. Extension of time for parts of a month shall be calculated by pro rata values of N_n and R_n being used.* *The factor $(N_w - N_n)$ shall be considered to represent a fair allowance for variations from the average number of days during which rainfall exceeds Y mm and wet conditions prevented or disrupted work.* *The factor $\frac{(R_w - R_n)}{X}$ shall be considered to represent a fair allowance for variations from the allowance for variations from the average number of days when wet conditions further to that allowed for the factor $(N_w - N_n)$, prevented or disrupted work during the calendar month.* *Accurate rain gauging shall be taken at a suitable point on Site and the Contractor shall, at his own expense, take all necessary precautions to ensure that the rain gauges cannot be interfered with.* *This formula does not take into account further on concurrent delays which could be caused by other abnormal climatic conditions such as floods, which have to be determined separately in accordance with Sub-Clause (5.12.5 Critical Plath Provision) hereof.* *<u>Method 2: Expected delay method</u>* *The Contractor shall make provision in his programme for the execution of the Works, for an expected delay of "n" normal working days (based on a working week of five normal working days) due to normal rainfall, for which he will not receive any extension of time.*

		Unless otherwise provided in the Project Specifications, the value of "n" shall be taken as equal to the tendered time for completion of the Works in months, rounded off to an integer. *Extension of time during normal working days will be granted to the degree to which actual delays as determined in accordance with Sub-Clause (5.12.5 Critical Path Provision) hereof, exceed the number of "n" normal working days.* *The value of "n" does not take into account further or concurrent delays which are caused by other abnormal climatic conditions such as floods, which have to be determined separately in accordance with Sub-Clause (5.12.5 Critical Path Provision) hereof.*
6.1	Payment to Contractor	**Add** the following new sub-clause: *6.1.2 Payment for works identified in the Scope of Work as being labour-intensive shall only be made in accordance with the provisions of the Contract if the works are constructed strictly in accordance with the provisions of the Scope of Work. Any non-payment for such works shall not relieve the Contractor in any way of his obligations either in contract or in delict.*
		Add the following new sub-clause: *6.1.3 The Contractor's payment invoices shall be accompanied by labour information for the corresponding period in a format specified by the employer. If the Contractor chooses to delay submitting payment invoices, labour returns shall still be submitted as per frequency and timeframe stipulated by the employer. The Contractors invoices shall not be paid until all pending labour information has been submitted.*
		Add the following new sub-clause *6.1.4 The Contractor shall be paid at Pretoria in the currency of the Republic of South Africa only at the Office of the Chief Financial Officer of the CITY OF TSHWANE, unless otherwise stated in the Data provided by Employer.*
6.2	Security	**Add** the following new sub-clause: *6.2.4 As an alternative to a performance guarantee, the Contractor may deposit with the Employer a cash amount in a sum equal to the amount stated in the Data provided by Employer. All the provisions in respect of the guarantee apply mutatis mutandis to the cash deposit accept that the amount deposited will be repaid to the Contractor within 30 (txaw2xde d34crv c3hirty) days after the issue of the Certificate or Certificates of Completion in respect of the whole of the permanent works.*
8.6	Insurances	**Replace** clause 8.6 with the following: ***8.6 Insurances***

		8.6.1 Without limiting the Contractor's/Sub-contractor's obligation in terms of the Contract, the Employer will effect and maintain for the duration of the Contract until the issuing of the Final Approval Certificate, the following insurances in the name of the Contractor (including all Subcontractors whether nominated or otherwise): *8.6.1.1 The Employer's insurer will indemnify the Contractor/Sub-contractor against physical loss of or damage to any part of the Property Insured not exceeding the maximum contract value or the final contract value estimated at inception including free issue materials were applicable as stated in the Contract Data:* *a. Whilst in transit including loading and unloading whilst temporarily stored at any premises and route to or from the Contract Site within the Territorial Limits;* *b. From the time of unloading, dismantling or preparation at the Contract Site and thereafter until the Property Insured has been officially accepted by the Employer and becomes his responsibility by means of a notice of completion certificate or similar evidence of legal transfer of risk;* *c. During the contractual defects liability or Maintenance Period which shall not exceed the period reflected in the Schedule but only so far as the Contractors and/or Sub-Contractors may be liable for such loss or damage under the defects liability or maintenance condition/s of the Insured Contract;* *d. Removal of debris;* *e. Surrounding property* *f. Work away;* *g. Off-site storage* *h. Temporary repairs;* *i. Contribution clause – marine;* *j. Escalation during Contract Period;* *k. Post loss escalation;* *l. Automatic reinstatement;* *m. Principals maintenance;* *n. Property taken over;* *o. Beneficial occupation;* *p. Escalation due to currency fluctuation;* *q. Manufacturers guarantees* *8.6.1.2 The Employer's insurer will indemnify the Contractor/Sub-contractor against all sums for which the Contractor/Sub-contractor shall become legally liable towards third party claimants to pay for and in consequence of:* *a. Accidental death of or bodily injury to or illness or disease contracted by any person (excluding employees of the Contractor/Subcontractor);* *b. Accidental physical loss or damage to tangible property occurring during the Period of Insurance and arising out of or in connection with the performance of the Insured Contract at the Contract Site as defined in the Schedule. The minimum limit of indemnity for any one event is R10-million in respect of contracts with a contract value of up to R50-million (excluding VAT).*

		8.6.2 Insurance premium payable *The Employer will pay the insurance premium for the works damage and public liability insurance cover. The insurance premium will be calculated based on the approved Capital Budget per financial year and the insurance premium will be charged out to the relevant departments by the Section: Insurance and Risk Management.* *8.6.3 Additional insurance by the Employer* *The Employer shall be free to effect at his own cost any additional insurance, which he deems necessary in own interest to cover loss or damage not insured in terms of the insurance policies of Sub-Clause 8.6.1.1 of this Clause.* *8.6.4 Additional insurance by the Contractor / Subcontractor* *The Contractor and Sub-contractor shall be free to effect and maintain at their own cost any additional insurance which the Contractor/Subcontractor deem necessary to cover damage, loss or injury not insured in terms of the insurance effected by the Employer's insurer. The cost of the additional insurance will be for the account of the Contractor/Subcontractor.* *8.6.5 Contractor satisfied with insurance* *The submission of a tender shall be construed as acknowledgement by the Contractor that he is satisfied with the insurance cover affected by the Employer.* *8.6.6 Contractor to observe conditions* *The Contractor shall give all notices and observe all conditions and requirements imposed by the relevant insurance policies, which shall be binding on the Contractor.* *8.6.7 Contractor to insure* *The Contractor/Sub-contractor must obtain for the duration of the contract until the issuing of the Final Approval Certificate, the following insurance policies at an insurance company within 14 (fourteen) days of the notification of acceptance of the tender and must pay all premiums and supply proof thereof to the relevant Employer's Agent, 30 (thirty) days before the inception of the contract, that the policies have been taken out and that all premiums have been paid:* *a. All Risk Insurance cover with regard to all Plant and Materials and Equipment, owned, leased or hired by the Contractor that are used in the execution of the contract for the full replacement value thereof.* *b. Motor Vehicle and Liability Insurance cover indicating the registration numbers of the vehicles owned, leased or hired by the Contractor that are used in the execution of the contract to the amount of at least R10-million per claim with the number of claims unlimited.*

		c. *SASRIA cover for motor vehicles and Plant and Materials and Equipment owned, leased or hired by the Contractor that are used in the execution of the contract for the full replacement value thereof.* *d.* *In respect of Plant and Materials and Equipment and Motor Vehicles brought onto the Site by or on behalf of Subcontractors, the Contractor shall be deemed to have compiled with the provisions of this Sub-Clause by ensuring that such Subcontractors have similarly insured such Plant and Materials and Equipment and Motor Vehicles.* *e.* *Proof must also be submitted that the Contractor complies with the conditions of the following legislation:* - *Compensation for Occupational Injuries and disease, 1993* - *Unemployment Insurance Act, 1996* - *The Contractor shall in respect of the Site of the contract works appoint in writing a Section 16 appointee to meet the requirements of the Health and Safety Act, No 85 of 1993 as amended.* *8.6.8* *The Employer's Agent involved must furnish the required insurance documentation 30 (thirty) days before the inception of the contract to the Section: Insurance and Risk Management.* *8.6.9* *Reporting of incidents* *In the event of an occurrence, which is likely to give rise to a claim under the insurance policy affected by the Employer, the Contractor / Subcontractors and Employer's Agent will adhere to the following procedures:* *a.* *In addition to any statutory obligations and/or requirements contained in the General Conditions of Contract, the Contractor shall notify the Employer and the Employer's Agent of every occurrence within 48 (forty-eight) hours giving the circumstances, nature and an estimate of the loss or damage.* *b.* *The Employer's Agent will be responsible to complete and submit the relevant claim documentation for each incident within 30 (thirty) days after the incident occurred to the Section: Insurance and Risk Management. Should the incident be reported by the Employer's Agent more than 30 (thirty) days after the incident occurred to the Section: Insurance and Risk Management, the claim will only be considered if the claim documentation is accompanied by a letter from the relevant Strategic Executive Director motivating the reason(s) for the late reporting of the incident, but the Employer's Agent must take note the Insurer might repudiate the loss if it is found that the insurers rights have been compromised as a result of the late reporting.* *c.* *The following documentation must be included with the claim documentation:*

		- *Photos of damages caused or suffered as proof or substantiation of the claims.* *d. In the event of Insured Property being damaged during the Contract Works beyond economical repair, the property must be safeguarded and be handed over to the Employer's insurer for salvage.* *e. The Section: Insurance and Risk Management will inform the Employer's insurer of the incident. The Contractor/Subcontractor shall afford all reasonable access to the Site to the Employer, the Employer's Agent, the Employer's insurers and/or representatives for the purpose of assessment of any loss or damage.* *8.6.10 Reporting of catastrophic incidents* *In the event of an occurrence, which is likely to give rise to a claim, under the insurance policy effected by the Employer, with an estimated loss or damage of more than R250 000,00, the Contractor and the Employer's Agent will adhere to the following procedures:* *a. In addition to any statutory obligations and/or requirements contained in the General Conditions of Contract, the Contractor shall notify the Employer and the Employer's Agent of every occurrence within 24 (twenty-four) hours giving the circumstances, nature and an estimate of the loss or damage.* *b. The Employer's Agent must notify the Section: Insurance and Risk Management on the same day that the Contractor/Sub-contractor has notified the Employer's Agent of the incident.* *c. The Section: Insurance and Risk Management will notify the Employer's insurer of the incident. The Contractor/Sub-contractor shall afford all reasonable access to the Site to the Employer, the Employer's Agent, the Employer's insurers and/or representatives for the purpose of assessment of any loss or damage.* *d. The Employer's Agent will be responsible to complete and submit the relevant claim documentation for each incident within 30 (thirty) days after the incident occurred to the Section: Insurance and Risk Management. Should the incident be reported by the Employer's Agent more than 30 (thirty) days after the incident occurred to the Section: Insurance and Risk Management, the claim will only be considered if the claim documentation is accompanied by a letter from the relevant Strategic Executive Officer motivating the reason(s) for the late reporting of the incident. Should the relevant claim documentation not be submitted within 30 (thirty) days, the claim will be repudiated.* *8.6.11 Reporting of crime related incidents* *All crime related incidents, losses or shortages irrespective of the value, must be reported within 24 (twenty-four) hours by the person who was involved or who has discovered the incident to the nearest*

South African Police Services (SAPS) station. The name of the Police Station, Investigation Officer and the Case number must be obtained and stated on the Contractor Claim Form. Should the incident not be reported to the SAPS, the claim will be repudiated.

8.6.12 Claim documentation

The Employer's Agent must obtain all relevant information from the Contractor/Sub-contractor and complete the Contractor Claim Form, included in this report as Annexure B that is available on the Intranet. The project number must be stated on the Contractor Claim Form.

The Employer's Agent must submit with the Contractor Claim Form a detailed cost sheet indicating the estimate of the loss or damage.

Any misrepresentation, misdescription or non-disclosure of material facts, at the option of the insurers, can result in claims submitted being declared null and void.

8.6.13 Authorization of claim forms

It is imperative that a formally delegated official or his nominee of the Employer should authorize the Contractor Claim forms as proof of the appropriate authorization, verification and approval of claims submitted. The Divisional Head must provide an authorization letter to the Section: Insurance and Risk Management stating the names and the specimen signatures of the delegated official or his nominee within 30 (thirty) days from approval of this report by Council. Should the delegated official or his nominee not sign the relevant claim form, the claim will be repudiated as this may lead to inappropriate independent verification of the validity of claims, thereby increasing the risk of insurance fraud and consequent reputation damage to the Employer.

8.6.14 Contractor to pay deductibles

Any claim in terms of the insurance affected by the Employer shall be subject to the Contractor being responsible for the payment of the amount stated in the Annexure to the Policies as being the deductible (first amount payable or Excess) as defined in the Certificate of Insurance issued by the Employer's insurer in terms of the Policy.

8.6.15 Settlement of claims

All incidents reported to the Section: Insurance and Risk Management in respect of an occurrence, which is likely to give rise to a claim will be forwarded to the Employer's insurer who will take the necessary actions for the settlement of any such claims.

The Contractor <u>shall negotiate</u> for the settlement of claims with the Employer or the Employer's insurer through the Section: Insurance and Risk Management. The Employer's Chief Financial Officer will authorize all settlements of claims.

Should action for the settlement of any such claim to the satisfaction of the Employer's Agent not be taken by the Contractor/sub-

		contractor within 30 (thirty) days after receipt of such claim by the Contractor/sub-contractor, the Employer or the Employer's insurer may settle any such claim, after giving the Contractor notice of its intention to do so; provided that no such claim shall be settled by the Employer or the Employer's insurer without first consulting the Contractor/sub-contractor. *The foregoing provisions of this Sub-Clause shall apply mutatis mutandis to any such claim received by the Contractor directly.*

C1.2.3 DATA PROVIDED BY THE EMPLOYER

<table>
<tr><th colspan="2">CLAUSE/OPTION</th><th colspan="2">DATA</th></tr>
<tr><td>1.1.1.13</td><td>The Defects Liability period is:</td><td colspan="2">12 (twelve) months from the date of the Certificate of Completion.</td></tr>
<tr><td>1.1.1.14</td><td>The time for achieving Practical Completion is:</td><td colspan="2">Completion Date is 12 months from Commencement Date</td></tr>
<tr><td>1.1.1.15</td><td>The name of the Employer is:</td><td colspan="2">City of Tshwane Metropolitan Municipality.</td></tr>
<tr><td>1.1.1.26</td><td>The Pricing Strategy is:</td><td colspan="2">Re-measurement Contract</td></tr>
<tr><td rowspan="2">1.2.1.2</td><td rowspan="2">The address of the Employer is:</td><td>Physical Address:</td><td>Capitol Towers North,
225 Madiba (Vermeulen) Street,
Pretoria</td></tr>
<tr><td>Postal Address:</td><td>P.O. Box 1409
PRETORIA
0001</td></tr>
<tr><td>1.1.1.16</td><td>The name of the Employer's Agent is:</td><td colspan="2">Tango's Consultants (Pty) Ltd</td></tr>
<tr><td rowspan="3">1.2.1.2</td><td rowspan="3">The address of the Employer's Agent is:</td><td>Physical Address:</td><td>402 WEST AVENUE
FERNDALE
2194</td></tr>
<tr><td>Postal Address:</td><td>P.O. BOX 1422
SUNDOWNER
2161</td></tr>
<tr><td>E-Mail Address:</td><td>admin@tangosgroup.co.za</td></tr>
<tr><td>3.1.3</td><td></td><td colspan="2">
• The Employer's Agent is required to obtain approval of the Employer:

▪ for expenditure on the Contract to exceed the Contract Price;
▪ prior to the execution of any of the following duties of functions:

<table>
<tr><th>CLAUSE</th><th>DUTY/FUNCTION</th></tr>
<tr><td>3.2.1</td><td>Nomination of person as Employer's Agent's Representative</td></tr>
<tr><td>3.3.4</td><td>Authorization to Employer's Agent's Representative or any other person</td></tr>
<tr><td>4.10.1</td><td>Approval to use the Site for any other purpose such as housing</td></tr>
<tr><td>5.3.1</td><td>Delivery of the written notice to commence the execution of the works</td></tr>
<tr><td>5.6.3</td><td>Approval of programme of construction</td></tr>
<tr><td>5.7.2</td><td>Permission to carry out work by day and by night</td></tr>
<tr><td>5.8.1.1</td><td>Approval to work on special non-working days and between sunset and sunrise</td></tr>
<tr><td>5.9.7</td><td>Approval of Contractor's designs</td></tr>
<tr><td>5.11</td><td>Suspension of progress of the Works</td></tr>
<tr><td>5.13.2</td><td>Reduction of penalty for delay</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th colspan="2">CLAUSE/OPTION</th><th>DATA</th></tr>
<tr><td></td><td></td><td><table>
<tr><td>5.14.2</td><td>The issue of a Certificate of Practical Completion</td></tr>
<tr><td>5.14.4</td><td>The issue of a Certificate of Completion</td></tr>
<tr><td>5.16.1</td><td>The issue of a Final Approval Certificate</td></tr>
<tr><td>6.3.1</td><td>Variation Orders in respect of variations which are not small</td></tr>
<tr><td>6.6</td><td>Instruction to expend on Provisional and Prime Cost Sums</td></tr>
<tr><td>6.11</td><td>Adjustment of Preliminary and General allowances</td></tr>
<tr><td>7.8.1</td><td>Order to execute work of repair, etc. during the Defects Liability Period</td></tr>
<tr><td>7.8.2</td><td>Determination of value of repair work</td></tr>
<tr><td>8.2.2.2</td><td>Order to repair and make good damage arising from any excepted risk</td></tr>
</table></td></tr>
<tr><td>5.3.1</td><td>The documentation required before commencement with Works execution are:</td><td>• Health and Safety Plan (Refer to Clause 4.3)
• Initial programme (Refer to Clause 5.6)
• Security (Refer to Clause 6.2)
• Proof that all contributions required in terms of the provisions of the Workman’s Compensation Act (Act no 30 of 1941) as amended in 1993, 2002 have been paid (Refer to Cause 4.3.2)
• A certified copy of Unemployment Insurance Certificate, Act of 1996 (Refer to Clause 4.3.2)</td></tr>
<tr><td>5.3.2</td><td>The time to submit the documentation required from the Commencement Date is:</td><td>14 days</td></tr>
<tr><td rowspan="2">5.8.1</td><td>The non-working days are:</td><td>Sundays</td></tr>
<tr><td>The special non-working days are:</td><td>• Annual builders holiday
• Statutory public holidays</td></tr>
<tr><td>5.13.1</td><td>The penalty for failing to complete the works is:</td><td>The penalty will be R5000/day.</td></tr>
<tr><td>5.14.1</td><td>Requirements for achieving Practical Completion</td><td>• Layer works, Surfacing, Pre-marking, Road signs
• All storm water systems, inlets, outlets, junction boxes and manholes must be completed.</td></tr>
<tr><td>5.16.3</td><td>The latent defect period is:</td><td>10 (ten) Years</td></tr>
<tr><td>6.1.3</td><td>Labour returns:</td><td>Labour returns will be submitted monthly.</td></tr>
<tr><td rowspan="2">6.2.1</td><td>Type of security for due performance:</td><td>• Fixed Performance Guarantee from approved financial institution or Cash Deposit.
• The forms for the Guarantees are to contain the wording of the pro forma document included as C1.3 or C1.4 contained herein.</td></tr>
<tr><td>Liability of performance guarantee/cash deposit</td><td>The liability of the guarantee shall be for <u>10 (ten) %</u> of the Contract Sum, excluding contingencies and VAT.</td></tr>
<tr><td>6.2.2</td><td>Retention money guarantee</td><td>Not permitted</td></tr>
</table>

<table>
<tr><th colspan="2">CLAUSE/OPTION</th><th>DATA</th></tr>
<tr><td>6.8.2</td><td>Adjustment in rates and/or prices</td><td>• The value of the certificates issued shall be adjusted in accordance with the Contract Price Adjustment Schedule with the following values:

<table>
<tr><th>Coefficient</th><th>Description</th><th>Value</th></tr>
<tr><td>x</td><td>Portion not subject to adjustment</td><td>0.10</td></tr>
<tr><td>a</td><td>Labour</td><td>0.21</td></tr>
<tr><td>b</td><td>Civil Engineering Plant</td><td>0.27</td></tr>
<tr><td>c</td><td>Civil Engineering Materials</td><td>0.42</td></tr>
<tr><td>d</td><td>Fuel</td><td>0.10</td></tr>
</table>
(Coefficients a, b, c and d must sum to one)

• The area nearest the Site is <u>Gauteng</u>.
• The base month is <u>the month and year prior to the closing of the tender</u>.</td></tr>
<tr><td>6.8.3</td><td>Price adjustment for variations in the cost of special materials</td><td>Allowed</td></tr>
<tr><td>6.10.1.5</td><td>The percentage on materials not yet built into the Permanent Works is:</td><td>80% (Eighty percent)</td></tr>
<tr><td rowspan="2">6.10.3</td><td>Percentage retention is:</td><td>10% (ten percent) of the value of works, excluding contingencies and VAT</td></tr>
<tr><td>The limit of retention money is:</td><td>5% (five percent) of Contract Sum, excluding contingencies and VAT.</td></tr>
<tr><td rowspan="4">8.6</td><td>Insurance of the Works and Public Liability Insurance</td><td>The Employer shall arrange this insurance.

A copy of the policy and the list of excesses may be obtained from

Contractors All Risk and Liability Insurance
Ms. Morongwa Mokoena (Tel: 012 358 1126) (morongwam@tshwane.gov.za)
Mrs Ronett Marlow-Reid (Tel: 012 358 1131) (ronettm@tshwane.gov.za)
Mr Lawrence Matjila (Tel: 012 358 1374) (lawrencem@tshwane.gov.za)</td></tr>
<tr><td>The value of plant and materials supplied by the Employer to be included in the insurance sum is:</td><td>R 0 (zero)</td></tr>
<tr><td>Responsibility for payment of deductibles in respect of Insurance of Works as well as Public Liability Insurance:</td><td>Deductibles are the responsibility of the Contractor</td></tr>
<tr><td>Construction Plant:</td><td>Contractor to insure. Policy to be approved by Employer</td></tr>
<tr><td>10.5</td><td>Determination of disputes</td><td>Ad-hoc Adjudication Board</td></tr>
<tr><td>10.5.3</td><td>Number of Adjudication Board members to be appointed:</td><td>One</td></tr>
</table>

CLAUSE/OPTION		DATA
10.6	Disagreement with Adjudication Board's decision, refer matters to:	Court proceedings

C1.2.4 DATA PROVIDED BY THE CONTRACTOR

<table>
<tr><th colspan="2">CLAUSE/OPTION</th><th colspan="3">DATA</th></tr>
<tr><td>1.1.1.9</td><td>The name of the Contractor is:</td><td colspan="3"></td></tr>
<tr><td rowspan="4">1.2.1.2</td><td rowspan="4">The address of the Contract is:</td><td>• Physical Address:</td><td colspan="2"></td></tr>
<tr><td>• Postal Address:</td><td colspan="2"></td></tr>
<tr><td>• Fax to E-Mail:</td><td colspan="2"></td></tr>
<tr><td>• E-Mail Address:</td><td colspan="2"></td></tr>
<tr><td rowspan="3">6.2.1</td><td rowspan="3">The security to be provided by the Contractor shall be one of the following:</td><td colspan="2">Type of Security</td><td>Contractor's choice (Indicate "Yes" or "No"</td></tr>
<tr><td colspan="2">Performance guarantee
(10% (ten percent) of the Contract Sum, excluding contingencies ad VAT)</td><td></td></tr>
<tr><td colspan="2">Cash deposit
(10% (ten percent) of the Contract Sum, excluding contingencies and VAT)</td><td></td></tr>
<tr><td>6.5.1.2.3</td><td>The percentage allowance to cover profits and overhead charges for dayworks is:</td><td colspan="3">_______ %. (Maximum of 15% will be allowed)
(In the case of the Contractor not providing a percentage the percentage as per the General Conditions of Contract will prevail)</td></tr>
<tr><td rowspan="7">6.8.3</td><td rowspan="7">Price adjustments for variations in the cost of special materials</td><td colspan="3">The variation in cost of special materials is:</td></tr>
<tr><td>Type of material</td><td>Unit</td><td>Base Rate or Price</td></tr>
<tr><td>Bitumen</td><td></td><td></td></tr>
<tr><td>Steel</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

C1.3 PERFORMANCE GUARANTEE

C1.3 PERFORMANCE GUARANTEE

WHEREAS

The City of Tshwane Metropolitan Municipality

(hereinafter referred to as the "Council"),

enters into a Contract (No ________________) with

____

(hereinafter referred to as the "Contractor")

for ____

____

AND WHEREAS in terms of the General Conditions of the Contract the Contractor is required to furnish an acceptable independent guarantee for the due and proper fulfilment by him of all his duties and obligations in terms of the said contract.

NOW THEREFORE we the undersigned ____

____ (full names of authorized agent(s))

and acting in my/our capacity as____

and ____

and as such duly authorized thereto, do hereby bind the said ____

(hereinafter referred to as the "Guarantor") as surety and co-principal Debtor in solidum for the sum of

R ___________________________ (____)

for the due and proper fulfilment by the Contractor of all or any of his duties and obligations in terms of the said Contract. The guarantee shall not be interpreted as accessory to the contract between Council and the Contractor. The Guarantor further undertakes, in the event of the Contractor failing duly and properly to fulfil any of his duties and obligations in terms of the said Contract, or if the Contractor is placed under provisional liquidation or in the event of termination of the Contract by the Council in terms of the General Conditions of Contract, to pay to the Council the said sum of

R ___________________________ (____)

or such portion thereof as may be required by the Council, immediately upon receiving written demand from the Council which written demand shall be addressed to the Guarantor at (domicilium address)

The Guarantor further hereby renounces the benefits of the legal exceptions:

Exceptio non numerate pecuniae

Exception non causa debiti

Beneficium de duobus vel pluribus reis debendi

Beneficium ordinis deu excussionis

Beneficium divisionis

and all other defence which could be pleaded against the validity of this guarantee, with the meaning and effect of which it declares itself to be fully acquainted.

This undertaking shall remain in full force and effect up to and including the date of issue of the Certificate of Completion, as provided for in the General Conditions of Contract, unless the Guarantor is advised in writing by the Council of his intention to institute claims, and the particulars thereof, in which event this guarantee shall remain in full force and effect until all such claims have been paid or liquidated. Notwithstanding the aforesaid, the Council may at its' sole discretion elect to have the amount provided for under this guarantee, paid out directly to it in the case of breach of contract by the Contractor by giving the Guarantor written notice to that effect, notwithstanding the fact that the Council may decide not to institute any further legal action against the Contractor.

This document is not negotiable or transferable.

FOR AND ON BEHALF OF THE BANKER/INSURER:

BANKER/INSURER:

NAME: ____
(in BLOCK letters)

CAPACITY: ____
(of authorized agent)

SIGNATURE: ____
(of authorized agent)

SIGNED at ___________________________on this ________________day of_____________________

WITNESSES:

(Full name in BLOCK letters and signature)

1.______________________ ________________________

2.______________________ ________________________

C1.4 CASH DEPOSIT GUARANTEE

Contract:	Contract EEBU 07 2025/2026
Description of Contract:	Tender for the appointment of a Contractor for the Upgrading of Pegasus Stormwater Canal in Equestria For a Period of 12 Months
Employer:	**CITY OF TSHWANE METROPOLITAN MUNICIPALITY**
Contractor:	

I/We, the undersigned, deposit herewith [1]cash / a bank certified cheque, in the amount of

____

____

as surety for the due performance of the Contract by the abovementioned Contractor, and for all losses, damages and expenses that may be suffered or incurred by the Employer as a result of non-performance of the Contract by the Contractor.

The amount thus deposited shall at the sole discretion of the above Employer be utilised and appropriated in the manner it deems fit which shall include but not be limited to the set off of claims upon occurrence of any one or more of the following events:

(a) the Contractor being placed under provisional liquidation or committing any one or more of the acts of insolvency as provided for in the Insolvency Act, 1936 (Act 24 of 1936);

(b) failure to comply with the conditions of the contract by the contractor; or

(c) if the contract is terminated.

A letter received from the Employer stating that any one or more of the aforementioned has occurred shall be sufficient notice to effect appropriation of such deposit. A certificate under the hand of the Employer's Agent as defined under the contract described above reflecting the amount of damages shall for all purposes be deemed to be sufficient to proof to do a set off of claims

The deposit shall, subject to the above, be returned to the Contractor on the issue of the Completion Certificate in terms of the Contract, unless the Employer has utilised and / or appropriated the monies as provided for above.

[1] Delete which is not applicable

FOR AND ON BEHALF OF THE CONTRACTOR:

NAME:
(in BLOCK letters) ______________________________

CAPACITY:
(of authorized agent) ______________________________

SIGNATURE:
(of authorized agent) ______________________________

SIGNED at ____________________ on this __________ day of ____________________

WITNESSES:
(Full name in BLOCK letters and signature)

1. ____________________ ____________________

2. ____________________ ____________________

C1.5 HEALTH AND SAFETY AGREEMENT

Article of Agreement in terms of Section 37(2) of the Occupational Safety Act, 1993 between

CITY OF TSHWANE
(Hereinafter referred to as the "EMPLOYER")

AND

____

____

____

____

Herein represented by ____________________ in his/her capacity as ____________________ duly authorised by virtue of a resolution dated ______________________, attached hereto Annexure A, of the said ____ (herein after referred to as the "CONTRACTOR")

WHEREAS the CONTRACTOR is the mandatory of the EMPLOYER as contemplated in an agreement in respect of

EEBU 07-2025.26 TENDER FOR THE SUPPLY, DELIVERY, INSTALLATION, TESTING AND COMMISSIONING OF 1x300MVA POWER TRANSFORMER AT KWAGGA 275/132KV SUBSTATION WITH ASSOCIATED EQUIPMENT FOR A PERIOD OF THREE (3) YEARS

AND WHEREAS section 37 of the Occupational Health and Safety act, 1993 (Act 85 of 1993), hereinafter referred to as the "ACT"), imposes certain powers and duties upon the EMPLOYER.

AND WHEREAS the parties have agreed to enter into an agreement in terms of section 37(2) of the ACT.

NOW THEREFORE the parties agree as follows:

(a) The CONTRACTOR undertakes to acquaint the appropriate officials and employees of the CONTRACTOR with all relevant provisions of the ACT and the regulations promulgated in terms thereof.

(b) The CONTRACTOR undertakes that all relevant duties, obligations and prohibitions imposed in terms of the ACT and Regulations will be fully complied with. Provided that should the EMPLOYER prescribe certain arrangements and procedures, that same shall be observed and adhered to by the CONTRACTOR, his officials and employees. The CONTRACTOR shall bear the onus of acquainting himself/herself/itself with such arrangements and procedures.

(c) The CONTRACTOR hereby accepts sole liability for such due compliance with the relevant duties, obligations, prohibitions, arrangements and procedure, if any, imposed by the ACT and Regulations and the EMPLOYER expressly absolves the EMPLOYER from itself being obliged to comply with any of the aforesaid duties, obligations, prohibitions, arrangements and procedure as the case may be.

(d) The CONTRACTOR agrees that any duly authorised officials of the EMPLOYER shall be entitled, although not obliged, to take such steps as may be necessary to ensure that the CONTRACTOR has complied with the undertakings as more fully set out in paragraphs 1 and 2 above, which steps may include, but shall not be limited to, the right to inspect any appropriate site or premises occupied by the CONTRACTOR, or to inspect any appropriate records held by the CONTRACTOR or to take such steps it may deem necessary to remedy the default of the CONTRACTOR at the cost of the CONTRACTOR.

(e) The CONTRACTOR shall be obliged to report forthwith to the EMPLOYER any investigations, complaint or criminal charge which may arise as a consequence of the provisions of the ACT and Regulations, pursuant to work performed in terms of this agreement, and shall, on written demand, provide full details in writing of such an investigation, complaint or criminal charge as the case may be

FOR AND ON BEHALF OF THE CONTRACTOR:

NAME:
(in BLOCK letters) ______________________

CAPACITY:
(of authorized agent) ______________________

SIGNATURE:
(of authorized agent) ______________________

SIGNED at ______________ on this ________ day of ______________

WITNESSES:
(Full name in BLOCK letters and signature)

1. ______________ ______________

2. ______________ ______________

FOR AND ON BEHALF OF THE EMPLOYER:

NAME:
(in BLOCK letters) ______________________

CAPACITY:
(of authorized agent) ______________________

SIGNATURE:
(of authorized agent) ______________________

SIGNED at ______________ on this ________ day of ______________

WITNESSES:
(Full name in BLOCK letters and signature)

1. ______________ ______________

2. ______________ ______________

C1.6 APPLICATION FOR A PERMIT TO DEPARTMENT OF LABOUR TO DO CONSTRUCTION WORK

Annexure 1

Occupational Health and Safety Act, 1993
(Regulation 3(2) of the Construction Regulations, 2014)

APPLICATION FOR A PERMIT TO DO CONSTRUCTION WORK

This application must be submitted with the following documents:

a) Health and Safety specification
b) Health and Safety plan
c) Baseline risk assessment.

1. Name, postal address and telephone numbers of the client

____

____

2. Details of the agent

(a) Title, Surname and initials: ______________________________

(b) Identity number / Passport number: ______________________________

(c) Registration number with SACPCMP: ______________________________

(d) Office Tel. Number and/or Mobile number: ______________________________

(e) Postal address: ______________________________

____

3. Name, postal address and telephone numbers of the principal contractor

____

____

____

4. Name, postal address and telephone numbers of the designer of the project

____

____

____

5. Name, Postal address and telephone numbers of the following persons

(a) Construction Manager: ______________________

____

(b) Construction Health and Safety Officer ______________________

____

(c) Construction Health and Safety Officer ______________________

____

6. Exact physical address of the construction and site office

____

____

7. Nature of construction work

____

____

8. Expected commencement date

____

9. Expected completion date

____

10. Estimated maximum number of persons on the construction site:

____

11. Planned number of contractors on the construction site accountable to the principal contractor:

____

12 Names(s) of contractors appointed

____

____

____

18. Signature of Client / Client's Agent ______________________

19. Signature of the Principal Contractor

FOR OFFICE USE ONLY

Authorization / Unique No.	LABOUR CENTRE	OFFICE APPROVAL STAMP

13. Date of application: ______________________________

14.
Submitted documents prescribed in Construction Regulation 5(4). (Please tick √)

CR 5(1)(a)		CR 5(1)(b)		CR 5(1); (C-S)	

15. Result of the application. (Please tick √)

Approved		**Declined**	

16. Reason for declining the application

____
____
____
____
____
____
____
____
____

17 Signature of the Supervisor: ______________________________

18 Signature of revoking officer / inspector: ______________________________

C1.7 ADJUDICATOR'S AGREEMENT

This agreement is made on the _______________ day of _________________________________ between:

____ *(name of company / organisation)*

of ____

____ *(address)* and

____ *(name of company / organisation)*

of ____

____ *(address)* (the Parties) and

____ *(name of Adjudicator)*

of ____

____ *(address)* (the Adjudicator).

Disputes or differences may arise/have arisen[1] between the Parties under a Contract dated _____________ and known as ____

and these disputes or differences shall be/have been[2] referred to adjudication in accordance with the CIDB Adjudication Procedure, (hereinafter called "the Procedure") and the Adjudicator may be or has been requested to act.

IT IS NOW AGREED as follows:

1 The rights and obligations of the Adjudicator and the Parties shall be as set out in the Procedure.
2 The Adjudicator hereby accepts the appointment and agrees to conduct the adjudication in accordance with the Procedure.
3 The Parties bind themselves jointly and severally to pay the Adjudicator's fees and expenses in accordance with the Procedure as set out in the Contract Data.
4 The Parties and the Adjudicator shall at all times maintain the confidentiality of the adjudication and shall endeavour to ensure that anyone acting on their behalf or through them will do likewise, save with the consent of the other Parties which consent shall not be unreasonably refused.
5 The Adjudicator shall inform the Parties if he intends to destroy the documents which have been sent to him in relation to the adjudication and he shall retain documents for a further period at the request of either Party.

[1] Delete as necessary
[2] Delete as necessary

SIGNED by: ________________	SIGNED by: ________________	SIGNED by: ________________
Name: ________________	Name: ________________	Name: ________________
who warrants that he / she is duly authorised to sign for and on behalf of the first Party in the presence of	who warrants that he / she is duly authorised to sign for and behalf of the second Party in the presence of	the Adjudicator in the presence of
Witness ________________	Witness: ________________	Witness: ________________
Name: ________________	Name ________________	Name: ________________
Address: ________________	Address: ________________	Address: ________________
Date: ________________	Date: ________________	Date: ________________

Contract Data

1	The Adjudicator shall be paid at the hourly rate of R _______________ in respect of all time spent upon, or in connection with, the adjudication including time spent travelling.
2	The Adjudicator shall be reimbursed in respect of all disbursements properly made including, but not restricted to: (a) Printing, reproduction and purchase of documents, drawings, maps, records and photographs. (b) Telegrams, telex, faxes, and telephone calls. (c) Postage and similar delivery charges. (d) Travelling, hotel expenses and other similar disbursements. (e) Room charges. (f) Charges for legal or technical advice obtained in accordance with the Procedure.
3	The Adjudicator shall be paid an appointment fee of R ______________ This fee shall become payable in equal amounts by each Party within 14 days of the appointment of the Adjudicator, subject to an Invoice being provided. This fee will be deducted from the final statement of any sums which shall become payable under item 1 and/or item 2 of the Contract Data. If the final statement is less than the appointment fee the balance shall be refunded to the Parties.
4	The Adjudicator is/is not[1] currently registered for VAT.
5	Where the Adjudicator is registered for VAT, it shall be charged additionally in accordance with the rates current at the date of invoice.
6	All payments, other than the appointment fee (item 3) shall become due 7 days after receipt of invoice, thereafter interest shall be payable at 5% per annum above the Reserve Bank base rate for every day the amount remains outstanding.

[1] Delete as necessary

PART C2: PRICING DATA

TABLE OF CONTENTS

C2.1 PRICING INSTRUCTIONS

1. General

1.1 This section provides the tenderer with guidelines and requirements with regard to the completion of the Price Schedule. The Schedule **shall be completed by hand in black ink** and the tenderer is referred to the Tender Specifications in regard to the correction of errors.

1.2 The Price Schedule shall be read with all the documents which form part of this Contract.

1.3 The following words shall have the meanings hereby assigned to them:

Unit: The unit of measurement for each item of work in terms of the Specifications and the Project Specifications.

Quantity: The number of units of work for each item.

Rate: The payment per unit of work at which the tenderer tenders to do the work.

Amount: The product of the quantity and the rate tendered for an item.

Lump sum: An amount tendered for an item, the extent of which is described in the Price Schedule, the Specifications and the Project Specifications, but the quantity of work of which is not measured in any units.

1.4 Reference shall be made to the General and Special Conditions of Contract regarding Provisional and Prime Costs Sums.

1.5 Work reserved for Labour Intensive construction methods will be numbered with a prefix “LI” in the Price Schedule to distinguish them from the conventional construction works. Such work shall be constructed using local labour who is temporarily employed in terms of the project specification.

2. Pay Items

2.1 Descriptions in the Price Schedule are abbreviated and comply generally with those in the Standard Specifications. The measurement and payment clause of each Standard Specification, read together with the relevant clauses of the Scope of Work, set out what ancillary or associated activities are included in the rates for the operations specified. Should any requirements of the measurement and payment clause of the applicable Standard Specification, or the Scope of Work, conflict with the terms of the Price Schedule, the requirements of the Standard Specification or Scope of Work, as applicable, shall prevail.

2.2 The item numbers appearing in the Price Schedule refer to the corresponding item number in the standard specifications or as amended in the Scope of Work. In the latter case, the item number is prefixed with the letter “B”. The same applies to new clauses added to the standard specifications. The prefix “LI” is simply highlighting that the item is to be done using labour intensive methods.

2.3 Unless otherwise stated, items are measured net in accordance with the drawings, and no allowance is made for waste.

2.4 The quantities set out in the Price Schedule are the estimated quantities of the Works, but the Contractor will be required to undertake whatever quantities may be directed by the Engineer from time to time. The Contract Price for the completed contract shall be computed from the actual quantities of work done, valued at the relevant unit rates and prices.

2.5 The units of measurement described in the Price Schedule are metric units. Abbreviations used in the Price Schedule are as follows:

mm	=	Millimetre	h	=	per hour
m	=	Metre	kg	=	kilogram
km	=	Kilometre	t	=	ton (metric = 1000kg)
m^2	=	square metre	no	=	number
m^2.pass	=	square metre pass	sum	=	sum
ha	=	Hectare	MN	=	mega newton
m^3	=	cubic meter	MN.m	=	mega newton metre
m^3.km	=	cubic meter kilometre	PC sum	=	prime cost sum
ℓ	=	Litre	prov sum	=	provisional sum
kℓ	=	Kilolitre	%	=	percent
MPa	=	mega pascal	kW	=	kilowatt
V	=	Volt	KVA	=	kilo volt ampere
A	=	Ampere	R/only	=	rate only
month	=	per month	pe	=	per establishment
day	=	per day	pm	=	per person per month
pd	=	per person per day	p	=	per person
ph	=	per person per hour			

3. Rates

3.1 The prices and rates to be inserted in the Price Schedule are to be full inclusive prices for the work described under the several items. Such prices and rates shall cover all costs and expenses that may be required in and for the execution of the work described, and shall cover the cost of all general risks, liabilities, and obligations set forth or implied in the documents on which the tender is based, as well as overhead charges and profit. Reasonable prices shall be inserted as these will be used as a basis for assessment of payment for additional work that may have to be carried out.

3.2 A price or rate is to be entered against each item in the Price Schedule, whether the quantities are stated or not.

An item against which no price is entered or where a word or phrase such as “included” or “provided elsewhere” will be accepted as a rate of nil (R0,00) having been entered against such items and covered by the other prices or rates in the Schedule.

Any work executed to which such a pay item applies, shall be measured under the appropriate items in the Price Schedule and valued at a rate of nil (R0,00). The rate of nil shall be valid irrespective of any change in the quantities during the execution of the Contract.

3.3 The Tenderer shall fill in a rate against all items where the words “rate only” appears in the amount column. The intention is that, although no work is foreseen under such item and no quantities are consequently given in the quantity column, the tendered rate shall apply should work under this item be actually required.

3.4 Except where rates only are required, the Tenderer shall insert all amounts to be included in his total tendered price in the “Amount” column and show the corresponding total tendered price.

3.5 The tenderer shall not group together a number of items and tender one rate for such group of items.

3.6 The tenderers shall be requested to supply three (3) quotations on each provisional sums items provided as and when needed. The service provider will be required to provide a minimum of three (3) quotations every time he is allocated work depending on the available budget and scope thereof. The approved quotation will be taken as a lump sum for that specific period only and paid for according to the CTMM Standard Specifications for Civil Engineering works 2005 or as specified in terms of a "B" item.

3.7 All rates and sums of money quoted in the Price Schedule shall be in rands and whole cents. Fractions of a cent shall be discarded.

3.8 All prices and rates entered in the Price Schedule must be **excluding VAT**. VAT will be added last on the summary page of the Price Schedule.

3.9 Should excessively high unit prices be tendered, such prices may be of sufficient importance to warrant rejection of a tender by the Employer.

4. Corrections of entries made by tenderer

Any entry made by the Tenderer in the Price Schedule, forms, etc., which the tenderer desires to change, **shall not be erased or painted out**. **A line shall be drawn through the incorrect entry and the correct entry shall be hand written above in black ink and the full signature of the Tenderer shall be placed next to the correction**.

C2.2 PRICING SCHEDULE

C2.2 PRICING SCHEDULE

SERIES 0 GENERAL
SECTION 001 GENERAL REQUIREMENTS AND CHARGES
SECTION 002 ENGINEER'S ACCOMMODATION
SECTION 003 TRAINING

SERIES 1 ANCILLARY WORK
SECTION 101 SITE CLEARING AND GRUBBING
SECTION 102 ACCOMMODATION OF TRAFFIC
SECTION 104 LANDSCAPING
SECTION 106 SERVICE DUCTS
SECTION 107 DAYWORKS

SERIES 2 EARTHWORKS
SECTION 202 TRENCH EXCAVATION
SECTION 203 MASS EARTHWORKS

SERIES 3 SEWER
SECTION 302 SEWER NETWORK

SERIES 4 WATER
SECTION 402 WATER NETWORK

SERIES 5 DRAINAGE AND EROSION PROTECTION
SECTION 501 SUBSURFACE DRAINS AND DRAINAGE BLANKETS
SECTION 502 PREFABRICATED CULVERTS, STORMWATER
SECTION 503 KERBING AND CHANNELLING
SECTION 505 EROSION PROTECTION

SERIES 6 ROADS AND PARKING AREAS
SECTION 601 GRAVEL PAVEMENT LAYERS
SECTION 602 CRUSHED-STONE PAVEMENT LAYERS
SECTION 603 UNPAVED AREAS
SECTION 604 STABILISATION
SECTION 605 PRIME COAT
SECTION 606 ASPHALT BASE AND SURFACING
SECTION 608 ROAD AND SURFACING REHABILITATION
SECTION 612 TRAFFIC SIGNS
SECTION 613 TRAFFIC MARKINGS

SERIES 9 QUALITY CONTROL
SECTION 903 TESTING

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 0	**GENERAL**				
Section 001	**General Requirements and Charges**				
001.01	**Preliminary and General Charges:**				
001.01.01	Fixed charges	Lump sum	1		
001.01.02	Time-related charges	Months	12		
001.03	**Excavate by hand to expose existing services and backfill**	m^3	25		
001.04	**Compliance with the Occupational Health and Safety Act and applicable regulations**				
001.04.01	Provision of a Health and Safety Plan	Lump sum	1		
001.04.02	Provision of a Health and Safety File	Lump sum	1		
001.04.03	Provision of construction supervisors-				
001.04.03.02	Full time	Month	12		
001.04.04	Provision of a safety officer-				
001.04.04.02	Full time	Month	12		
001.04.05	Health and safety training	Prov Sum	1		
TOTAL CARRIED FORWARD					
Signature of person authorised to sign the tender:				Date	

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD					
001.04.06	Provision of personal protective clothing and equipment	Lump sum	1		
B001.04.07	Provision of safety fences, signs and barricades	Lump sum	1		
001.05	**Community liaison officer**				
001.05.01	Task Level 5 notch 1 (B1-1).	Month	12		
001.05.02	Percentage on item 001.05.01 for charges and profit	%			
001.06	**Contract Notice Board** (See Drawing STD-001)	no	4		
TOTAL CARRIED FORWARD					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 0	**GENERAL**				
Section 002	**Engineer's Accommodation**				
002.01	**Services**				
B002.01.01	Services for offices and laboratories	Month	12		
002.02	**Treatment and maintenance of areas surrounding offices and laboratories**	Month	12		
002.03	**Office and laboratory accommodation**				
002.03.01	Provision of office and laboratory accommodation, including fittings, furniture and equipment and car ports, as specified	Lump sum	1		
002.04	**Provision of survey equipment and assistants**				
002.04.01	Dumpy level	days	30		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 1	**ANCILLARY WORK**				
Section 101	**Site Clearing and Grubbing**				
101.01	**Clearing and grubbing**				
101.01.01	Areas	m²	13 600		
101.01.02	Strips	m	100		
101.02	**Cutting and removing large trees with a girth -**				
101.02.01	exceeding 1m and up to and including 2m	no	15		
101.02.02	exceeding 2m and up to and including 3m	no	10		
101.02.03	exceeding 3m and up to and including 4m	no	1		
101.03	**Grubbing and the removal of the stumps and roots of large trees with girth -**				
101.03.01	exceeding 1m and up to and including 2m	no	1		
101.03.02	exceeding 2m and up to and including 3m	no	1		
101.03.03	exceeding 3m and up to and including 4m	no	1		
101.04	**Re-clearing of areas (only on the written instructions of the Engineer)**				
101.04.02	Areas not classified as strips	m²	75		
TOTAL CARRIED FORWARD					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD					
101.05	**Removal and disposal of specific elements**				
101.05.01	Concrete kerbing / kerbing combinations	m	200		
101.05.02	Concrete or brick elements (reinforced or unreinforced)				
101.05.02.01	230mm brickwork	m^2	10		
101.05.02.02	115mm brickwork	m^2	10		
101.05.02.04	Concrete elements (unreinforced)	m^3	10		
101.05.02.05	Concrete elements (reinforced)	m^2	10		
101.05.03	Asphalt surfacing	m^2	10		
101.05.04	Interlocking / non-interlocking paving blocks	m^2	10		
101.05.05	Sewer Pipeline	m	10		
101.05.06	Armorflex blocks	m^2	10		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 1	**ANCILLARY WORK**				
Section 102:	**Accommodation of Traffic**				
102.01	**Accommodation of traffic and maintenance of bypasses**	m²	600,00		
102.07	**Existing roads used as bypasses**	m²	100,00		
102.08	**Maintenance of surfacing of pavement layers of bitumen-surfaced bypasses and existing bitumen-surfaced roads used as bypasses**	m²	150,00		
102.12	**Provision of temporary bridges for maintaining access to properties**				
102.12.01	Temporary pedestrian bridges	no	2,00		
102.12.02	Temporary vehicular bridges	no	2,00		
102.14	**Temporary traffic-control facilities**				
102.14.01	Flagmen	pd	1 200		
102.14.02	Portable Stop and Go signs	no	4		
102.14.03	Amber flashing lights	no	6		
102.14.04	Road signs, TR-series, 1200mm in diameter or 900mm x 675mm if rectangular	no	4		
102.14.05	Road signs, TW-series, 1524mm sides	no	5		
102.14.06	Road signs, TG-series	m²	5		
102.14.07	Danger plates and delineators	no	85		
102.14.08	Moveable barricade / road sign combination	no	4		
TOTAL CARRIED FORWARD					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD					
102.14.09	Traffic cones	no	50		
102.14.10	Plastic New Jersey barrier	no	50		
102.15	**Re-use or removal of traffic-control facilities**				
102.15.01	Amber flicker lights	no	2		
102.15.02	Road signs, TR and TW series	no	2		
102.15.03	Road signs, TG-series	no	2		
102.15.04	Danger plates and delineators	no	50		
102.15.05	Plastic New Jersey barrier	no	10		
102.16	**Obliteration of bypasses**	m^2	1 000		
TOTAL CARRIED TO SUMMARY					
Signature of person authorised to sign the tender:				Date	

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 1	**ANCILLARY WORK**				
Section 103	**Overhaul**				
103.01	Overhaul on material hauled outside the defined free-haul boundaries (Free-haul boundaries will be defined as 1km outside the indicated site boundaries)	m^3.km	76 954		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 1	**ANCILLARY WORK**				
Section 104	**Landscaping and Grassing**				
104.01	**Trimming**				
104.01.01	Machine trimming	m^2	6 168		
104.01.02	Hand trimming	m^2	100		
104.02	**Use of machines for trimming or shaping (alternative to sub item 104.01.01)**				
104.02.01	Bulldozer	h	30		
104.02.02	Motor grader	h	30		
104.03	**Preparing areas for grassing and ground covers**				
104.03.01	Scarifying	ha	6		
104.03.02	Top soiling on the Site with -				
104.03.02.01	Topsoil obtained from the Site or borrow areas provided by the Employer	m^3	20		
104.03.02.02	Topsoil provided by the Contractor from other sources (including all haul)	m^3	15		
104.03.04	Supplying and applying chemical fertilizers				
104.03.04.02	Superphosphate	t	1		
104.03.04.04	2:3:2 (22)	t	1		
TOTAL CARRIED FORWARD					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD					
104.03.05	Stockpiling of topsoil	m^3	450		
104.04	**Grassing**				
104.03.04	Hydro seeding				
104.03.04.01	Providing approved seed mixture for hydro seeding	kg	3		
104.03.04.02	Hydro seeding	ha	1		
104.06	**Anti-erosion compounds such as organic adhesives or bio-degradable covering material**	kg	3		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 1	**ANCILLARY WORK**				
Series 106	**Service Ducts**				
106.01	**Bedding and backfilling up to 300mm above pipes**				
106.01.01	Using selected excavated material	m^3	100		
106.01.02	Using imported selected material	m^3	150		
106.01.05	Using stabilized material	m^3	200		
106.02	**The casting of in situ concrete in bedding and the encasing of pipes (Class 20/19 concrete)**	m^3	100		
106.03	**Soilcrete**	m^3	200		
106.04	**Service duct pipes**				
106.04.01	Ordinary pipes				
106.04.01.01	uPVC 110 similar approved	m	100		
106.04.03	Pipe fittings				
106.04.03.01	uPVC110 pipes or similar approved	no	100		
106.04.03.01	end plug for uPVC110 pipes or similar approved	no	100		
106.04.03.01	spacer module for uPVC110 pipes or similar approved	no	100		
106.05	**Duct markers**	no	100		
106.06	**Extra over item 106.01 and 106.03 for using material obtained from sources provided by the Contractor**	m^3	100		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 1	**ANCILLARY WORK**				
Series B107	**Dayworks**				
B107.01	**Labour during normal working hours**				
B107.01.01	Unskilled labour	h	100		
B107.01.02	Semi-skilled labour	h	100		
B107.01.03	Skilled labour	h	20		
B107.02	**Extra-over item B107.02 for charges and overheads**				
B107.02.01	Unskilled labour	%			
B107.02.02	Semi-skilled labour	%			
B107.02.03	Skilled labour	%			
B107.03	**Construction Plant**				
B107.03.01	Tipper trucks				
B107.03.01.01	6m³ capacity	h	20		
B107.03.01.02	10m³ capacity	h	20		
B107.03.02	Backhoe loaders (Mass 7 - 8 ton)	h	20		
B107.03.03	Bulldozer (Mass 20 - 25 ton, Power 135 - 165 kW)	h	20		
B107.03.04	Tracked Excavator (Mass 18 - 22 ton, Power 70 - 105 kW)	h	10		
B107.03.05	Generator (15kVA)	h	10		
B107.03.06	Grader (Mass 16 - 20 ton)	h	20		
B107.03.07	Wheel Loader (Mass 10 - 13 ton)	h	10		
TOTAL CARRIED FORWARD					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD					
B107.03.08	Milling machine (W350 or equivalent)	h	12		
B107.03.09	Rollers				
B107.03.09.01	Pneumatic Roller (14 - 21 ton)	h	12		
B107.03.09.02	Single drum vibratory padfoot roller (7 - 10 ton)	h	12		
B107.03.09.03	Single drum vibratory padfoot roller (10 - 14 ton)	h	12		
B107.03.09.04	Single drum vibratory smooth roller (7 - 10 ton)	h	12		
B107.03.09.05	Single drum vibratory smooth roller (10 - 14 ton)	h	12		
B107.03.09.10	Pedestrian roller (500 - 550kg, width 390mm)	h	12		
B107.03.09.11	Pedestrian roller (1000 - 1500kg, width 900mm)	h	12		
B107.03.10	Compressor (185 cfm) including 2 drills and hoses	h	6		
B107.03.11	Concrete Mixer (250 litre)	h	6		
B107.03.12	Cranes				
B107.03.12.01	Capacity 50 ton	h	12		
B107.03.12.02	Capacity 100 ton	h	12		
TOTAL CARRIED FORWARD					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD					
B107.03.13	Pumps				
B107.03.13.01	Electric submersible (50mm)	day	8		
B107.03.13.02	Diesel centrifugal (50mm)	day	8		
B107.03.13.03	Diesel centrifugal (100mm)	day	8		
B107.03.13.04	Petrol centrifugal (50mm)	day	8		
B107.03.13.04	Petrol centrifugal (100)	day	8		
B107.04	**Transport of Construction Plant**				
B107.04.01	Flatbed truck (2 - 4 ton)	km	50		
B107.04.02	Lowbed (30 - 40 ton)	km	50		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 2	**EARTHWORKS**				
Section 201	**General**				
201.01	**Excess overburden at borrow pits provided by the Employer**	m^3	200		
201.02	**Temporary stockpiling of material**	m^3	300		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 2	**EARTHWORKS**				
Section 202	**Trenching**				
202.01	**Trench excavation**				
202.01.01	Up to 1,0m wide				
202.01.01.01	Up to 1,0m deep	m^3	149		
202.01.01.02	Over 1,0m deep and up to 1,5m deep	m^3	22		
202.02	**Extra over items 202.01, 202.03 and 202.09 for excavating in -**				
202.02.01	Intermediate material	m^3	15		
202.02.02	Hard material	m^3	22		
202.03	**Excavations outside the normal trench profile**	m^3	20		
202.04	**Hand excavation (extra over item 202.01)**	m^3	45		
TOTAL CARRIED FORWARD					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD					
202.06	**The backfilling of trenches with material obtained from excavations**	m^3	74		
202.07	**Extra over items 202.06 and 202.13 for using backfill material obtained -**				
202.07.02	From sources provided by the contractor	m^3	67		
202.10	**Removal of spoil material -**				
202.10.01	To positions indicated on the Drawings or by the Engineer	m^3	74		
202.10.02	To dumping areas to be provided by Contractor	m^3	74		
202.12	**Extra over item 202.06 for additional compaction of backfill to 93% of modified AASHTO density in road reserves**	m^3	100		
202.13	**Backfilling trenches with soilcrete**	m^3	74		
202.15	**Reinstatement of bitumen surfaced roads**	m^2	100		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 2	**EARTHWORKS**				
Section 203	**Mass Earthworks**				
203.01	**Excavation and borrow to fill**				
203.01.01	Compaction to 90% of modified AASHTO density	m^3	4 610		
203.02	**Extra over item 203.01 for excavating in -**				
203.02.01	Intermediate material	m^3	691		
203.02.02	Hard material	m^3	461		
203.02.03	Boulder material class A	m^3	230		
203.02.04	Boulder material class B	m^3	230		
203.03	**Excavate and spoil of -**				
203.03.01	Soft material	m^3	10 993		
203.04	**Removal of oversize material**	m^3	10 993		
203.05	**Variations in compactive effort (applicable to sub item 203.01.03 and item 203.07)**				
203.05.01	Vibratory rollers	m^2.pass	500		
203.05.02	Impact rollers	m^2.pass	500		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
302	**Sewers**				
302.01	**Supplying, laying and jointing of sewer pipes irrespective of depth or width of trench:**				
302.01.01	For uPVC, Class 34 (160mm, push socket connection)	m	200		
302.02	**Constructing of pipe beddings**				
302.02.01	Class B bedding				
302.02.01.01	160mm diameter	m	200		
302.09	**Construction of manholes, up to 1,0 m deep**				
302.09.01	For sewers 300 mm in diameter and smaller				
302.09.01.01	(Type of manhole stated)	No.	2		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 5	**DRAINAGE AND EROSION PROTECTION**				
Section 502	**Prefabricated Culverts and Stormwater Sewers**				
502.01	**Backfilling with selected excavated material compacted to -**				
502.01.01	90% of modified AASHTO density	m^3	325		
502.01.02	93% of modified AASHTO density	m^3	255		
502.01.03	95% of modified AASHTO density	m^3	2100		
502.06	**Supplying and laying portal and rectangular culverts**				
502.06.01	Complete with precast invert slab (rectangular culvert)				
502.06.01.01	2400 mm x 1500 mm (slab 260 mm, D25/30-XC4-20)	m	60		
502.06.01.01	3000 mm x 1200 mm (slab 320 mm, D25/30-XC4-20)	m	40		
502.06.01.01	3000 mm x 1500 mm (slab 320 mm, D25/30-XC4-20)	m	60		
TOTAL CARRIED FORWARD					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD					
502.10	Cast in situ concrete				
502.10.02	In invert slabs for portal or rectangular culverts, including formwork to provide class F1 surface finish and class U2 surface finish for unformed surfaces				
502.10.02.01	Class 15/10	m^3	300		
502.10.02.02	Class 30/20	m^3	500		
502.10.04	**Formwork for concrete under item 502.10.02 above**				
502.10.04.01	Class F1 surface finish	m^2	100		
502.10.04.02	Class F2 surface finish	m^2	150		
502.13	**Welded-steel fabric**				
502.13.01	SMF 617	kg	5		
502.13.02	SMF 311	kg	5		
502.14	**Reinforcement**				
502.14.02	High-yield-stress steel				
502.14.02.01	Y10	Ton	1		
502.14.02.02	Y12	Ton	1		
502.14.02.03	Y16	Ton	1		
502.14.02.04	Y20	Ton	1		
TOTAL CARRIED FORWARD					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 5	**DRAINAGE AND EROSION PROTECTION**				
Section 503	**Kerbing and Channelling**				
503.02	**Concrete kerbing-channelling combination** (See drawing STD007 - Sheet 1)				
503.02.01	Mountable kerb (Fig. 8C) with concrete channel	m	400		
503.02.02	Barrier kerb (Fig. 12) with concrete channel	m	600		
TOTAL CARRIED FORWARD					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD					
503.03.04	Semi-vertical kerb (Fig. 7) to 500mm sloping kerb	no	100		
503.01.05	Extra over Items 503.03.01, 503.03.02, 503.03.03, 503.04.04 for variations in concrete volume due to variations in standard dimensions	m^3	5		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 5	**EROSION PROTECTION**				
Section 505	**DRAINAGE AND EROSION PROTECTION**				
505.01	**Foundation trench excavation and backfilling**				
505.01.02	In all other classes of material	m^3	400		
505.02	Surface preparation for the bedding of gabions	m^2	1 350		
505.03	Gabions				
505.03.01	Gabion boxes (2 x 1 X 0,5 using 2,7mm wire diameter and 80mm x 100mm mesh)	m^3	100		
505.03.02	Gabion boxes (3 x 1 X 0,5 using 2,7mm wire diameter and 80mm x 100mm mesh)	m^3	200		
505.03.03	Gabion boxes (1 x 1 X 1 using 2,7mm wire diameter and 80mm x 100mm mesh)	m^3	300		
505.03.04	Gabion boxes (1,5 x 1 X 1 using 2,7mm wire diameter and 80mm x 100mm mesh)	m^3			
505.03.05	Gabion boxes (2,0 x 1 X 1 using 2,7mm wire diameter and 80mm x 100mm mesh)	m^3	700,0		
505.03.06	Gabion Reno Mattress (6 x 2 X 0,3 using 2,7mm wire diameter and 80mm x 100mm mesh)	m^3	600,0		
505.04	Extra over item 505.03 for supplying gabions with PVC-coated wire (Thickness of 2mm PVC coating stated)	m^3	1 600,0		
505.05	Filter fabric for gabions and riprap (Synthetic Filter Fibre, Grade 2)	m^2	1 300		
505.09	Concrete pitching				
505.09.02	Interlocking precast concrete block pitching (Armourflex 205 EROSION CONTROL BLOCK WITH TWO OVAL OPENINGS & TWO ROPE DUCTS • SIZE - 340 mm. LONG x 294 mm. WIDE x 115 mm. 0,022m3/m2 voints filling material)	m^2	400		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 6	**ROADS AND PARKING AREAS**				
Section 601	**Gravel Pavement Layers**				
601.02	**Gravel layers constructed from material obtained from borrow pits**				
601.02.01	Subgrade				
601.02.01.02	Compacted to 95% of modified AASHTO density	m³	350		
601.03	**Gravel layers constructed from material obtained from excavations**				
601.03.01	Subgrade				
601.03.01.01	Compacted to 90% of modified AASHTO density	m³	250		
601.03.02	Subbase				
601.03.02.01	Compacted to 95% of modified AASHTO density	m³	150		
601.03.03	Base				
601.03.02.02	Compacted to 98% of modified AASHTO density	m³	100		
601.04	**Extra over item 601.03 for obtaining material from**				
601.04.01	Intermediate excavations	m³	120		
601.06	**Extra over Item 601.02 for borrow material from sources to be supplied by the Contractor**				
601.06.01	G5 material compacted to 95% of modified AASHTO Density	m³	80		
601.06.03.01	Compacted to 98% of modified AASHTO density	m³	160		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 6	**ROADS AND PARKING AREAS**				
Section 604	**Stabilization**				
604.01	**Chemical stabilization extra over unstabilized compacted layers**				
604.01.01	Subbase	m^3	1000		
604.01.02	Base	m^3	1200		
604.02	**Chemical stabilizing agent**				
604.02.01	Cement	t	1		
604.03	**Mechanical modification, extra over untreated layer**	m^3	500		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 6	**ROADS AND PARKING AREAS**				
Section 605	**Prime Coat**				
605.01	**Prime coat**				
605.01.04	Invert bitumen emulsion which complies with SANS 1260 (MSP 1)	ℓ	100		
605.02	**Aggregate for blinding**	m^2	1 200		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 6	**ROADS AND PARKING AREAS**				
Section 606	**Asphalt Base and Surfacing**				
606.02	**Asphalt surfacing**				
606.02.01	40mm Continuously graded (medium)	t	400		
606.05	**Tack coat of 30% stable grade emulsion**	ℓ	4 320		
606.09	**100 mm cores in asphalt paving**	No.	6		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
Section 609	**Segmented Paving**				
609.01	**Construction of segmental block paving made from -**				
609.01.01	60mm Type S-A, Class 25 (Grey in Colour)	m²	250		
609.01.03	60mm Type S-A, Class 25 (Terrecota in Colour)	m²	300		
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
Series 612	**Traffic Signs**				
	-				
612.01	Sign boards with painted background, symbols, lettering and borders in engineering-grade retro-reflective material with sign boards constructed from:				
612.01.03	Sheet steel (Chromadek) with an:				
612.01.03.01	Area not exceeding 2 m²	m²	10		
612.03	**Sign supports**				
612.03.01	Structural steel	t	0		
612.03.02	Steel tubing	t	1		
612.04	**Extra over Items 612.03.01 and 612.03.02 for providing**				
	-				
612.04.01	Unpainted galvanized steel members	t	1		
612.05	Excavation and backfilling for sign supports	m³	12		
	-				
	-				
	-				
	-				
	-				
	-				
TOTAL CARRIED TO SUMMARY					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
Section 613	**Traffic Marking**				
613.01	**Road-marking paint**				
613.01.06	- Kerb markings (any colour)	m²	100,5		
613.02	**Retro-reflective road-marking paint**				
613.02.01	- White lines (broken or unbroken) 100 mm wide	km	0,2		
613.02.02	Yellow lines (broken or unbroken) 100 mm wide	km	0,2		
613.02.03	White lettering and symbols	m²	20,0		
613.02.04	Yellow lettering and symbols	m²	10,0		
613.02.05	Traffic-island markings (any colour)	m²	10,0		
B613.02.06	Reflective tape	m²	10,0		
613.04	**Variation in the rate of application**				
613.04.01	- White paint	ℓ	20,0		
613.04.02	Yellow paint	ℓ	20,0		
613.04.03	Glass beads	kg	50,0		
613.06	Setting out and the premarking of lines (excluding traffic-island markings, lettering and symbols)	km	0,4		
	TOTAL CARRIED TO SUMMARY				

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
Series 702	**FALSEWORK, FORMWORK AND CONCRETE FINISH**				
702.01	Formwork Class F1 surface finish to:				
702.01.01	Single-surface formwork				
702.01.01.03	Plane, vertical	m²	4003		
702.02	Formwork, class F2 surface finish				
702.02.01	Single-surface formwork				
702.02.01.03	Plane, vertical	m²	129		
	Provision of designs and drawings of falsework and formwork by an ECSA registered Professional Engineer or Technologist (for the whole culvert)	L/sum	1		
Total Carried Forward To Summary					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
Series 703 :	**STEEL REINFORCEMENT FOR STRUCTURES**				
703.03	Welded steel fabric for -				
703.03.01	Apron slab and cut off walls				
703.03.01.01	SMF 888	kg	1		
703.03.02	Concrete Barriers and Parapets and End blocks				
703.03.01.01	SMF 888	kg	1		
703.04	Reinforcement for - (Base and walls of the stormwater concrete canal)				
703.04.02	High-yield-stress steel	t	93		
Total Carried Forward To Summary					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
Series 704	**Concrete**				
704.01	**Cast in situ concrete:**				
704.01.02	Durability Concrete (Class D): Wingwall footings and walls (D25/30-XC4-20)	m³	100,00		
704.01.03	Durability Concrete (Class D): Apron slab and cut off walls (D25/30-XC4-20)	m³	100,00		
704.01.04	Cast in situ stormwater concrete canal	m³	2318,45		
C13.8.16	**Perforated drainage pipes:**				
C13.8.16.1	M65 Netlon drainage pipe wrapped in Kaymat U34 or similar approved	m	1400,00		
Total Carried Forward To Summary					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
Series 706	**JOINTS IN STRUCTURES**				
706.02	**Installation of Proprietary expansion Joints**				
706.02.01	(a) J1 complete as shown on drawings	m	200,00		
706.02.02	(b) J2 complete as shown on drawings	m	200,00		
706.04	**Sealing joints with:**				
706.04.01	(a) 10mm x 10mm Silicon sealant	m	200,00		
706.04.02	(b) 40mm Deep x 15mm Silicon sealant	m	200,00		
Total Carried Forward To Summary					

Signature of person authorised to sign the tender:	Date

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
SERIES 9	**QUALITY CONTROL**				
Section 903	**Testing**				
903.01	**Provision of testing equipment**				
903.01.03	150mm x 150mm x150mm concrete-cube moulds	no	20		
903.03	Special tests on concrete and asphalt				
903.03.01	Compressive-strength tests on concrete cubes	no	60		
903.06	**Special tests requested by the Engineer:**				
903.06.01	Employer's contribution to concrete durability tests:				
903.06.01	(a) Tests for water sorptivity	PC sum	1,00		
903.06.01.01	(i) Handling costs and profit in respect of item C20.1.2.1(a)	%			
903.06.02	(b) Tests for oxygen permeability	PC sum	1,00		
903.06.02.01	(i) Handling costs and profit in respect of item C20.1.2.1(b)	%			
903.06.03	(c) Tests for chloride conductivity	PC sum	1,00		
903.06.03.01	(i) Handling costs and profit in respect of item C20.1.2.1(c)	%			
903.06.04	(d) Tests for concrete cover	PC sum	1,00		
903.06.04.01	(i) Handling costs and profit in respect of item C20.1.2.1(d)	%			
Total Carried Forward To Summary					

Signature of person authorised to sign the tender:	Date

SUMMARY OF PRICING SCHEDULE

SECTION	DESCRIPTION	AMOUNT	
SERIES 0	**GENERAL**		
001	General Requirements and Charges	R	-
002	Engineers Accommodation	R	-
SERIES 1	**ANCILLARY WORK**		
101	Site Clearing and Grubbing	R	-
102	Accommodation of Traffic	R	-
103	Overhaul	R	-
104	Landscaping and Grassing	R	-
106	Service Ducts	R	-
107	Dayworks	R	-
SERIES 2	**EARTHWORKS**		
201	General	R	-
202	Trenching	R	-
203	Mass Earthworks	R	-
SERIES 3	**SEWERS**		
302	Construction	R	-
SERIES 5	**DRAINAGE AND EROSION PROTECTION**		
502	Prefabricated Culverts and Stormwater Drainage	R	-
503	Kerbing and Channelling	R	-
505	Drainage and Erosion Protection	R	-
SERIES 6	**ROADS AND PARKING AREAS**		
601	Gravel Pavement Layers	R	-
604	Stabilisation	R	-
605	Prime Coat	R	-
606	Asphalt Base and Surfacing	R	-
609	Construction of Segmental Block Paving	R	-
612	Traffic Signs	R	-
613	Traffic Markings	R	-
SERIES 7	**STRUCTURES**		
701	Foundations for Structures	R	-
702	FALSEWORK, FORMWORK AND CONCRETE FINISH	R	-
703	STEEL REINFORCEMENT FOR STRUCTURES	R	-
704	Concrete	R	-
706	Joints in Structures	R	-
SERIES 9	**QUALITY CONTROL**		
903	Testing	R	-

TOTAL SCHEDULE OF PRICES	**R**	**-**
TOTAL OF SCHEDULED PRICES	R	-
Add 10% for contingencies	R	-
SUBTOTAL	R	-
Add 15% VAT	R	-
CONTRACT PRICE CARRIED FORWARD TO FORM OF OFFER	**R**	**-**

Signature of person authorised to sign the tender:	Date

PART C3: SCOPE OF WORK

1. SCOPE OF TENDER

The scope is for the supply, delivery, installation, testing, and commissioning of 300MVA 275/132kV transformer bay equipment for the refurbishment of Kwagga Substation

1.1 The scope of this tender/contract must be provided in full by one tenderer/contractor. The contractor and sub-contractors must be fully trained, experienced, and competent to carry out the work according to the tender/contract and articles of agreement of the OHS-Act (Act 85 of 93) or the latest act.

1.2 Dismantling of the burnt equipment (transformer, circuit breaker, surge arrestors, current transformers, voltage transformers, disconnectors, marshalling kiosks, multicore cables and all stones around the bay area)

1.3 Demolish and remove existing Transformer Plinth and backfill with G5 and compact. (**See BOQ C2.2 – 11.2.4.1**) all rubble to be removed and dumped to approved dumping site

1.4 Supply and install of 275kV, 3150A, 31.5 kA, SF6 three pole circuit breaker and its associated steel structure, foundation bolts , clamps & connectors

1.5 Supply and installation of 275kV, three pole, rotary type, 3150A, 31.5 kA disconnector motorized with earthing switch and steel support structures, connectors and other fittings/accessories

1.6 Supply and install 3x275kV Single pole Capacitive Voltage Transformer 275kV, complete with steel supporting structures and carrier current accessories, connectors and other fittings/accessories-

1.7 Supply and install 3x275kV single pole, Current Transformer for Transformer Bay complete with steel support structures, connectors and other fittings/ accessories.

1.8 Supply and install 3x275kV, 20 kA Lightning Arresters for line bays and transformer bay with surge counters and steel supporting structure, connectors and other fittings/accessories

1.9 Supply and install 3x275kV post insulators complete with bus support clamps and steel support structures

Page 2 of 14

1.10 Supply and install Conductor String insulator, low voltage Control cables and accessories Earthing connection material for main equipment's junction boxes, Bay Marshalling Kiosks

1.11 Erect a new plinth to be able to carry 300MVA (275/132kV) power transformer

1.12 Supply, delivery, installation of 300MVA 275/132kV power transformer and commission including the NEC

1.13 The contractor will be responsible for the decommissioning of all obsolete electrical equipment structures on site. Obsolete equipment to be transported to City Of Tshwane (CoT) scrapyard in Pretoria west and oil to be disposed by accredited service provider which will comply with environmental management and rehabilitation of all contaminated soil

1.14 The contractor will be responsible for the complete scope of work including the integration of (protection, control, SCADA, etc.) of the 275kV switchgear, 132kV Control, SCADA, and Protection panels.

1.15 During construction the substation will be live at all times. Switching out of equipment for reconfiguration of the substation will be limited and especially during winter and peak times.

1.16 The quantities indicated against each item on the bill of quantities are only approximate figures and the City of Tshwane does not guarantee to purchase this or any quantity. The contractor must confirm the quantities with the employer's engineer or appointed employer representative prior to placing orders with the manufacturers.

1.17 Commissioning of all installed equipment and transformer to control room (Cold & Hot Commissioning).

1.18 Building of substation perimeter wall using precast concrete slabs: (2000 meters length, 3.6m height). Wall slabs shall be installed 3.6m above natural ground level with anti-digging of 0.6m below natural ground level. Inclusive of barbed concertina wire 730mm wide fixed to the top of wall

1.19 Installation and commissioning of cameras around the substation

NB: . The contract will be awarded to one prospective bidder only. The bidder shall be responsible for certifying all the work done including issuing of any professional certificates where they are needed

2. TENDER BRIEFING SESSION

Compulsory tender site meeting will be held on:

Date & Time: **26 January 2026 (10:00 AM)**

Venue: Kwagga 275/132kV Substation located at 108 WF Nkomo street

3. EXTENT OF WORK

The total project work includes the following, but not necessarily in the order as listed:

3.1 Design of works

The design work will include all the following work that is specified in more detail in the specification, particulars, and activity schedule (The contractor's civil, mechanical and electrical designs must be approved before manufacturing and construction can start):

a) Electrical single line diagram: All equipment in circuit format with descriptions.

b) Electrical equipment diagrams: Mostly obtained from the suppliers of the equipment.

For new equipment.

c) Protection system: The protection equipment system operation and control.

d) Communication system: The control/communication system including the Scada system.

e) Mapping of Input/Output list.

3.2 Project Implementation Plan

a) A Project Implementation Plan must be provided before any construction work starts.

b) The plan must allow for the CoT switching requirements, peak power loads, electricity tariff conditions, etc.

c) A shutdown of construction work must be provided for over the Christmas period to the New Year.

3.3 Site Works and Civil Engineering

The site work will include all the following work that is specified in more detail in the specification, particulars and activity schedule: In addition to this document the Standard Specification for Municipal Civil Engineering Works and National Building Regulations form part of the specification. A professional civil engineer (structural) must certify the design for the above work.

a) Terrain civil work: Cable trenches/canals, road, storm water, fencing, yard stoning.

b) The construction of a new plinth and structures foundations.

c) All the structures and building compaction must be tested by a qualified person and the results made available. The building compaction must be tested on each corner of the new building and every three-meter interval.

d) Site clearing: Removal of all the excess material from site

e) Soil condition: All excavations for tender purposes must be based on using a TLB for excavations. Pickable and Intermediate soil will fall in this category.

3.4 Electrical Works and Mechanical Structures

The supply, installation testing and commissioning of the following:

a) Multicore cables between all the 275kV, 132kV equipment (existing & new) and protection and control equipment.

b) Communication and Scada system interfaces on the newly connected equipment.

c) The VTs, CTs, Circuit breakers and isolators in the HV yard as specified.

d) Commissioning: The testing of all the equipment, system operation and control

e) Switching: Arrange switching during the construction period. It may be required that due to electricity supply constraints that some work can only be done during the night and on weekends after normal working hours.

f) The contractor will be responsible for the decommissioning and removal of the obsolete 275kV switchgear and 132kV Control & Protection panels and reconfiguration and refurbishment of the existing.

3.4.2 Decommissioning of obsolete equipment

Removal of the existing 275kV equipment and power transformer including multicore cables.

3.5 Commissioning of works

a) Test all electrical equipment and the system.

b) Check and test all mechanical structures.

c) Check and certify all civil works.

d) A test plan and procedures must be provided before any testing starts.

e) Supply Operating and Maintenance Manuals (O&MM) of all the equipment and the system on both digital/electronic format and hard copy.

f) Supply of all civil and electrical drawings in an editable electronic format.

3.6 CoT Safety agent

The safety agent for CoT will perform all his/her duties during the execution of the project in accordance with regulation 5 (1) (a) of the construction regulation 2014.

3.7 Other

No telephone, water and sanitary facilities are available, and the Council will not provide any. All sanitary facilities shall be provided by the contractor, and they shall be neat and hygienic throughout the contract period.

The Contractor shall allow in his tender price for his own accommodation and for the provision of a site office, which shall be large enough to hold site meetings to accommodate a minimum of 12 people. A table and chairs shall be provided to meet the above requirement.

4. SOCIO-ECONOMIC PLAN

a) The contractor must submit a detailed proposal on the number of job opportunities to be created for the local community during the project.

b) The contractor must provide skills development and technical training as specified in the activity quantities bill schedule for CoT employees per field on the following: -

1. Operators (switching)
2. Maintenance
3. SCADA
4. Protection

c) The contractor must allow for a formal technical training for at least ten (10) CoT employees per course at SAQA accredited institutions to enhance their skills on the listed courses below: -

1. High Voltage Substation Design Course
2. Protection Course.
   - Introduction to Protection.
   - Intermediate Protection Course.
   - Advance Protection Course.
3. Essential Micro Station Course
4. Planning Course
5. High Voltage Circuit Breaker Commissioning and Test Course
6. AutoCad Course (CAD) - Basic Course

d) The City of Tshwane (CoT) has a mandate and responsibility to fight poverty, build clean, healthy, safe and sustainable communities. To achieve this, the City adopted an Integrated Poverty Reduction and Community Development Strategy which requires all departments to cooperate and contribute towards poverty reduction through employing EPWP participants on projects. Therefore, the Water and Sanitation Business Unit is committed to utilize participants that are registered on the CoT Central Database on all projects. The aim is to ensure commitment by each contractor on a project to utilize all of its personnel of the EPWP Central Database in order to enhance poverty alleviation and the uplifting of participants.

The successful contractor appointed will have to request labour from the EPWP Office that will do a random selection from the Central Database. All labour personnel on a project must be appointed from the Central Database provided by the EPWP Office. The idea is to place beneficiaries in the correct or appropriate project roles/occupations to help them achieve income capacity and/or to equip them through skills development. The contractor must provide data about the number of beneficiaries required, qualifications, type of placement/occupation and gender before the project starts. The successful contractor appointed must accommodate students that are in need of practical training or in- service training. One student per region per annum must be trained on this contract. The minimum wage as per Sectoral Determination: Civil Engineering Sector published in the Government Gazette will be payable.

Civils Works	**Requirements**
Setting out of works	N\A
Concrete mixing	N\A
General Workers	N\A
Installation Works	
Cable termination	Trade Test Certificate in Electrical Engineering
Electrical Installations	Trade Test Certificate in Electrical Engineering
CLO	N\A
Total number of people to be appointed under EPWP	

e) The CoT will determine how many women, youth etc will benefit from the project.

f) The contractor must employ local labourers and preference must be given to residents in the ward and/or region where the project is located.

g) The Contractor must provide protective Personal Protective Equipment (PPE) with the EPWP branding for the EPWP local labourers appointments.

h) The Contractor must ensure that all the EPWP local labourers have undergone the medical tests where necessary.

i) The contractor must submit a monthly report on the job opportunities created in line with EPWP initiative and Prove of Payment to EPWP's.

5.COMMUNITY LIAISON OFFICER

The Office of the Speaker will submit the results (minutes) and attendance register of the Community Liaison Officer (CLO) election meeting to the chairperson of the Project Steering Committee, the contractor, and the Expanded Public Works Programme (EPWP) Division. The elected Community Liaison Officer (CLO) will be appointed by the contractor for the duration of the project and be remunerated by the contractor. Where the Community Liaison Officer (CLO) is no longer available and another is appointed, the exiting Community Liaison Officer (CLO) shall cease to receive remuneration. An employment agreement containing the general terms and conditions of the contract, will be issued to the Community Liaison Officer (CLO) and must be signed by the Community Liaison Officer (CLO) before his/her commencement of duties.

- Community Liaison Officer (CLO) for liaison with the local community, who as part of his/her duties.
- The CLO shall attend all steering committee meetings with Project Manager and the Ward Councillor.
- The agreement shall make provision for the payment of the CLO by the Contractor at a salary equivalent to the City of Tshwane entry level scale of the administrative officer which is Task level 5 (R277 918 .00 Annually) and it will adjust as per SALGA agreement.
- Only one CLO shall be appointed per project.
- Should the Contractor experience any difficulties with the community, these difficulties shall immediately be brought to the attention of the Department/Project Manager who shall arrange a meeting with the relevant Ward Councillor(s) and the CLO to resolve such difficulties.
- The main Contractor shall ensure that any Sub-Contractor he/she may appoint shall agree to these conditions.
- Should any of the above conditions be less favourable than any Bargaining Council Agreement or Act applicable to the Contractor, the more favourable condition will apply.

Page 9 of 14

6 SUBCONTRACTORS / EXEMPT MICRO ENTERPRISE (EME's)

a) The contractor must appoint subcontractor / Exempt Micro Enterprise's (EME's) within the ward where the project is executed.

b) The contractor shall identify activities within the project scope which will be allocated to local sub-contractors / EME's, which shall among others, include but not limited to: -

- Procurement of material from Exempt Micro Enterprise's (EME) within the City of Tshwane area to promote these enterprises for example,
- Steel, Bricks
- Cement and ready mix concrete
- Transportation of equipment,
- Security

7 PREFERENTIAL PROCUREMENT POLICY FRAMEWORK ACT,2000:2022

In terms of the Supply chain Management policy 2025/26 Section 47 states that:

7.1 SUB-CONTRACTING

When subcontracting The City shall obligate main contractors or service providers to engage targeted enterprises in the performance of their contracts incorporating resource specifications. These will be made a condition of the tender for the city to implement at project management level. In cases that the city decides to unbundle the tender to appoint different service providers to an extend that the contract value per service provider does not exceed 30million then the provision of sub-contracting will not be applicable.

(1) Sub-contracting must be subjected to approval by the city manager. The appointed service provider must source competent and capable service providers and where applicable be registered with the relevant body and submit a list of sub-contractors for approval to the City of Tshwane.

(2) Sub-contracting entity should have an equal B-BBEE level status or higher than the main contractor.

(3) Minimum of 30% can be sub-contracted for tenders above 30 million

(4) Local economic participation should be given priority when making a list of potential subcontractors available.

- City of Tshwane Participants with specific attention for the region in which the contract is to be executed should be given first priority and the below competent and capable designated groups should be prioritized
    - An EME or QSE
    - An EME or QSE which is at least 51% Black Owned
    - An EME or QSE which is at least 51% Owned by Black youth
    - An EME or QSE which is at least 51% Black Women Owned
    - An EME or QSE which is at least 51% owned by black people with disabilities.
    - An EME or QSE which is 51% owned by black people living in rural or underdeveloped areas or townships
    - A cooperative which is at least 51% owned by black people
    - An EME or QSE which is at least 51% owned by black people who are military veterans; or
    - More than one of the categories referred to in paragraphs (a) to (h).

Should subcontractors within Tshwane not be identified, the appointed service provider can extend the list of subcontractors to:

- Gauteng Participants
- National participants

(5) In relation to a designated sector a contractor must not be allowed to sub-contract in such a manner that the local production and content of the overall value of the contract is reduced to below the stipulated minimum threshold if the appointed Service Provider scored points for Local Content and Production.

7.2 EVALUATION CRITERIA ON SUBCONTRACTING

The bids submitted by the prospective local subcontracting companies will be evaluated by the Main Contractor.

8 BID MEETING AND SITE VISIT

a) There will be a **compulsory** tender Bid meeting and site visit, where tenderers will be required to complete the tender site visit and Bid Meeting attendance register form at the meeting.

b) Site meeting is compulsory and will be held at Rosslyn substation (see Part C3.2 for address).

c) Prospective tenderers must already be in possession of the tender document at the bid meeting and have prior studied the contents thereof obtaining the knowledge of what is required.

d) Tender meeting and site visits shall be at the cost of the tenderer and the tenderer shall provide their own transport.

e) Tenderers must be on time and attend the full tender meeting and site visit.

9 DRAWINGS

a) A4 Drawings are included in the tender.

b) For new 275kV and 132kV equipment

10 ACTIVITY, PARTICULARS AND GUARANTEES (PARTC 2.1), QUANTITIES & BILL SCHEDULE (PART C2.2)

a. The tenderer must complete the schedule of particulars and guarantees for all items in full. Failure to do so, will result in the tender being disqualified from further evaluation.

b. The prices must be completed in pen (black) in the schedule and included in the tender document as was issued.

c. All item/activities as listed in the bill must be priced individually and no item prices are allowed to be included somewhere else combined with other item prices.

d. This schedule will be provided on soft copy to tenderers with meeting minutes of the site meeting.

e. The description of items may not be changed or deleted as well as the quantities. Only changes that are minuted / instructed by the engineer will be allowed.

f. All tenderers must tender to the above as their main offer.

11 EVALUATION CRITERIA

Administrative

Mandatory requirements

Functionality evaluation

Preferential points system

1. Functionality will be evaluated and scored out of 100 points. Bidders are required to obtain a minimum of 70 evaluation points on functionality to move on to the next stage where they will be evaluated on Price and B-BBEE status.
2. Final evaluation shall be done according to the 90/10 preference point system.

12 ALTERNATIVE OFFERS

a. Alternative offers will only be considered if tenderer(s) have submitted a fully completed main offer. For alternative offers a complete separate detailed activity, quantities and bill/price schedule must be submitted as a separate document.

b. Tenderers must for each offer provide a typed copy on SD card or memory card (in a PDF format) of the above schedule with their offers.

Page 13 of 14

13 CONSTRUCTION INDUSTRY DEVELOPMENT BOARD GRADING

a) Only those tenderers who are registered with the Construction Industry Development Board CIDB, or are capable of being so prior to the evaluation of submissions, in a contract grading designation equal to or higher than a contractor grading designation determined in accordance with the sum tendered for **8EP** or higher class of construction work, are eligible to submit tenders

b) Joint ventures are eligible to submit tenders if they meet minimum requirements as per CIDB guidelines for joint venture criteria

- Every member of a joint venture is registered with the CIDB prior to the closing date of tender.

14 SURETY

a. The Tenderer must supply a letter of intent, from a financial institution, with the tender for providing a surety of 10% of the tender price.

b. The Contractor must provide a surety of 10% of the contract price within 14 days after appointment/award.

c. The Contractor will carry the costs to provide the surety.

15 FORWARD COVER

a. Forward cover to be taken by the successful bidder for all the imported equipment's.

b. The contractor must carry the cost of the forward cover to be provided for the refurbishment of Kwagga 275/132kV substation.

16 REFERENCE

a. The following words will have the same meaning:

i. CoT and CTMM

ii. BID(S) and TENDER(S).

iii. BIDDER(S) and TENDERER(S)

Page 14 of 14

iv. BIDDING and TENDERING

If anywhere in this document it still refers to Bid(s), Bidder(s) and bidding it shall be replaced with Tender(s), Tenderer(s) or Tendering.

PART C4: SITE INFORMATION

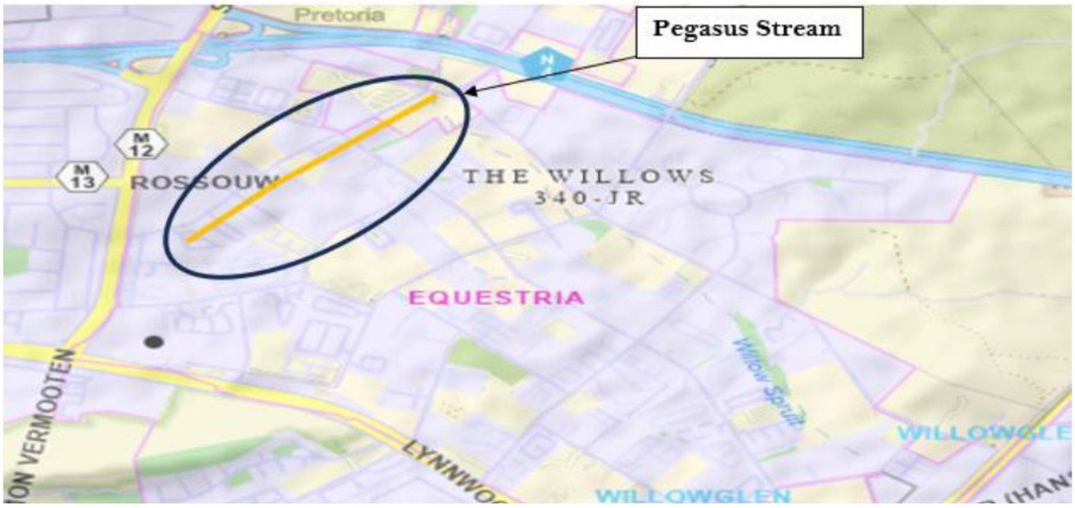
TABLE OF CONTENTS

C4.1 DESCRIPTION OF THE SITE AND SURROUNDINGS

TABLE OF CONTENTS

C4.1.1 Locality

below is the locality map of the site:



Locality Map

C4.1.2 General Description of the Site

Pegasus Canal is located in the eastern part of the City of Tshwane under Region 6, in Equestria. The canal is a major stormwater system that drains the areas between the Bronberg mountain, parts of Die Wilgers and Equestria.

- Scope of work:
    - Construction of a 7-metre-wide reinforced concrete open canal with a total length of 700 metres.
    - Construction of two bridge culvert systems along Griffith Avenue and Furrow Road.
    - Construction and rehabilitation of embankments along canal route.
    - Construction of Stormwater pipelines and outlet structures.

C4.1.3 Site Conditions

C4.1.3.1 Topography

The topography of the area is gently sloping in a north easterly direction toward a watercourse to the North-East of the scope area. illustrate the topography of the area. The alignment of the stormwater canal is generally characterised by a gradient sloping in a north-easterly direction, with an average longitudinal slope ranging between 1.6% and 2.9%. The existing natural ground mean sea level along the route ranges from 1350m to 1334m at the end of the proposed canal.

C4.1.3.2 Site Geology

The subsurface horizons comprise topsoil, transported soil, reworked residual soil and residual soil. The material along the canal route is cohesive and may not be used for construction but may be used as a liner.

C4.1.3.3 Hydrology

The area faces hydrological challenges due to summer rainfall, leading to surface runoff, localized flooding, and a need for enhanced stormwater infrastructure.

PART C2

PRICING DATA

(To be filled in by Tenderer/Contractor)

CONTENTS

PART	DESCRIPTION
C2.1	**Pricing Instruction** Section 4: Specifications Section 5: Particulars of Particulars
C2.2	**Activity Schedules / Bill of Quantities**

PART C2: PRICING DATA

(NOTE: All pages of this section shall be printed on YELLOW paper)

PRICING DATA

C2.1 PRICING INSTRUCTIONS

1. General

1.1 This section provides the tenderer with guidelines and requirements with regard to the completion of the Price Schedule. The Schedule has to be completed in black ink and the tenderer is referred to the Tender Specifications in regard to the correction of errors.

1.2 The Price Schedule shall be read with all the documents which form part of this Contract.

1.3 The following words shall have the meanings hereby assigned to them:

Quantity	The number of units of work for each item
Unit:	The unit of measurement for each item of work in terms of the Specifications and the Project Specifications.
Amount	The product of the quantity and the rate tendered for an item
Rate:	The payment per unit of work at which the tenderer tenders to do the work.
sum	Where an item cannot be indicated with a unit of Measurement listed on point 2 below or which has more than one activity within it shall be referred to as “sum” to indicate unit of measurement

2. Units of Measurements

The units of measurement described in the Price Schedule are metric units.

Abbreviations used in the of Quantities are as follows:

mm	=	millimetre	h	=	hour
m	=	metre	kg	=	kilogram
km	=	kilometre	t	=	ton (1000kg)
m^2	=	square metre	no.	=	number
m^2	=	square metre	sum	=	lump sum
ha	=	hectare	MN	=	meganewton
m^3	=	cubic metre	MN.m	=	meganewton-metre
m^3.km	=	cubic metre-kilometre	PC sum	=	Prime Cost sum
l	=	litre	Prov sum	=	Provisional sum
kl	=	kilolitre	%	=	Per cent
MPa	=	megaspascal	kW	=	kilowatt
Qty	=	Quantity			

3. Rates

This price list has columns for quantity, rate and price for the goods. Entries in these columns are made as follows:

3.1. If the Supplier is to be paid an amount for the goods which is a fixed price for an item or a fixed price for each of a series of items, the tendering supplier enters the amount in the price column only, the other two columns being left blank.

3.2. If the Supplier is to be paid an amount for the goods which is the unit rate for each item multiplied by the quantity of the item supplied, (i.e. a 'Price Schedule' arrangement) - the tendering supplier enters the rate which is then multiplied by the quantity (which has been entered either by him or by the Purchaser) to produce the price which is also entered.

3.3. If the Supplier is to be paid an amount for an item of the goods which is the rate multiplied by the quantity supplied -whatever that quantity turns out to be (i.e. a 'schedule of rates' arrangement) - the tendering supplier enters the rate only, the other two columns being left blank. The tendering supplier's offer cannot include a total of the prices which covers all the items which the Supplier has to supply if any of the supply is dealt with using items with a rate only.

3.4. Rate only entries must not be made for work covered by other items.

CORRECTION OF ENTRIES MADE BY TENDERER

Any entry made by the Tenderer in the Price Schedule, forms, etc, which the tenderer desires to change, shall not be erased or painted out. A line shall be drawn through the incorrect entry and the correct entry shall be written above in black ink and the full signature of the Tenderer shall be placed next to the correction

SECTION 4

SPECIFICATION

CONTENTS

PART	DESCRIPTION	APPLICABLE
4.2	275kV Surge Diverters and insulating bases	Yes
5	Instrument Transformers:	
5.1	132kV Outdoor voltage transformers	Yes
5.2	275kV Outdoor voltage transformer	Yes
5.3	132kV Post insulators Current transformers	Yes
5.4	275kV Post insulators current transformer	Yes
5.5	132kV Insulators	
5.6	275kV Insulators	
6	Insulated Cables:	
6.1	11kV Cables Feeders	Yes
6.2	Multi-core Cables	Yes
7	Earthing System:	
7.1	Earth Grid	Yes
7.2	Soil Resistivity test	Yes
7.3	Earth Grid Survey	
7.4	Lightning Mast with earth mat	
7.5	Welding connections	
8	Control & Protection equipment:	
8.1	132kV Overhead line C&P system IEC1850 enabled	No
8.2	132kV Bus-Coupler C&P System IEC61850 enabled	Yes
8.3	132kV Busbar Protection Scheme IEC61850 enabled	No
8.4	275/132kV Transformer C&P System IEC61850 enabled	Yes
8.5	275/132kV Transformer C&P System IEC61850 enabled comms enabled	Yes
8.6	132kV Interconnector/Bus-Section Panel C&P Equipment System IEC61850 enabled: SCADA comms enabled	Yes
8.7		Yes
9	AUXILLIARY EQUIPMENT	
9.1	Low Voltage (LV) Supplies:	Yes
9.2	110V Batteries & Battery Stands:	Yes
9.3	110V Battery Charger	
9.4	Pilot Cable Termination Panel	

PART	DESCRIPTION	APPLICABLE
10	**Civil Works:**	
10.1	275kV & 132kV yards common areas around buildings	**Yes**
12	**Protection and Control:**	
12.1	**Control and Protection Equipment**	**Yes**
12.1.1	**Addendum to Control and Protection**	**Yes**

13	**<u>Auxiliary Equipment</u>:**	
13.1	**Low Voltage AC Wall Mounted Change-over & Distribution Panel**	**Yes**
13.2	**110V Battery Charger 110V Batteries and Battery Stands**	**Yes**
13.3	**110V Batteries and Battery Stands**	**Yes**
13.4	**Pilot Cable Termination Panel**	**Yes**
14	**<u>Building and Civil Works</u>:**	
14.1	**Building and Civil Works**	**Yes**
14.2	**Yard Stone**	**Yes**
15	**<u>Electrical Installation of Substation Building, Yard Lighting and Lightning Protection</u>:**	
15.1	**Electrical Installation of Substation Building, Yard Lighting and Lightning Protection**	**Yes**
16	**<u>Steel Lattice Construction Portal Type Gantries for 132 kV Overhead Busbars</u>:**	
16.1	**Steel Lattice Construction Portal Type Gantries for 132 kV Overhead Busbars**	**No**
17	**<u>Communication System/Network</u>:**	
17.1	**Optical Fibre Based Teleprotection- & Communications Equipment**	**Yes**
17.2	**Marshalling kiosk & Termination boxes**	**Yes**
18	**<u>SCADA</u>:**	
18.1	**SCADA Interface**	**Yes**
19	**<u>Cables/Lines</u>:**	
19.1	**132kV Overhead Power Line**	**No**
19.2	**33kV Power Lines - General Quality Specification**	**No**
19.3	**132kV Underground Cable/Lines**	**No**

SECTION 4: TECHNICAL SPECIFICATION

PART 1.1: GENERAL REQUIREMENTS

SPECIFICATION No: GR.01/0-97 – Rev 4

CONTENTS

1. SCOPE

Part 1 is the general specifications and must be read with the specific specifications of the various equipment.

2. STANDARDS AND COMPLIANCE WITH SPECIFICATION

All work shall be in accordance with this Specification and Standard Specifications herein, and the General Conditions of Contract Governing Tenders and Special Conditions of Contract Governing tenders: Energy and Electricity Division.

Where no particular specification clause is referred to with respect to any item of equipment to be supplied, the latest issue/amendment of the relevant SANS specification or NRS, IEC or BS Specification shall be adhered to (in the same order).

In order to help control costs, the Tenderer shall where possible offer his available standard commercial equipment.

Tenderers shall highlight any deviations from the specification on a clause by clause basis explaining the reasons for any deviations in detail. Reference to attached pamphlets, brochures etc., which may contain details of such deviations, are not acceptable. Tenderers main offer must comply fully with this specification. Any alternative offer shall supply the same functionality as called for in this specification. Tenders not complying with these functional requirements will be summarily rejected.

All civil work shall be in accordance with the Standard Specifications for Municipal Civil Engineering Works.

3. ENVIRONMENT

Altitude above sea-level	1 530 m
Maximum ambient temperature	40 °C
Average daily maximum ambient temperature	30 °C
Minimum ambient temperature	-5 °C
Average daily minimum ambient temperature	2 °C
Maximum ground temperature	25 °C
Minimum ground temperature	10 °C
Relative humidity	94%
Lightning conditions	Severe
Degree of pollution	Medium
Earth resistivity	Varying between 50 and 1000 ohm per metre at a depth of 1,5m
Maximum wind speeds :	
a) Steady conditions;	25 m/s
b) Gusty conditions.	45 m/s

4. SYSTEM PARTICULARS

4.1 132 kV System

Nominal system voltage (r.m.s. line to line)	132 kV
Highest system voltage (r.m.s. line to line)	145 kV
System frequency	50 Hz
Maximum symmetrical fault current capacity (3 second rating)	31.5 kA
System BIL at sea-level	650 kV
System insulation level at Pretoria altitude	550 kV
Number of phases	3
Phase rotation	R-Y-B anti-clockwise
System earthing	Neutral points on 132kV transformer windings solidly earthed

4.2 275 kV System

Nominal system voltage (r.m.s. line to line)	275 kV
Highest system voltage (r.m.s. line to line)	36 kV
System frequency	50 Hz
Maximum symmetrical fault current capacity (3 second rating)	13.10 kA
System BIL at sea-level	170 kV
Number of phases	3
Earthing	Through NEC and NER

5. RECONSTRUCTION AND DEVELOPMENT PROGRAMME

The contractor shall approach this contract and execute the Works with due consideration of the Reconstruction and Development Programme (RDP) of the Government of National Unity. It is expected that existing local Planning and Development Forum of RDP Committees or forums or committees still to be established, will monitor the extent to which government policy in this regard is supported.

It may be expected that these forums or committees or a committee established specifically for this contract, will also be involved in the requirements of labour, assessment of training needs and development requirements of entrepreneurs as contractors/sub-contractors as well as utilisation of sub-contractors from the relevant local communities.

The contractor shall give his full co-operation to these forums and committees.

All labour and sub-contractors utilised on this contract shall be drawn from the communities of the CITY OF TSHWANE METROPOLITAN MUNICIPALITY where large unemployment prevails and the need for a better quality of life exists, all in accordance with the goals of the RDP.

If the contractor intends to utilise certain categories of employees (generally considered as being key-personnel of the contractor), or certain sub-contractors (generally specialist sub-contractors) in the Works, full details in this regard must be provided with the Tender. This clause shall apply mutatis mutandis to such a sub-contractor if accepted in terms of the General Conditions of Contract.

Should the contractor fail to comply with the conditions of this clause, the Engineer may suspend the progress of the Works in terms of clause 48 of the Special Conditions of Contract and the contractor shall not be entitled to make a claim for a delay or additional Cost.

Compliance with this clause does not relieve the contractor of any of his contractual obligations or liabilities

6. SITE SECURITY

The Contractors will be responsible for all security until hand over to the Council. This shall include all temporary security site lighting.

7. SITE OFFICE

The Engineer will allocate to the Contractor an area for the purpose of stacking or storing materials and the erection of site offices. On completion of the Contract Work, the Contractor will remove all buildings, equipment, rubble and materials at the construction site and leave it in a tidy condition.

8. FOOD, ACCOMMODATION AND TRANSPORT

Suitable provision shall be made for the supply of drinking water and food under sanitary conditions acceptable to the health inspectors of the Council.

The safe transport of plant, tools, materials and labour to and from the working sites is the responsibility, Contractor.

9. CONTRACT MANAGEMENT

9.1 Project Team

The Tenderer shall submit a list of his proposed project team, with a brief CV of each candidate. The Engineer shall have the right to instruct the Contractor to change the team after negotiation with the Contractor.

9.2 Subcontractors

The Contractor shall submit a list of proposed subcontractors for approval to the Engineer. Any changes to the list of subcontractors shall be approved by the Engineer. Subcontractors may not subcontract work further without permission of the Engineer. The Engineer may at any time ask for a subcontractor to be changed.

9.3 Work Scheduling

Within 3 weeks of order date the Contractor shall submit a detailed plan covering all important activities. The Engineer, together with the Contractor, shall agree the final schedule. This schedule will be saved as the base case and may not be changed. The milestones so generated will become the contractual dates for payments.

9.4 Site Office

The Contractor shall establish a permanent on-site organisation for the proper control, management and execution of the works.

9.5 Progress Meetings

Weekly meetings shall be held at which reports shall be submitted to the Engineer indicating progress and adherence to the work program.

Minutes of meetings shall be kept by the contractor and shall be made available to all participants, and others to be decided by the Engineer, within 3 working days.

Agenda to be circulated to all participants by email or by hand 1 week before each meeting.

9.6 Progress Reports

Monthly progress reports reflecting the status at the end of each calendar month shall be made available to the Engineer before the 5th working day of the following month and shall include, but not be limited to, updated versions of the following:

a) Cover sheet for monthly report;

b) minutes of the previous meeting;

c) cash flow statements showing actual expended amounts and forecast amounts to the end of the project on a monthly basis;

d) gantt charts generated on the approved project management software showing sequence and duration of work, as well as actual progress achieved and expected completion time. The base information as quoted for shall be shown and shall remain unchanged for the duration of the project;

e) attendance list;

f) list of site instructions to date;

g) list of variation orders to date;

h) list of drawings on the project;

i) list of rainfall days;

j) schedule of plant and personnel on site; and

k) list of subcontractors on site.

Furthermore, all variations to the contract, extras, omissions, etc., shall be processed and presented in the form to be directed by the Engineer.

10. SITE INSTRUCTION BOOK

The Contractor shall supply and keep in safe custody on site, a site instruction book of standard A4 size, with numbered pages and provision for two carbon copies per page.

The first page of every instruction will be removed and retained by the Engineer for record purposes.

11. DELIVERY AND STORAGE

The Contractor shall make his own arrangements regarding transport and off-loading of labour and materials and shall provide his own plant. The Contractor will be responsible for the safe storage of all equipment, materials and plant after delivery and will be held responsible for loss by theft or damage in any way, whether installed on the contract or not, until take-over of the works by the Council.

The Contractor will assume full responsibility for all materials which are supplied to him on site. He must provide adequate security measures to minimise the risk of theft. Materials on site shall be insured by the Contractor against all risks to their full value. Proof of such insurance and pre-payment of premiums to cover the duration of the Contract <u>must</u> be provided before the issue of any payment certificates will be considered.

12. SAFETY OF PERSONNEL

The Contract may involve work within close proximity of and work upon possible live high voltage equipment. Correct safety procedures must be adhered to at all times and work must be carried out under control and supervision of an experienced responsible person as detailed in the Occupational Health and Safety Act of 1993 as amended.

13. COMMENCEMENT AND COMPLETION DATES, PROJECT SCHEDULING

Within 1 week of written notification of acceptance of his tender, the Contractor shall arrange a kick-off meeting with the Engineer at which open points will be discussed and design freeze dates established.

The Contractor shall put the work in hand and shall submit a detailed programme to the Engineer for approval within two weeks after award of the contract, detailing the commencement date; duration and completion date and detail cash flow of each activity concerning the works. A suitable number of milestones shall be defined in order to ensure that the project is kept on schedule and that sufficient resources are employed.

The Contractor shall use a project planning programme approved by the Engineer.

Manufacture of equipment off-site is to run concurrently with the execution of the civil and building works. The various phases shall be properly co-ordinated to ensure that accommodation for equipment is ready when the equipment is ready for delivery.

A detailed manufacturing schedule for all equipment shall be supplied to the Engineer for his approval within 1 month of award of the contract. The Engineer will then insert hold points and inspection points at his discretion. The Engineer reserves the right to visit any works of the Contractor or any Sub-contractor at any reasonable time without prior announcement.

14. INFORMATION TO BE SUBMITTED WITH TENDER

Tenders shall be submitted complete with comprehensive literature, drawings, etc., describing the equipment offered. This information shall include the following as a minimum requirement:

a) Dimensioned drawings, to metric scale of each item of equipment;

b) Typical circuit diagrams of control and protection system;

c) Description of units and its operation, including vital design parameters (max. system voltage, fault capacity, current rating, impulse withstand level etc.).

All tenders must be fully priced. Items not specifically called for, but required for the successful completion of the works, shall be added by the tenderer.

Tenderers are further required to indicate in their tender their past experience in the execution of works of similar nature and scope.

Detail cash flow for each activity concerning the works.

15. INFORMATION TO BE SUBMITTED BY SUCCESFUL TENDERER

15.1 As-Built Drawings

The successful Tenderer shall during the course of this service update all drawings to reflect the as-built status of the works. Full sets of "AS-BUILT" drawings shall be supplied by the Contractor before final take over. These drawings must be to the satisfaction of the Engineer. One set of drawings shall be left on site, and the other used by the Contractor to correct the originals.

16. STATEMENT OF COMPLIANCE

Tenders are to be accompanied by the Statement of Compliance, stating whether the tender complies with the Conditions of Contract and the Specification.

17. STANDARD REGULATIONS

Wherever applicable the equipment, work and installation shall conform with the:

a) The Standard Regulations for the Wiring of Premises issued by the South African Bureau of Standards.

b) Any special requirements of the Supply Authorities of the area or district concerned.

Please note the requirements of Electrical Machinery Regulation R4 and R5. These state that no person employed by the Contractor or any Sub-contractor may enter any existing substation or switch-house without the uninterrupted presence of a "competent person" as defined in the Occupational Health and Safety Act acting on behalf of the client, unless a "permit to work" as referred to hereinafter has been obtained. When the electrical apparatus in any new substation or switch-house is made alive for the first time and at all times thereafter, such substation shall be treated as an existing substation and the requirements of the above paragraph shall apply for high voltage work.

18. PERMIT-TO-WORK

As the work may be done in stages, sections of the area can be energised. We draw your attention to the Electrical Machinery Regulation R4 & R5. The Contractor shall not work on any part(s) of the high voltage distribution system until such part(s) of the system have been isolated and earthed and the appropriate measures have been taken to prevent accidental re-energising of the part(s) and a "permit to work" authorisation in writing has been obtained from the Engineer or his duly authorised representative.

Before the responsible person of the Contractor signs for and accepts the permit he must satisfy himself that the part of the system on which he requires to work has been effectively isolated and earthed, that all circuits have been clearly identified, and that the Engineer has made it safe to work at the point of working.

The "permit-to-work" shall be made in duplicate and shall contain the following:

a) Written description of location of points of isolation and of earthing.

b) Name and signature of person to whom the permit is issued.

c) Time and date of issue of permit.

d) Statement handing-over section(s) of system clearly defining the part(s) handed-over as being safe to work upon.

e) Signature of the Supply Authority or his duly authorised representative.

The responsible person of the Contractor shall retain the original "permit-to-work" shall be handed to the Contractor and shall retain it while his work is being completed on that part of the system covered by the permit.

After ensuring that no person employed by the Contractor or any Sub-contractor is still working on the system, that work is completed and that the installation has been made safe, the Contractor shall sign the "permit-to-work" and return it to the Engineer. Then the electrical installation may be re-energised. The same person that took out and signed the permit must return it.

Notwithstanding the foregoing, the Contractor shall at all times take all necessary precautions and make all necessary tests to ensure the safety of all persons employed by him or by any Sub-contractor.

No extras to the contract or extension of time will be allowed due to any of the above factors.

19. PROTECTION OF EQUIPMENT AGAINST DAMAGE

Equipment shall be adequately protected against possible damage during transportation, off-loading and handling on site. Relays, instruments and other delicate equipment shall be adequately protected against transport and other damage to the satisfaction of the Engineer.

20. LV DISTRIBUTION VOLTAGE

The low voltage distribution will be at a nominal voltage of 400/230 volt 50 Hz 3 phase AC.

The voltage on miniature substations or transformers shall be set at a No Load voltage of 400/230 volts.

Distribution will be by 4 wire, 3 phases and a neutral. The neutral shall be solidly earthed at the substation.

21. TEST BY SUPPLY AUTHORITY

On completion of the work, the whole of the installation will be inspected and tested by the Engineer.

The Contractor will be required to attend on the Supply Authority's inspector(s) requests and give all assistance required and provide such tools, materials, implements and instruments as are necessary for the tests.

22. ARTICLES OF VALUE

Any article of value, archaeological finding, etc., found on the site during the execution of the Contract shall be handed to the Engineer who shall be the sole referee as to what constitutes articles of value and to report to who ever may be concerned.

23. WITNESSING OF TESTS

The Council reserves the right to have the Engineer inspect and witness factory and onsite commissioning tests of all equipment to the satisfaction of the Engineer.

The Contractor shall make due allowance for these inspection points in his manufacturing programme and to avoid delays occurring, shall notify the date for inspection or witnessed tests at least 14 days in advance of the actual date.

The Council does not accept responsibility for the late delivery on the basis of inspection delays.

All tests shall be documented to the satisfaction of the Engineer.

24. EXISTING SERVICES

The Contractor shall be responsible for obtaining drawings from other Municipal Departments and authorities showing the positions of underground services.

25. HANDOVER

The last payment on takeover (i.e prior to retention payments) will only be done on completion of a Handover Certificate and receipt of all manuals and test certificates

SECTION 4: TECHNICAL SPECIFICATION

PART 1.2: SITE SAFETY, SECURETY, STORAGE AND SUPERVISION REQUIREMENTS

SPECIFICATION No: SR.01/0-2003 (Previous No: SR.01/0-97)

CONTENTS

1. WORKING IN LIVE YARDS

In order that the Council may make the necessary arrangements, each application for a Work Permit shall be submitted to the Engineer, together with all the required particulars, **at least three full working days** before access to the site yard is required.

With regard to the switching out of equipment to facilitate the carrying out of Contract Work, it shall be distinctly understood that switch-out dates, times and periods are subject to load and operational requirements. Operational and/or load requirements may dictate that Contract Work on the existing network be carried out over weekends or outside normal working hours.

The Contractor shall obtain, complete and return the following documentation one week before access to the site is required:

a) Issuing of substation keys to Contractors (where applicable)

b) Temporary Permit to enter a security area

c) Appointment of a competent person to supervise workers near electrical equipment

d) Duties and responsibilities for the competent person supervising construction work near live electrical work.

2. SECURITY MEASURES

Work inside electrical yards is subject to the Council's security measures and the contractor shall contact the Council's Chief Security Officer prior to the commencement of any work under the Contract, in order to make the required security arrangements. The costs of security measures shall be included in the rates for site work.

If so required by the Council, all Employees of the Contractor and his Subcontractors employed with regard to the execution of the Contract shall be security cleared on such conditions as laid down by the Council.

Should any Employee of the Contractor or his Subcontractor be declared unfit for whatever security reasons, the Contractor or the Subcontractor shall have the right to appoint any person in lieu of the disqualified Employee, subject to the Council's security clearance.

The Contractor undertakes -

a) to treat all information regarding the Contract and the execution thereof as strictly confidential;

b) that he himself, his Subcontractors and all Employees concerned will sign the Council's Declaration of Secrecy;

c) in the execution of the Contract, to report to the Council's Chief Security Officer, without delay and confidentially, any information regarding:

d) Any suspected espionage in respect of the lay-out of the site where the work is being executed, or in respect of sites where protective measures are applied.

e) Actions which may be interpreted as sabotage, or any planning in this regard.

f) Any suspected subversive activities among his Employees.

g) The loss of any classified documents which came into his possession as a result of the Contract.

h) The contravening of any security measure by an Employee.

i) Housebreaking, theft, arson, vandalism, loss of identity documents, security keys or lock combinations.

j) Corruption, blackmail, intimidation, striking or inciting or unauthorized access to an office or premises.

k) Any Employee who is involved with the Contract and who is suspected of bringing drugs, intoxicating liquor, a weapon, ammunition or explosives on the site of the Council.

The Council shall have the right to inspect, at all reasonable times, and through its Security Department, the Contractor's and Subcontractor's premises and offices where work in connection with the Contract is executed or where documents in that connection are kept, in order to prescribe suitably security measures, and to determine whether the prescribed security measures are bing implemented satisfactorily.

3. STORAGE OF MATERIALS

The Contractor shall be solely responsible for all security arrangements for the safe storage of materials on site. The Council will not be liable for any loss or damage of any materials or equipment whatsoever.

Prices for supply and delivery of materials shall allow for all transport, handling, loading and off-loading on site.

The receiving and handling thereafter on site of all materials is the responsibility of the Contractor.

4. WORKING HOURS

Site work carried out for the execution of this Contract shall be confined, as far as possible, to normal working hours on normal working days (i.e. 07h00 - 17h00 on Mondays to Fridays) excluding Public Holidays.

Work to be done outside normal working hours shall be approved by the Engineer who shall be notified of the reasons in writing at least three working days in advance of any work to be done outside normal working hours.

5. CLEARING SITE

On completion of the Contract the contractor shall clear the Site of all temporary offices, sheds, temporary structures and waste material and rubbish. Nothing shall be buried on site.

SECTION 4: TECHNICAL SPECIFICATION

PART 1.3: QUALITY ASSURANCE REQUIREMENTS

SPECIFICATION No: QR.01/0-2003 – Rev 4 (Previous No: QR.01/0-97)

CONTENTS

1. QUALITY SYSTEM

The Contractor shall provide and operate throughout the Contract, to the satisfaction of the Engineer, a Quality System in accordance with the requirements specified hereinafter.

The Contractor's quality assurance activities shall include, but not be limited to, those functions defined in the Schedule and such additional activities as the Engineer may direct to prove conformity to the Specification. They shall provide for the detection and removal of all non-conforming material either prior to or at the latest state of process or manufacture where the required characteristics can be measured or observed.

A valid ISO 9000 listing will be acceptable to the Engineer.

2. INFORMATION REQUIRED IN THE TENDER

The Contractor shall complete and submit in his Tender the Quality System Questionnaire.

In support of this information and when called upon to do so, the Contractor shall submit a description of his Quality System or a Quality Manual.

3. QUALITY SYSTEM DOCUMENTATION

3.1 Contractor's Quality Control Plan (QCP)

Within one month of instructions to proceed, the Contractor shall submit for approval of the Engineer two copies of a draft Quality Plan for the contract Works, defining the inspections, tests and other quality activities, which he proposes to carry out at each stage of his work under the Contract. The Engineer shall add his witness and hold points to the quality plan. Quality activities, which are to be performed at sub-contractor’s premises, shall be clearly defined.

The Quality Plan shall be in two parts, covering:

a) Quality activities during design (if applicable), and manufacture.

b) Quality activities at Site.

Following approval of the Quality Plan and within 1 month of approval by the Engineer, the Contractor shall submit to the Engineer four copies of the approved documents.

3.2 Witnessing by Engineer

Following his approval of the Contractor's Quality Plan the Engineer will notify to the Contractor the inspections, tests and other quality activities, which he intends to witness. He may at any time call for the witness of such additional inspection and tests as he may require proving conformity with the Specification. When the Engineer has confirmed his intentions to witness any inspections or tests the Contractor shall be given due notice of his readiness. Work or dispatch may not proceed if the Engineer has not witnessed or attended tests required by the Quality Control plan.

The Engineer shall indicate on the QCP whether he wishes to attend factory witness tests, and site commissioning tests. The documentation of these tests shall be incorporated into the Contract Documentation system.

4. INSPECTION AND TESTING

4.1 Scope

Inspection and testing shall include all items in Schedule A and all relevant tests listed in the appropriate Standards. The quality plan shall be to the approval of the Engineer.

4.2 Statutory Testing

The Contractor shall be responsible for ensuring that all tests and approvals required by Statutory Authorities are duly performed and the relevant approval documents issued, free of charge, to the Employer.

Where classification of equipment is required, an approved Classification Society shall carry it out at the Contractor’s expense. On completion, the Contractor shall issue the relevant documents to the Engineer.

4.3 Testing

Cognisance should be taken of the specific requirements detailed in other parts of Section 3 regarding testing. Tenderers are to ensure that all uncertainties regarding separate requirements are clarified with the Engineer in advance.

All test reports shall be incorporated into the Instruction, Operating and Maintenance Manuals.

4.3.1 Type tests

The electrical equipment, relays and control equipment shall be certified by means of test certificates to have been tested successfully and in accordance with the specified requirements and Standards. It shall also be certified that they have passed the following tests successfully:

a) Temperature rise test;
b) ability to withstand overload test;
c) durability test;
d) contact test;
e) insulation test;
f) high-frequency disturbance test; and
g) any other type tests normally carried out by the manufacturer and those laid down by the appropriate Standard Specifications.

If type testing is to be done specifically for the purpose of this contract, testing shall be carried out in accordance with the specified requirements by an independent recognised testing institute approved by the City of Tshwane.

Existing type test certificates will be considered on their merits and Tenderers are requested to submit copies of existing type test certificates with their tenders. Should reasonable doubt arise as to the validity of the test certificates submitted and accepted by the City of Tshwane, in respect of the relays to be supplied, the City of Tshwane may direct that further certificate(s) be obtained on a sample unit/sample units, provided by the successful Tenderer at his expense. An independent recognised testing institute shall carry out such further testing.

4.3.2 Routine tests

These are part of the manufacturing process and the test results shall be included in the operation and maintenance manuals.

A high-voltage test of insulation shall be carried out.

Any other factory routine tests normally carried out by the manufacturer and those laid down by the appropriate Standard Specification.

The general philosophy shall be to deliver a system to site only once it has been thoroughly tested and its specified performance has been verified, in so far as site conditions can be simulated in a test laboratory.

4.3.3 Instruments

All measurements shall be calibrated in accordance with SANS-ISO 9001.

4.3.4 Detailed testing requirements

The Contractor shall give the City of Tshwane or its appointed representative not less than fourteen (14) days notice of such equipment being ready for inspection or witnessing of tests, as necessary (90 days in respect of overseas tests).

In order to assist the City of Tshwane in making provision for inspection and witnessing of tests, the name of the manufacturer, the place of manufacture, the place where equipment can be inspected and where equipment will be tested, shall be provided. Should the Contractor wish to change to another manufacturer, he shall in due time advise the City of Tshwane in writing of the details called for above.

The Contractor shall at the time of placing orders or sub-orders advise all Sub-contractors that all equipment may be subject to inspection and witnessing of tests by the City of Tshwane or its appointed representatives.

Factory tests shall be regarded as an integral part of the manufacturing of the various items and shall therefore be allowed for in the unit prices quoted for supplying.

Site and commissioning tests shall be regarded as an integral part of the installation of the various items and shall be allowed for in the unit prices quoted for installation.

The Engineer shall be furnished with two copies of the Contractor's records of all factory tests immediately after such tests and before any material is shipped. No material shall be installed before the Engineer has officially approved these tests.

The Engineer shall be furnished with two copies of the Contractor's records of all site and commissioning tests immediately after completion of such tests.

4.3.5 Site tests

Site tests shall be carried out in detail to confirm the integrated operation of the control and protection scheme.

Testing shall at the least include the following:

a) Secondary injection tests, to prove panel circuits and the operation, speed and operating curves of relays;
b) functional testing of all elements, to prove the operation of the different circuits. This includes the interfacing with yard equipment and the various other substation functions, like busbar protection, breaker fail/busbar strip protection, inter-tripping, aided tripping, interlocking, indications, alarms, control functions, communication networks, operator stations and master station control operations;

c) tests to prove the key features of instrument transformers;
d) primary injection, carried out from the yard equipment, to prove instrument transformer circuits; and

On-load testing, as a final proof of instrument transformer circuits and the phase relation of current and voltage inputs to the protection relays.

4.4 Procedures Subject to Approval

The Contractor shall submit his proposal to the Engineer when it is a condition of this Specification that a manufacturing, inspection or testing process be subject to the approval of the Engineer or when any matters require to be agreed between the contracting parties, as when specified Standards leave acceptance criteria to be so agreed.

Wherever practicable the Contractor's proposals shall be submitted early enough to allow ample time for agreement to be reached.

The approval of equipment, etc (issue for Manufacture/Construction) shall not relieve the Contractor of his responsibility regarding the correctness thereof or any subsequent failures as a result of faults or omissions by the Contractor.

5. WELDER QUALIFICATION

Welders who hold valid certificates of competence in accordance with the relevant National or International Standard shall carry out all welding.

6. CONTRACTOR'S RECORDS AND REPORTS

The Contractor shall maintain adequate records for inspection by the Engineer and shall submit for the Engineer's approval all test data, results and certificates as required. Following final tests on completion, test sheets recording the results of the tests shall be submitted in triplicate.

The Contractor shall obtain and submit to the Engineer copies of the relevant data and certificates when others carry out inspections and tests.

7. AUDITS BY THE ENGINEER

The Contractor's procedures and implementation thereof shall be subject to audit by the Engineer after Contract award. The frequency of audits shall be dependent upon the complexity and duration of the work. The Engineer shall give Two weeks notice to the Contractor of an intended audit.

8. QUALITY ASSURANCE REQUIREMENTS

Tenders shall present a Quality Plan to the satisfaction of the Engineer in the format suggested by ISO 9000.

9. PROVISION OF STANDARD SPECIFICATIONS

The Tenderer shall supply the latest issues and amendments of the list of specifications to be issued on the tender designation to the successful tenderer. The standard specifications are:

a) SANS Catalogue;

b) IEC Catalogue;

c) BSI Catalogue;

d) IEC 129 - Disconnectors;

e) IEC 51 - Switchgear;

f) IEC 255 - Protection relays;

g) IEC 694 - Common clauses;

h) IEC 298 - Metal encapsulated, type tested, works manufactured switchgear assemblies for voltages up to 72.5kV;

i) IEC 298 - Testing the response of Type tested, works manufactured, metal encapsulated switchgear, for voltages up to 72.5kV, to an internal arc fault;

j) NRS 001 - Technical specifications guidelines for drafting;

k) SANS 0200 - Earthing;

l) IEC 185 - Current transformers;

m) IEC 186 - Voltage transformers;

n) IEC 529 - Degrees of protection afforded by enclosures (IP code);

o) SANS-1195 - Busbars and busbar connections; and

p) SANS-1222 - Enclosures for electrical equipment.

SECTION 4: TECHNICAL SPECIFICATION

PART 1.4: TECHNICAL REQUIREMENTS

SPECIFICATION No: TR.01/0-97 – Rev 3 (previous No: TR.01/0-97)

CONTENTS

1. STANDARDS

The design, manufacturing and testing of the equipment offered shall be strictly in accordance with this specification and the current editions of the following Standard Specifications and Codes of Practice, except where amended herein.

The hierarchy of the specifications shall be as follows:

a) This specification;

b) SANS;

c) NRS;

d) IEC; and then

e) BS

The following documents shall be read in conjunction with this specification:

1.1 South African Sources

Occupational Health and Safety Act No 85 of 1993.	
Bolts and Nuts	SANS 135
Busbars	SANS 1195
Galvanising	SANS 763
Insulating Oil	SANS 555, IEC 296
Insulators	SANS 177
Marking of small wiring	NRS 003-1:1994
Mineral Lubricating Oil	SANS 053
Moulded case circuit breakers.	SANS 156: 1977 Amendment No 1: March1987
National colour standards for paint.	SANS 109: 1975 Amendment No 2: 1989.
PVC Insulated Electric Cables	SANS 150, SANS 1507

1.2 IEC Sources

Alternating current and disconnectors and earthing switches.	IEC 129 (1984)
Auxiliary switches	IEC 129
Bushings for alternating voltages above 1000 V.	IEC 137 (1984)
Common clauses for high-voltage switchgear and control-gear standards.	IEC 694 (1980) Amendment No1 (1985) Amendment No 2 (1993)
Contactors	IEC 158-1
Current transformers	IEC 185
Degrees of protection afforded by enclosures (IP code).	IEC 529 (1989)

Dimensional standardisation of terminals for high-voltage switchgear and control-gear .	IEC 518 (1975)
Dimensions of low-voltage switchgear and control-gear. Standardised mounting on rails for mechanical support of electrical devices in switchgear and control-gear installations.	IEC 715 (1981)
Disconnectors	IEC 129
Electric Power Switchgear and Accessories	IEC 51
Electrical and magnetic devices.	IEC 50-151 (1978)
Electrical Protection Relays	IEC 255
General definitions and test requirements.	IEC 60-1 (1989)
Graphical symbols for use on equipment.	IEC 417 (1973)
Guide for the checking of SF_6 taken from electrical equipment	IEC 480 (1974).
Guide to the testing of circuit breakers with respect to out-of phase switching	IEC 267 (1968)
High voltage alternating current circuit breakers - guide for maintenance.	IEC 1208 (1992)
High voltage metal-enclosed switchgear for rated voltages of 72,5 kV and above	IEC 517.
High voltage test techniques.	IEC 60 (1989)
High-voltage alternating current circuit breakers	IEC 56 (1987) Amendment 1 (1992)
IEC Standard voltages	IEC 38 (1993)
Insulation Co-ordination	IEC 71
International Electrotechnical Vocabulary	IEC 50
Low voltage control gear. Part 1 : Connectors	IEC 158-1 (1970)
Low voltage motor starters	IEC 292-1
Oil immersed Power Transformer	IEC 354
On-load tap changer	IEC 214
Partial discharge measurement	IEC 529, IEC 270 (1981)
Post Insulators	IEC 273
Power Transformers	IEC 76
Radio interference measurement	IEC 270
Rotating electrical machines	IEC 34 (1994), BS 2613 and BS 3979
Specification and acceptance of new sulphur hexafluoride.	IEC 376 (1971)
Sulphur Hexafluoride (SF6) Gas	IEC 376
Surge Diverters	IEC 99.1
Switchgear, control gear and fuses.	IEC 50-441 (1984)

Synthetic testing of high voltage alternating current circuit breakers.	IEC 427 (1989) Amendment No 1 (1986)
Tests on hollow insulators for use in electrical equipment.	IEC 233 (1990)
Voltage transformers	IEC 186

1.3 British Sources

Cartridges fuse for voltages up to and including 1 000V ac and 1500 V dc.	BS 88 (1988)
Direct Acting Indicating Analogue Indicating Instruments	BS 3693
Electrical Measuring Instruments and Associated Apparatus.	BS 162
Electrical power switch-gear and associated apparatus	BS-162
Electrical protection relays.	BS 142 (1982) Appendix G.
Electroplated coatings of tin	BS-1872
Lead Based Primary Paints	BS 2523
Phosphate Treatment of Iron and Steel	BS 3189
Specification for current transformers	BS 3838: 1973 (1982)
Structural Steel	BS 5950, BS 449
Weldable Structural Steel	BS 4360

The equipment shall be designed to include all possible provisions for the safety of those concerned in operation and maintenance.

All outdoor equipment shall be designed to prevent accumulation of moisture. The terminal boxes shall be to IP55 as a minimum requirement.

Where it is not possible to protect metal parts by painting or galvanising, these parts shall be constructed of stainless steel or brass.

Control panels and kiosks shall be designed to be rodent proof and outdoor 'live' structures shall be designed and positioned to eliminate possible short circuits, which could be caused, by birds or animals.

2. REQUIREMENTS FOR DESIGN AND LAYOUTS OF EQUIPMENT

The contractor shall ensure that the design and layout of the equipment to be supplied on this contract is such that in the operating condition it shall comply fully with the regulations promulgated in terms of the Occupational Health and Safety Act of 1993 and the latest amendments.

Where equipment supplied on this Contract is to be positioned in the proximity of existing equipment, structures or plant, the Contractor shall establish beyond any doubt that the said Regulations shall not be contravened by virtue of this proximity during the erection and testing periods and in the final operating conditions. Any queries in this regard must be submitted in writing to the Engineer.

Where special inspection and testing are required the cost shall be included in the contract price for the equipment and the contractor shall be responsible for the arrangement of such inspections and testing.

3. GALVANISING

The pre-galvanising treatment, the hot process galvanising and the testing shall be carried out in accordance with SANS 763.

A minimum thickness of 0.063mm of zinc is to be achieved during the galvanising process.

The preparation and the galvanising shall not adversely affect the function or the properties of the galvanised equipment.

The material shall be completely shaped, cut, drilled, countersunk, welded, etc., before galvanising.

Surfaces, which are in contact with oil while in service, shall not be galvanised.

Alternative processes shall not be used unless approved in writing by the Engineer.

The galvanising of bolts shall be carried out after all mechanical operations have been completed, but the associated nuts may be threaded after galvanising. The galvanised threads of bolts shall be cleaned of spatter by spinning or brushing.

4. PAINTING

4.1 General

The material shall be completely shaped, cut, drilled, countersunk, welded, etc. before any paintwork commences.

4.2 Painting of Non-Galvanised Steelwork

Cubicles, which contain wiring and other apparatus and are assembled in the works, shall receive the external finishing coat of paint in the works.

Before painting the parts shall be thoroughly cleaned by sand or shot-blasting or metal brushes and acid bathed to remove all traces of rust, scale or grease.

Immediately after cleaning all rough surfaces shall be filled.

Paint finish for indoor conditions shall be powder coating in excess of 80 microns. White chassis plates shall be supplied.

Unless otherwise specified, all indoor Panels should be painted Cloud Grey F48 to SANS 1091 of 1975.

5. BOLTS AND NUTS

Bolts and nuts shall comply in all respects with the current edition of SANS 135. The bolts, nuts and washers used on outdoor galvanised steel work shall be hot dip galvanised in accordance with Clause 1.4.

For electrical connections, no brass bolt or stud shall be less than M6 size.

6. ALUMINIUM AND ALUMINIUM ALLOYS

Aluminium shall be of the highest purity commercially obtainable, and be suitable for the electrical and mechanical applications for which it is intended.

Aluminium and aluminium alloy castings shall be free from porosity.

7. LABELS

All equipment to be supplied on this contract shall be provided with clear and concise descriptive labelling describing the function and the circuit number of the apparatus concerned. These shall be to the approval of the Engineer. All labels shall be in English.

In the case of open busbar, phase identification discs shall be fitted where practical, i.e. for strung busbar on the gantry beam below every string insulator set and for solid busbar on post insulator support pedestals. These shall be 150mm diameter discs and shall be coloured red, yellow or blue according to phase and shall be fitted to be visible from ground level. They shall be properly affixed by each fuse holder, link, protection relay, switch, control handle, control relays and indicator lamps shall be labelled to indicate its function and current rating for fuses.

Complete particulars of instrument transformers and surge diverters must be engraved or stamped on permanent weatherproof labels.

The manufacturer's details of switchgear such as rating, type, serial number etc. shall be engraved or stamped on a permanent weatherproof label.

8. OIL

New oil shall be supplied on this contract for all equipment required to be oil filled. Re-refined oil will not be accepted.

Insulating oil shall comply with the current editions of SANS 555 and shall be passed through a filter before use.

Lubricating oil shall comply with the current edition of SANS 053.

9. SF6 GAS

New sulphur hexafluoride (SF6) gas shall be supplied on this contract for all equipment required to be gas filled.

SF6 gas shall comply with the recommendations of IEC Publication No. 376.

10. DENSITY METERS

Unless specified elsewhere each gas compartment of equipment supplied with SF6 gas shall be supplied with density gauges equipped with at least one change-over contact for low gas density alarm condition and density alarm condition trip and one for lockout if applicable.

These gauges shall be easily visible from ground level by the operator. Arrangement of the gauges shall be to the approval of the Engineer.

11. SPARES

All spare parts or materials containing electrical insulation shall be delivered in approved cases suitable for storing such parts over a considerable period of time without deterioration due to climatic conditions or other causes.

Cases of spares shall be clearly marked with the contract number and as to what their contents are and a packing list shall be easily accessible from outside.

Individual spares shall be packed in plastic sheet or plastic bags, and tags listing the part number and description tied to the parts.

12. SPECIAL TOOLS

Where special tools are required for effecting adjustments, for dismantling purposes or for maintenance, a full kit of such tools shall be provided.

The cost of the special tools shall be deemed to have been included in the price of the device for which they are required, unless specially listed.

These tools are not to be used during erection.

A special lockable cupboard shall be supplied at each substation to house the special tools.

13. STRUCTURES

Structures with foundations shall be provided and erected to support the busbars, isolating switches, earthing switches, instrument transformers, surge diverters, etc.

A drawing (or drawings) shall be issued with this specification detailing the envisaged layout of the substation equipment. The design and layout of the equipment to be supplied on this contract shall be based on this envisaged layout.

The structures complete with busbars and droppers shall be designed such that under all conditions of loading, temperature variations and maximum swing under fault conditions the electrical clearances shall be equal to or greater than those specified. The temperature variation of busbars shall be considered to be 75° C to -5° C.

Safety clearances to enable operation, inspection, cleaning, repairs, painting and normal maintenance work shall be strictly in accordance with BS 162.

This contract covers the supply and fitting of droppers and connecting clamps to all items of equipment shown on the drawings of an envisaged layout of yard equipment whether these are to be supplied on this contract. The name/s of the supplier/s of associated yard equipment will be available from the Engineer. Where these connections are to be made onto existing commissioned equipment this work shall be carried out only after staff of the Engineer have certified that the existing equipment has been made safe and the necessary dead orders have been obtained.

Where the supply to the substation is by overhead line, the yard structures covered by this contract shall be provided with all the fittings or anchor bolts necessary for the anchorage of the tension insulators to be provided and fitted by the overhead line contractor. The structures shall be designed to allow for the loading of these incoming conductors (and earth wires) with the factors of safety specified in Clause 14 below. The final connection from the yard equipment to the terminal landing span conductors shall be the responsibility of the supplier of the yard structures specified herein.

Provision shall be made on each leg of all structures to accommodate an M16 bolt for the earth strap.

14. LOADING CALCULATIONS AND FACTORS OF SAFETY

The assumed maximum working loads shall be the combined simultaneous loading of "dead weight", windage and tension loadings.

The "dead weight" shall be the vertical loading of the conductors, insulators and equipment supported by the structures and the structures themselves.

The windage loading shall be the product of an assumed wind pressure of 700 Pa and the "effective projected area" of the structures, equipment, insulators and conductors supported. The "effective projected area" is as follows: -

a) The true projected surface area of flat objects x 1.

b) The true projected surface area of round, elliptical or hexagonal objects x 0.6.

c) The true projected area of all the members of the side of lattice supporting structures X1.5.

For equipment and structures of less than 10 metres total height the wind pressure shall be assumed to be 900 Pa. For structures of total height above 10 metres the assumed wind pressure shall be that determined from the curve of pressure against height as shown in Table 3 (section 4.5) of SANS 0160 - 1980 "Code of Practice for the general procedures and loadings to be adopted for the design of buildings", adjusted by multiplying the figure by a gushing factor of 1,37 (i.e. for a 140km/hour wind).

The tension loading shall be the combination of the tensions applied to the supported yard conductors and the tension due to the incoming lines and earth wires.

For calculation purposes working tension of each line conductor (or earth wire) shall be considered to be 4500 Newtons (i.e. 9000 Newtons per phase for twin conductors per phase) and allowance must be made for variation in landing direction (from that shown on the drawings issued with this specification) of up to 30° laterally and 20° vertically. The yard conductors shall be assumed to be at -5 C for the calculation of the assumed maximum working load.

The ratio of unsupported length of compression members to their least radius of gyration shall not exceed 120 for main members or 200 for bracing members.

The calculated tension/compression stress of any member of the completed structure resulting from the assumed maximum working load shall not exceed 40% of the elastic limit/crippling strength of that member (i.e. a safety factor of 2.5).

The tension of each single conductor shall not exceed 4500 Newtons at -5 C and a maximum safety factor of 2.5, based on the elastic limit or the 0.1% proof stress, shall apply.

The strength of the insulator strings shall be such that a factor of safety of 3 exists at maximum assumed working load condition.

The clamps and connectors shall be such that no slipping shall occur at any load less than 3 times the maximum nominal working tension of 4500 Newtons.

The design of the structures shall be such that under the assumed maximum working loads the deflection in the structures will not exceed the limits as specified by BS 5950 and SANS 0160, nor shall this deflection disturb the alignment of the apparatus supported.

15. MANUFACTURE AND ERECTION OF STRUCTURES

The design of the structures should preferably allow for the use of readily available standard steel sections. All structural steel shall be of mild steel to the requirements of BS 4360.

All members of the structure shall be manufactured with the utmost care. Jigs shall be used for cutting and drilling of the material such that when erected on site all members shall fit neatly together and all holes shall be truly aligned. No cutting, drilling, punching etc. of steel already galvanised will be permitted.

Bolthole clearances shall not exceed 2mm for bolts of up to M15 and shall not exceed 3mm for larger bolts unless otherwise approved. Holes shall not be elongated unless otherwise approved.

Each fabricated member shall be stamped (before galvanising) with an erection mark corresponding to the markings shown on the final approved structural arrangement drawings.

All structural steelwork shall be hot-dip galvanised.

Care shall be taken that the galvanised surfaces are not damaged during storage, transport or erection.

The design of the structure and the procedure for erection shall ensure that no members are strained or damaged during erection of the structures or the erection and tensioning of conductors.

Bolts shall be galvanised, and shall project at least 1 thread past the fastening nut, but not more than 3 threads or 3 mm, whichever is the lesser.

A hole to accommodate an M16 bolt for the earth strap shall be provided on each leg.

Foundation bolts shall be cast into the foundation on site using templates made of steel angle or U-section.

16. DRAWINGS, DOCUMENTATION AND DETAILED DESIGN

16.1 General Requirements for Drawings

Cognisance should be taken of the specific requirements detailed in other parts of Section III regarding the drawings and documentation. Tenderers are to ensure that all uncertainties regarding separate requirements are clarified with the Engineer in advance.

All manufacturing, layout, construction and detail drawings shall be to scale and fully detailed.

Schematic and other electrical drawings shall preferably be A3 in size and suitable for reduction to A4 for inclusion in instruction books, etc. All drawings and graphical symbols shall be to IEC specifications. Graphical symbols shall be in accordance with NRS-002.

Drawings for approval shall bear approved contract references and shall be submitted in duplicate as prints. After having been approved, the contractor shall supply CAD drawings on CD (Compact Disk) in DXF format suitable for use with Autocad version 2009 and with Microstation version 5.0.

All drawings to be supplied shall be approved and signed before manufacturing of the equipment is started.

All drawings, diagrams, sketches and plans shall be clear, well laid out, of a high standard and in all respects subject to the approval of the Engineer. Legends, notes and descriptions shall be incorporated in each drawing, diagram or plan. Separate loose legend sheets or descriptions or other leaflets will not be acceptable.

The wording of drawing titles shall be to approval. The name of the Manufacturer, Supplier and/or Contractor as well as the Contract Number shall appear prominently on all drawings, plans and diagrams. All final drawings shall display a drawing number issued by the City of Tshwane.

Drawing sheet sizes shall comply with the ISO A series, sizes A4 to A0, and preferably be in size A3.

All drawings, diagrams or plans shall use S.I. metric units and be in English.

The cost of all drawings, diagrams and plans to be supplied on this Contract shall be included in the Tender Price of the equipment to be supplied. The equipment will not be considered to be "delivered complete" if the drawings and manuals called for have not been supplied, which will result in payment being withheld.

16.2 Documentation to be submitted with the Tender

This list is a minimum requirement only. The Engineer reserves the right to request additional drawings and information during adjudication. Such additional drawings shall be submitted within 7 days of request.

Tenderer's Drawing Number	Description
	a) General arrangement of equipment. This drawing shall give the principal dimensions and approximate position of all equipment. b) General arrangement and Block diagram of all control and protection schemes. c) Configuration of the offered substation automation system; d) technical specification and description of systems; e) outline and general arrangement drawing(s) of all panels, showing the proposed lay-out of equipment on the panels, relay dimensions and method of mounting of relays and other equipment; f) catalogues, brochures, technical specification sheets, schematic diagrams and logic block diagrams of the control gear , relays and other equipment offered; g) scope of supply; h) reference list; i) such other drawings, illustrations, brochures, schedules, diagrams, sketches and descriptions of information as the City of Tshwane may require to determine whether the equipment offered complies with the Specification; and j) estimates of cable types and quantities.

Where main and alternative offers are being submitted, a set of drawings for each alternative shall be submitted. In such cases the drawing title shall clearly indicate to which offer the drawing is applicable.

In amplification of his tender, a Tenderer may submit with his tender such descriptive literature, leaflets, brochures or illustrations, as he deems necessary. No information contained in such literature will exonerate the Contractor from his obligations with respect to the particulars and guarantees stated in the Schedule of Particulars and Guarantees or the requirements of the contract.

16.3 Documents and Drawings to be submitted after Award of Tender

A project schedule, which indicates the general approval procedure required for the detailed design stage of this project, has been included with this document.

16.3.1 Electrical Manufacture/Construction Design (M/CD)

The Contractor shall, on or before the date indicated on the provided project schedule, submit a complete detailed Manufacture/Construction Design (for input from the CoT) to the CoT. The first submission of the design shall include at least the following information (in duplicate):

a) Complete index and summary of all documentation submitted for detail design;
b) overall single line diagram of substation;
c) substation yard equipment layout and sectional drawings;
d) substation building equipment layout;
e) 132 kV circuit-breaker mechanism manual & schematic diagrams;
f) 132 kV isolator and earth switch mechanism manual and schematic diagrams;
g) 33 kV switchgear manuals and schematic diagrams;
h) 11 kV switchgear manuals and schematic diagrams;
i) 132/33 & 132/11 kV transformer auxiliary equipment schematic diagrams;
j) battery charger manual and schematic diagrams;
k) DC distribution board schematic diagrams;
l) AC distribution board schematic diagrams;
m) LVAC board layout and schematic diagrams;
n) sample multi-core cable schedules;
o) communication equipment user's guides;
p) communication panel layout diagram;
q) communication panel schematic diagrams;
r) pilot board layout;
s) control system software user's guides;
t) control system programmer's manuals;
u) SMMI operating system manual;
v) operator's training manuals;
w) control system detailed physical implementation;
x) control system detailed screen layouts and implementation-specific information;
y) control panel(s) detailed physical layout and construction;
z) GPS manual;
aa) inverter manual;
bb) detailed battery and battery charger capacity calculations;
cc) type tests for all equipment;

dd) user's guides for all protection relays and auxiliary devices;

ee) protection implementation block diagrams;

ff) relay and controller configuration diagrams;

gg) complete schematic diagrams for all protection & control schemes and panels with proper integration of switchgear and other equipment schematic diagrams; and

hh) any other equipment details considered necessary to constitute a complete design.

The second revision of the Design shall include all the revised items from the first revision, as well as:

a) Detailed cable schedules;

b) detailed factory and site inspection and testing program; and

c) label schedules drawn to scale.

Three iterations have been allowed for the satisfactory completion of the Design. The properly integrated Design submission is considered to be an extremely important part of the Contract, and Tenderers' attention is drawn to the special payment conditions applicable to this Design.

The approval of drawings (issue for Manufacture/Construction) shall not relieve the Contractor of his responsibility regarding the correctness thereof or any subsequent failures as a result of faults or omissions by the Contractor.

16.3.2 Civil and general Manufacture/Construction Design (M/CD)

The following is a list of the documents and drawings to be submitted by the Contractor for approval within the time indicated on the provided project schedule or stated in the specification:

a) Contracts Work Progress Chart in the form of a detailed Gantt chart, which is also to be submitted monthly;

b) detailed sub-order chart;

c) list of drawings to be submitted;

d) arrangement drawings and details of circuit-breakers, disconnectors, earth switches, lighting arrestors, kiosks and auxiliary plant;

e) foundation plans of equipment showing the static and dynamic loading at each support point, together with dimensioned plans of foundations required for all parts of the apparatus including particulars of holding-down bolts, chases for cables, etc. to enable the Civil Contractor to design the various foundations in detail for subsequent approval by the main Contractor;

f) detail drawings of all foundations and associated civil works requirements;

g) detail drawings of structures, showing dimensions of principal members and fixing for equipment and foundations;

h) sectional elevation drawings of each type of switch unit or bay, showing the positions of apparatus forming an integral part of each unit or bay;

i) operating and maintenance instructions. See clause 17 below; and

j) a quality control plan for and with witness and hold part points during the manufacture of the various items in the contract.

17. OPERATING AND MAINTENANCE MANUALS (O&MM'S)

NO WORKS TESTING WILL BE PERMITTED UNLESS THESE MANUALS HAVE BEEN IN THE ENGINEER'S POSSESSION FOR AT LEAST 20 WORKING DAYS.

The O&MM's shall include the following, where applicable:

a) Table of contents;

b) Descriptions. General and detailed descriptions, including pamphlets, mode of operation;

c) maintenance instructions and handbooks of all component equipment for the overall system;

d) drawings, including layouts, mechanical drawings, single line diagrams, schematics, cable block diagrams and schedules;

e) parts lists, drawings and schedules for spares ordering purposes;

f) commissioning reports, including all settings;

g) test reports;

h) program listings; and

i) equipment settings.

One month after final take-over the Contractor shall submit two (2) further IOMM's in a form approved by the Engineer.

Note:

Both approval copies shall be marked up by the Contractor's commissioning engineer before leaving site. One copy shall be left at the CoT site, and the other copy shall be used by the Contractor to compile the final O&MM's, including as-built drawings and commissioning reports.

Approval copies are considered an integral and essential component of the system to be supplied. Payment on delivery will only be made if the O&MM's for approval have been delivered to the Engineer and the required operator training has been completed (if required by Protection, Power system Control and/or Scada). Similarly, retention's will only be released when the final O&MM's have been received by the Engineer.

The Contractor shall also provide O&MM's for any spare apparatus and materials which he may be called on to supply.

18. WIRING

Wiring shall be carried out strictly in accordance with the requirements of the appropriate NRS, SANS, IEC or BS Standards and the following supplementary rules.

18.1 Small Wiring

The marking and colouring of small wiring shall be carried out strictly in accordance with NRS003-1: 1994 and the following set of supplementary rules:

All cables and wiring shall be of approved types and sizes. Unless otherwise approved. The minimum size of wire to be used internally in the control cubicles shall be multi-strand, 2,5 mm² copper wire. The size of the wiring for current transformer secondary circuits shall be 2,5 mm². Should the total circuit burden become excessive the size of the wiring for current transformer secondary circuits shall be increased to 4.0 mm².

All multi-core cable cores shall be of at least seven strands of copper. All panel wires shall have at least 40 strands of copper.

Small wiring shall be properly insulated and of CMA grade manufactured in accordance with the appropriate SANS Standard Specification. PVC insulated wire shall be of the fire retardant type, insulated to withstand 2kV to earth for one minute.

All wires shall be terminated with suitable crimped lugs, fitted with a compression tool designed for this purpose.

If stud type terminals are employed, stranded conductors shall be terminated with tinned (not soldered) approved claw washer or lock nuts, or with approved crimping lug. Separate washers or lugs shall be used for each conductor.

All wiring shall be taken to terminals and wires shall not be jointed or teed between terminal points.

All wiring, external as well as internal, shall be ferrule marked to approval with suitable ferrules. Both ends of the same wire shall be identically marked and shall be consistent with the associated drawings. Spare cores shall be marked with their respective cable number in addition to the requirements of NRS003-1, Annexure A.

Ferrule markers shall be of a durable insulating material having a reasonable glossy finish to prevent adhesion of dirt. Ferrule markers shall be marked clearly and permanently and shall not be affected by moisture or oil. Unless otherwise approved, ferrules shall be white with black marking. The type of ferrule marker to be used shall be to approval.

All communication cables like optic fibre, twisted pair, ribbon and coaxial cables shall be uniquely marked and labelled to the approval of the Engineer.

All optic fibre cables, twisted pair, ribbon type and coaxial type communication cables shall be routed separately or individually. They shall be mechanically protected and supported, and shall not rely on control wiring looms for support. Requirements in terms of minimum bending radii shall be observed.

18.2 Interpretation of and additions to NRS003-1

Numbering shall always be in ascending order from the defined starting point.

Where a starting point is defined as an odd or even number, the ascending numbers shall be odd or even only.

Connections made directly to the secondary terminals of current transformers and to star points in current transformer circuits shall take the lowest number in the group allocated for the purpose. The lowest even number shall be used for S1 terminal connections and the lowest odd number for S2 and/or S3 terminal connections. Preference shall be given to commencing the ascending numbering from the S1 terminal side. Where phase and neutral current transformers are in circuit together, phase current transformers shall take precedence.

The polarity of current transformers shall be determined as follows:

a) Terminal P1 shall always be nearest the circuit breaker.

b) Terminal P2 shall always be nearest the star point of a transformer.

Numbers shall be skipped where necessary for the possible future addition of items of equipment in series.

The addition of 500 to numbers, where associated equipment on the same panel would otherwise have caused a duplication of numbers, shall be extended to provide for more than two associated sets of equipment by adding 600, 700, 800 or 900 to the numbering of the third, fourth, fifth and sixth similar set of associated equipment respectively.

Numbering of a circuit shall continue in ascending order from the branch point but shall have 100, 200, 300 or 400 added to prevent duplication of numbers already appearing in the main succession numbering. For example, a branch connection from H13 through a coil shall be numbered H114 beyond the coil and shall progress to H116 etc.

18.3 MCCB's, Isolators, Fuses and Links

MCCB's, isolators, fuses and links shall be provided as required for the protection and isolating of circuits. The arrangement, type and kA rating of MCCB's and fuses shall be to approval.

The MCCB's, isolators, fuses and links shall be mounted vertically in horizontal rows in such a way as to allow easy access and replacement from the front. MCCB's shall be mounted at or near the top of control panels to prevent inadvertent operation by substation maintenance and cleaning staff.

All MCCB's, isolators, fuses and links of the same circuit shall be mounted adjacent to each other.

MCCB's and isolators shall be of the DIN rail mounting type to allow for easy replacement.

Fuses and links shall be mounted on insulated draw-out carriers that hold the fuses or links positively after withdrawal. In all cases the top terminal of the fuse or link shall be the live terminal.

Fuse link holders shall be black and solid link holders shall be white.

All MCCB's, isolators, fuses and links shall be suitably and permanently labelled, displaying the designation and identification number and using the prefix "MCB" for circuit breakers, "ISOL" for isolators, "FS" for fuses and "LK" for links. Current ratings shall also be displayed.

The labels shall not be fixed to removable parts of MCCB's, isolators, fuses or links.

18.4 Multi-Core Cable and Wire Terminals and Trunking

Terminal blocks shall be provided inside the control cubicles in an easily accessible position(s) for terminating multi-core cable tails and for connecting up with the internal wiring in the cubicles. Unless otherwise approved, terminal blocks shall be mounted horizontally in vertical rows in order that ferrule numbers may be read without difficulty.

All terminals and connections for secondary wiring shall be sufficiently large to accommodate at least <u>two</u> 2,5 mm² PVC insulated wires.

Terminal blocks shall either be of the double-ended insertion type with suitable provision made for mounting the terminal blocks on terminal boards or rails in rows.

Terminal blocks of the insertion type shall incorporate serrated clamping yokes of plated steel which clamp the wire ends onto a silver or nickel plated serrated current bar by means of plated steel clamping screws. The complete assembly shall be encased in a non-hygroscopic moulding of insulating material with high electrical and mechanical strength. Entrelec M10/10.RS or Klippon type RSF 1 spring loaded terminals are preferred. Klippon type SAKR terminals are required for pilot cable termination board application. Terminals of the type where clamping screws are in direct contact with the wire are not acceptable. The Engineer shall approve the precise type of terminal used.

Terminal blocks shall be mounted such as to allow sufficient space for cable tails and working on cable glands without impeding access to any other equipment.

Terminal blocks shall be wired such that all internal or incoming wiring enters from one side and all outgoing or external connections (multi-core cable tails) enter from the other side.

Terminal blocks shall not be covered by compound.

No more than two wires shall be connected to any one terminal

At least 10% spare terminals shall be provided on all sets of terminal blocks, with a minimum of two (2) terminals.

Covers of transparent insulating material shall be fitted where necessary on terminal rows to prevent accidental contact with live equipment.

Each terminal shall be marked clearly, permanently and conspicuously and all sets or groups of terminal blocks shall be suitably identified with durable labels fixed in an approved manner.

Suitable slotted trunking with clip on covers shall be installed to channel interior wiring in a neat and orderly way. The space between the rows of terminal blocks and slotted trunking shall preferably not be less than 75 mm.

SECTION 4 : TECHNICAL SPECIFICATION

PART 1.5 : YARD LABELLING

SPECIFICATION No:

1. EXTENT OF WORK

Comprehensive yard labelling has to be implemented for the indication of circuits, bays and primary equipment items, in addition to the normal requirements for labelling for new equipment. The labels must be ready for installation during individual bay outages where a bay outage is required to install a label.

Tenderers are referred to:

a) Section III Part 1.4: Item 7 "Labels" for normal requirements for labelling of new equipment.

b) Section V Part 2: Schedule of Prices for individual price items.

c) Section VI Part 16: "Label Schedules" for the names and quantities of labels required.

d) Section VII: Drawing number PS09-150Z for the different label details.

SECTION 4 : TECHNICAL SPECIFICATION

PART 1.6 : SUBSTATION TESTING & RE-COMMISSIONING

SPECIFICATION No: Rev Z/9.

CONTENTS

1. SCOPE

This specification covers the complete testing and commissioning of all new control and protection (ICAP) equipment and all new non-ICAP equipment as well as the testing and re-commissioning of all existing primary and secondary equipment in order to re-commission the total substation.

2. STATION TESTING AND RE-COMMISSIONING OF ALL EQUIPMENT

The new control and protection (ICAP) equipment shall be tested and commissioned by the contractor, but he will also be responsible to test and re-commission “other” or non-ICAP equipment in order to re-commission the total substation. All existing and new secondary (non-ICAP) equipment such as battery chargers and auxiliary supply equipment, as well as primary equipment such as circuit breakers, isolators, current transformers, voltage transformers, current carrying connectors, surge divertors and power transformers shall be tested and re-commissioned as specified. Earthing and bonding of equipment must also be confirmed. The work shall encompass the following aspects with respect to the substation as an entity as well as to each individual bay.

2.1 First stage:

Available drawings, substation and equipment are available at the clients drawing office.

All marshalling kiosks and other panels and cubicles that are to remain after the refurbishment shall be dusted out and cleaned (apart from any cubicle refurbishment work described elsewhere).

The schematic diagrams shall be correlated with the physical bay wiring and cabling by means of visual inspection, ringing out and tracing of the circuits. Any alterations that may be found shall then be marked up on the schematic diagrams to represent 'as found' drawings. Again, this can primarily be restricted to the equipment and circuits, or parts of circuits, which will be retained after the station refurbishment.

Proposals as to the improvement of equipment characteristics or sub-standard parameters, correction of errors and replacement of defective parts or functions must be submitted as part of the first stage of the testing.

Generation of a new set of drawings, as if for a new substation, combining the new control and protection schemes with the existing drawings and the existing equipment, for each bay of the substation, the substation itself and scheme common drawings (i.e. bus zone scheme). It has to be ensured that all details of non-ICAP equipment are included in the drawings listed in Part 1.3: Drawings and Documentation. Schematic diagrams of motor drives, mechanisms and interface equipment of transformers, circuit breakers, isolators, earth switches and transformer cooling equipment must be included.

These proposals and drawings shall be handed to the Engineer and where applicable, approval will be given by the Engineer to incorporate the proposed changes. All the information gathered shall be incorporated in the ICAP-designs and be included in the DDS in a suitable format.

2.2 Second stage:

All approved modifications shall be carried out and commissioned as part of the control and protection installation and commissioning process.

Apart from the tests prescribed for the ICAP system the following tests shall be conducted on each bay for a given substation:

a) All the circuit breakers associated with the panels shall have their opening and closing motion measured depicting the position of the breaker related to time as the breaker opens or closes. The total opening and closing times shall also be indicated. These results shall be graphically represented and the breakers shall then be certified if it complies with the manufacturers specifications.

b) In conjunction with the Control Centre, functional test of inter-trip circuits:

i. For pilot wire inter-trip receive relay: - determine the operating range and operating time over the relay's range of operating voltage at 10 V intervals.

ii. For pilot wire inter-trip system: - From the furthermost point on the line, send an inter-trip signal and measure the receiving voltage at the substation being tested with the relay in service.

iii. For all inter-trip systems: - In conjunction with the Engineer or his representative, determine the time elapsed for a substation on a particular line to send an inter-trip and for the system voltage at the substation to fall below 30% of the nominal system voltage.

c) Measure and record the earthing bonding resistance as well visually inspect the earthing from a centrally defined point within the substation that has been proved to have a low earthing resistance:

i. Control panels

ii. Protection panels

iii. Tap change control panel (TCCP)

iv. Transformer/line marshalling kiosk (TMK), (LMK)

v. Transformer

vi. Cooling fins (where applicable)

vii. Closing rectifier

viii. Battery chargers

ix. HV apparatus (neutral CT's etc)

x. Neutral isolators

xi. Switchgear

xii. Fences

Where there are two bonding straps to a piece of equipment, the resistance of each bond shall be determined separately.

d) Do core and sheath insulation tests on all multi-core cables for the complete bay/scheme

e) Current transformers, determine:

   i. Polarity from the furthermost possible point.

   ii. Magnetising curves. One ratio per core. Specify the ratio. The magnetising curves shall be represented graphically in the format as described in the requirements for documents.

   iii. Star point connections

f) Functional tests, as part of the commissioning of the ICAP system, of:

   i. Main tripping circuits

   ii. Back-up circuits

   iii. Control circuits

   iv. Tap change control circuits (where applicable)

   v. Alarms circuits

   vi. No volt relay (secondary injection)

   vii. Back-up Auxiliary supply failure circuits

   viii. Battery charger chop over relay

   ix. Stability of the bus zone tripping circuits

   x. Coupler interlocking

g) Functional testing of all VT circuits and testing of VT's (phasing).

h) Check all fuse ratings and MCB ratings (mainly restricted to remaining battery charger, transformer marshalling kiosks and 275 kV yard marshalling kiosks).

i) Check lugs for correct application and type (crimping).

j) Do primary injections on all CT's and VT's and record readings on the secondary side at the furthermost accessible points.

k) All redundant wiring inside the remaining panels shall be removed and all redundant cores shall be strapped into the harness inside the panel (mainly restricted to remaining battery charger, transformer marshalling kiosks and 275 kV yard marshalling kiosks).

l) Commission with primary voltage and current. Prove phasing with phasing gear where possible. Do synchronising checks. Voltage and current measurement on all accessible points and record results. Prove stability of the bus-zone.

Any changes made during the testing and commissioning shall be included in the "as commissioned" documentation.

SECTION 4 : TECHNICAL SPECIFICATION

PART 1.7 : IMPLEMENTATION PLAN

SPECIFICATION No: - Rev Z/8

1. IMPLEMENTATION PLAN

The purpose of this section is to highlight the aspects involved and points for consideration in preparation of the detail implementation planning that is required of the Contractor in order that due allowance is made in terms of budget and manpower to perform this element of the project work at a sufficient level of refinement. Preparing the Detail Implementation Program will be the second major project activity running concurrently with and following the Functional Design Specification activity as an important step towards preparation for site work.

Here a distinction is drawn between the Detail Project Schedule in the sense of the overall scheduling of all the project elements and activities including detailed equipment specification and procurement scheduling, schemes design, laying down the sequence and duration of activities in the factory and on site including testing and commissioning to ensure optimal (cost/time/quality) project scheduling on the one hand and;

A Detail Implementation Plan in terms of which the project work on site is interfaced with physical and operational system constraints to ensure that the intervention at the Kwagga Infeed Station in order to refurbish the control and protection equipment is done at the absolute minimum risk to the safety of workmen, system stability and disruptions of supply on the other hand.

In the 132 kV yard of the Station the majority of existing current transformers will be replaced departmentally as part of the larger refurbishment initiative. Isolators and earth switch mechanisms in this yard will also be refurbished and upgraded. This departmental work will be co-ordinated with the Refurbishment of Control and Protection Equipment contract work to be performed during the same period when the bay or equipment is out of operational service. The Contractor shall make allowance in costing and scheduling the site work for allowing the Employers departmental teams or own contractors reasonable access to the primary plant of this refurbishment work.

The Detail Implementation Plan shall be drawn up taking into account the following considerations plus any further factors that come to the fore in the process. The Contractor shall submit the Plan to the Engineer for approval and endorsement by all parties that could be affected by it.

1. Seasonal loading of the Infeed Station;

2. Operational constraints in terms of Kwagga/Rooiwal/Pta West/Njala interconnect;

3. Minimum / maximum loading on given Kwagga elements or sections;

4. Energy unit (opportunity) cost for different system switching configurations and the duration of these conditions;

5. System stability and outage risk associated with specific temporary switching configurations;

6. Minimising loss of protection functionality in terms of bus zone or back-up protection schemes including the justification of specific interim protection schemes;

7. Considerations such as sequence of work dictated by the re-use requirement on certain of the existing protection equipment in the same or similar equipment bays and;

8. Basic constraints such as the accessibility of existing multi-core cables in cable ducts for purposes of re-routing.

SECTION 4 : TECHNICAL SPECIFICATION

PART 1.8 : DAYWORKS

SPECIFICATIO No: Rev Z/8

SCOPE

Extra work which is not covered in any Contract Item, and which is ordered by the Engineer in writing as such shall be undertaken by the Contractor on a day work basis.

Day labour as may be required for such day works shall be provided by the Contractor at the rates of wages of the particular category as inserted in the schedules provided for this purpose.

When the Contractor is required to supply materials in connection with such day works as may be ordered, the percentage over actual cost price at the Works on which the Contractor agrees to supply such material as may be required shall be as inserted in the schedules provided for this purpose.

The Contractor shall, when required by the Engineer, produce all time sheets, correspondence, invoices and receipts and any other particulars necessary to enable the Engineer to certify the correctness of claims for payment in terms of this provision.

SECTION 4: SPECIFICATIONS

PART 1.9: HEALTH AND SAFETY

CONTENTS

1. DOCUMENT PURPOSE AND INTENT

The specifications contained in this document relate to the health and safety requirements pertaining to the associated works, so as to ensure the health and safety of the persons carrying out the associated works.

Compliance to the Occupational Health and Safety Act (Act 85 of 1993) and the Regulations shall not be limited to the specifications and definitions contained in this document.

A comprehensive, documented Health and Safety Plan is to be drawn up by the Main Contractor, based on the results of Health and Safety Risk Assessments conducted by him, and the specifications provided, and presented to the engineer for approval prior to commencement of work.

Monitoring of compliance on site shall be to the requirements of the OHS Act and Regulations as well as the contents of the H&S Plan(s) of the Main-Contractor and Sub-Contractors.

2. APPLICATIONS AND INTERPRETATION

This document is to be read and understood in conjunction with the following:

- Occupational Health and Safety Act (Act 85 of 1993).
- All regulations published in terms of the Occupational Health and Safety Act.
- Construction Regulations, 2003.
- SANS codes referred to by the Occupational Health and Safety Act.
- Contract Documents
- Basic Conditions of Employment Act (Act 75 of 1997)
- South African Rail Commuter Corporation Ltd: General conditions and specifications for work on, over, under or adjacent to Railway lines and near High Voltage Equipment. (SPK7/2)

<u>ABBREVIATIONS</u>

- OHS: Occupational Health and Safety
- CEO: Chief Executive Officer
- CR: Construction Regulations
- HCS: Hazardous Chemical Substances
- MSDS: Material Safety Data Sheet
- AIA: Approved Inspection Authority
- HBA: Hazardous Biological Agents
- OEL: Occupational Exposure Limit

3.1 DEFENITIONS

The following definitions from the Occupational Health and Safety Act are listed as follows:

Chief Executive Officer
In relation to a body corporate or an enterprise conducted by the State, means the person who is responsible for the overall management and control of the business of such body corporate or enterprise.

Danger
Means anything that may cause injury or damage to persons or property.

Employee (Contractor)
Means, subject to the provisions of Subsection (2), any person who is employed by or works for any employer and who receives or is entitled to receive any remuneration or who works under the direction or supervision of an employer or any other person.

Employer (Client / Engineer**)**
Means, subject to the provisions of Subsection (2), any person who employs or provides work for any person or remunerates that person or expressly or tacitly undertakes to remunerate him, but excludes a labour broker as defined in Section 1(1) of the Labour Relations Act, 1953 (Act No. 28 of 1956).

Healthy
Means free from illness or injury attributable to occupational causes.

Machinery
Means any article or combination of articles assembled, arranged or connected and which is used or intended to be used for converting any form of energy to performing work, or which is used or intended to be used, whether incidental thereto or not, for developing, receiving, storing, containing, confining, transforming, transmitting, transferring or controlling any form of energy.

Medical Surveillance
Means a planned programme of periodic examination (which may include clinical examinations, biological monitoring or medical tests) of employees by an occupational health practitioner or, in prescribed cases, by an occupational medicine practitioner.

Plant
Includes fixtures, fittings, implements, equipment, tools and appliances, and anything which is used for any purpose in connection with such plant.

Properly Used
Means used with reasonable care, and with due regard to any information, instruction or advice supplied by the designer, manufacturer, importer, seller or supplier.

User
In relation to plant or machinery, means the person who uses plant or machinery for his own benefit or who has the right of control over the use of plant or machinery, but does not include a lessor of, or any person employed in connection with, the plant or machinery.

Reasonably Practicable
Means practicable having regards to:

(a) the severity and scope of the hazard or risk concerned,
(b) the state of knowledge reasonably available concerning that hazard or risk and of any means to remove or mitigate that hazard or risk.
(c) the availability and suitability of means to remove of mitigate that hazard or risk; and
(d) the cost of removing or mitigating that hazard or risk in relation to the benefits deriving there from.

Risk
Means the probability that injury or damage will occur.

Safe
Means free from any hazard.

Standard
Means any provision occurring:
(a) in a specification, compulsory specification, code of practice or standard method as defined in Section 1 of the Standards Act, 1993 (Act No. 29 of 1993); OR
(b) in any specification, code or any other directive having standardization as its aim and issued by an institution or organization inside or outside the Republic which, whether generally or with respect to any particular article or matter and whether internationally or in any particular country or territory, seeks to promote standardization.

The following definitions from the Construction Regulations are listed as follows:

Agent
Means any person who acts as a representative for a client.

Competent Person
Means any person having the knowledge, training, experience and qualifications specific to the work or task being performed:
Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training.

Construction
Means any work in connection with:

(a) the erection, maintenance, alteration, renovation, repair, demolition or dismantling of or addition to a building or any similar structure;
(b) the installation, erection, dismantling, or maintenance of a fixed plant where such work includes the risk of a person falling;
(c) the construction, maintenance, demolition or dismantling of any bridge, dam, canal, road, railway, runway, sewer or water reticulation system or any similar civil engineering structure; OR
(d) the moving of earth, clearing of land, the making of an excavation, piling or any similar type of work.

Contractor
Means an employer, as defined in Section 1 of the Act, who performs construction work and includes principal contractors.

Hazard Identification
Means the identification and documenting of existing or expected hazards to the health and safety of persons, which are normally associated with the type of construction work being executed or to be executed.

Health and Safety File
Means a file, or other record in permanent form, containing the information required as contemplated in these regulations.

Health and Safety Plan
Means a documented plan, which addresses hazards, identified and includes safe work procedures to mitigate, reduce or control the hazards identified.

Health and Safety Specification
Means a documented specification of all health and safety requirements pertaining to the associated works on a construction site, so as to ensure the health and safety of persons.

Method Statement
Means a document detailing the key activities to be performed in order to reduce as reasonably as practicable the hazards identified in any risk assessment.

Principal Contractor (Main Contractor)
Means an employer, as defined in Section 1 of the Act who performs construction work and is appointed by the client to be in overall control and management of a part of or the whole of a construction site.

Risk Assessment
Means a program to determine any risk associated with any hazard at a construction site, in order to identify the steps to be taken to remove, reduce or control such hazard.

4. NOTIFICATION OF CONSTRUCTION WORK

- The Principal/Main Contractor shall notify by registered mail, the local relevant Provincial Director of the Department of Labour, before commencing with construction work, of the intended work in the form of Annexure A of the Construction Regulations.
- A copy of the completed Annexure A of the Construction Regulations, as well as proof of notification shall be included in the Health and Safety Plan. (Proof of fax or proof of hand delivery)
- A copy of the completed Annexure A is to be kept on site by the principal Contractor.

5. LEGAL DOCUMENTATION/APPOINTMENTS

The following documents must be provided in the Health and Safety Plan:

- Health and Safety Policy signed by CEO.
- Letter of good standing with the Compensation Commissioner, Federated Employers or similar insurer.
- Health and Safety Organogram (or table), outlining the Health and Safety Team, as well as the appointment(s) they have under the Act and Regulations (reference to specific section/regulation applicable to appointment)

Example:

Tom Smith
Section 16(2)
Construction supervisor CR 6(1)

Dick Smith
Construction vehicle competent person CR 21(1)(j)
Excavation competent person CR 11(1)

Harry Smith
H&S Rep - Section 17(1)

- The competency of each member of the Health and Safety Team must be provided and should` include knowledge, training, experience & qualifications specific to the work or task being performed.

Signed copies of the following legal appointments must be provided in the Health and Safety Plan:

APPOINTMENT	**OHS-ACT / REGULATION REFERENCE**
Section 16.2 appointment	Section 16.2
Health and Safety Representative (if necessary)	Section 17
Health and Safety Committee Members (if necessary)	Section 19
Incident Investigator	GAR 8(2)
First Aiders (Include training certificates)	GSR 3
Fire Fighters	ER 9 & CR 27(h)
Risk Assessor	HC (Incl. Asbestos & Lead); CR 7

The following information must be provided in the Health and Safety Plan:

- Indicate the estimated number of employees to be working on site.
- Indicate the expected number of contractors to be appointed by the Principal/Main Contractor.

The following Competent Persons, **where applicable**, shall be appointed in writing by the Principal/Main Contractor, prior to any work being carried out, and shall adhere to the requirements of the specific sub-regulations.

The competency of each of these appointed competent persons must be provided and should include knowledge, training, experience & qualifications specific to the appointment.

The table below indicates the applicability of the appointments but contractors should by no means be limited to these indications.

APPOINTMENT	OHS-ACT / REGULATION REFERENCE
Construction Supervisor	CR 6 (1)
Assistant Construction Supervisor	CR 6 (2)
Fall Protection Competent Person	CR 8 (1)
Formwork/ Support Work Competent Person	CR 10 (a)
Excavation Work Competent Person	CR 11 (1)
Demolition Work Competent Person	CR 12 (1)
Scaffolding Competent Person	CR 14 (2)
Batch Plant Competent Person	CR 18 (1)
Explosive Powered Tools Competent Person	CR (b) 19
Construction Vehicle and Mobile Plant Competent Person	CR 21 (1)(j)
Electrical Installation Competent Person	CR 22 (d)
Stacking Competent Person	CR 26 (a)
Fire equipment Competent Person	CR 27 (h)
Confined Spaces Competent Person	GSR (5)
Blasting Competent Person	
Safety Officer Full time or part time	CR 6(6)
Traffic Safety Officer	CR 6(6)
General Machinery Competent Person	GMR (2)
Lifting Machines Operators	DMR 18(11)
Pipe Jacking Competent Person	
Competent Person referred to in South African Rail Commuter Corporation Ltd: General conditions and specifications for work on, over, under or adjacent to Railway lines and near High Voltage Equipment. (SPK7/2)	(SPK7/2)

- **Indicate in the H&S Plan, which of these listed appointments are applicable to the construction work in question.**
- no work involving any of the listed appointments may be performed without the knowledge and approval of an appointed competent person.
- The competent person shall be responsible to determine the level of supervision required for each activity.
- The agent/engineer must be informed of any changes made to the above appointments.
- The agent/engineer reserves the right to require from any contractor at any stage to appoint a full or part time construction health and safety officer.

6. GENERAL DUTIES OF PRINCIPAL CONTRACTOR

- The principal contractor will be responsible for co-operation between all contractors to ensure compliance to the OHS–Act and Regulations on site.

- To ensure the above, the Principal/Main Contractor must carry out the following and provide proof of such in his H&S plan:

    - Provide health and safety specifications to Contractors.
    - Appoint Contractors in writing.
    - Proof than Contractors H&S Plan has been approved, implemented and maintained.
    - Proof that Contractors are registered with the Compensation Commissioner or similar insurer.
    - Proof that Contractors made provision for the cost of Health and Safety measures during the construction process.
    - A comprehensive & updated list of all contractors on site, also indicating the type of work being done.
    - Copies of Section 37(2) agreements with the relevant contractors.

7. SUPERVISION OF CONSTRUCTION WORK

- The agent/engineer must be informed if the Construction Work Supervisor is also appointed as a Construction Supervisor for another site.

8. RISK ASSESSMENT

- Risk assessments of all required activities/hazards shall form an integral part of the Health and Safety plan.

- All risk assessments shall be conducted in terms of an acceptable methodology, prior to commencement of work, according to the provisions of CR 7 and should cover at least the following:

    - Excavations
        - including excavating in proximity of Petronet pipe line
    - Backfilling in trenches
    - Pipe laying
    - Blasting
        - blasting in proximity of Petronet pipe line
        - open trench blasting
        - pipe jack blasting
    - Identification of existing Services
    - Pipe jacking underneath Railway line (SPK7/2)

- Pipe Jacking
  - Ventilation
  - Lighting
  - Flooding
- Clearing of vegetation
- Work in the vicinity of houses/buildings
- Movement of Construction Vehicles
- Working in confined spaces
- Demolition
- Temporary stockpiling
- Connecting to existing sewer
- Accommodation of traffic
- Accommodation of pedestrians
- Temporary pedestrian bridges
- Temporary vehicle bridges
- Employee movement across railway line
- Control of access of public/pedestrians to excavations
- Work surrounding live sewage connection
- Possibility of flooding of Moreleta Spruit

- All health hazards that can be present during any of the above activities and should include individual dusts, gases, fumes, vapours, noise, extreme temperatures, illumination, vibration and ergonomic hazards due to any of the above activities.

- The above list is by no means exhaustive and should not be limited to these activities but must cover all activities that forms part of the said construction work. Each activity must be split down to individual tasks and all associated hazards identified and listed in the risk assessment. This ensures that critical tasks and subsequent critical hazards are not missed.

- The risk assessment to be included in the H&S Plan must clearly indicate:

  - The methodology used to do the risk assessments.
  - Breakdown of processes and activities covered.
  - High risks anticipated.

- All risk assessments are to be conducted by competent persons as appointed under paragraph 5 of this document. The plan must include a declaration in this regard or the risk assessment must contain the signature(s) of this appointed persons.

- Risk assessments are to be handed to the agent prior to commencement of work.

- The agent reserves the right to stop any work if such work is not conducted in terms of the recommendations of the risk assessment.

- Risk assessments are to **cover safety as well as health and ergonomical hazards.**

9. SAFE WORK PROCEDURES

Safe Work Procedures are to form part of the H&S Plan and **must be compiled for all the above-identified activities.**

The safe work procedures must address the following elements:

- The work method to be followed to conduct work safely

- Mitigation of identified risks
- Reducing and controlling risks and hazards that have been identified
- Responsibilities of competent persons
- Required personal protective equipment
- Correct equipment/tools/machinery to be used
- Reference to relevant registers to be completed
- Reference to applicable risk assessment
- **The following two tables provides information on all factors to be taken into account when the Risk Assessments and Safe Work Procedures are compiled:**

Physical	**Chemical**	**Biological**	**Mechanical**	**Psycho-social**
Noise	Liquids	Insects	Guards	Stress
Vibration	Dusts	Fungi	Hand tools	Work pressure
Ionising radiation	Fumes	Bacteria	Machinery	Monotony
Non-ionising radiation	Fibers	Viruses		Unsociable hours
Health and cold	Mists			Ergonomical:
Electricity	Gases			• Posture
Pressure	Vapours			• Movement
				• Repetitive tasks

System	**Stress/Agency**	**Illness/Disease**
Musculoskeletal	Lifting/loads Repetitive strain Abnormal postures Whole body vibration	Muscular pain syndromes Tenosynovitis Bursitis Osteoarthrosis
Sensory	Noise	Hearing loss
Skin	Cement (chromates), rubber Thinners, epoxies Tar, pitch Solar radiation	Allergic contact dermatitis Irritant contact dermatitis Acne, Skin cancer Keratoses, Cancer
Respiratory	Silica Asbestos Spray paints, woods, epoxies Irritant dusts, welding fumes Organic Solvents	Silicosis, TB Asbestosis, Cancer Asthma Bronchitis Headaches, Dizziness, Cancer
Psychosomatic	Physical stress Psychosocial stress	Head aches Depression Fatigue Substance abuse
Nervous System	Lead Organic solvents	Peripheral and central neuropathy Headaches, Dizziness, Mood disorder, Dementia, Cancer

10. SAFETY OF PUBLIC/PEDESTRIANS

Access to the construction site must be cordoned off as much as possible in all work areas.
All excavations are to be fenced/barricaded to prevent access by public / pedestrians.
Barriers must be of an impenetrable nature – barrier tape will not be seen as a sufficient barrier mechanism.
Work must be planned in such a manner as to ensure that the minimum amount of trenches are left open after hours or during weekends.
No trenches/excavations are to be left open during any December shutdown period.
Temporary pedestrian crosses over excavations are to be of adequate width and provided with sturdy handrails.

11. FALL PROTECTION

In addition to the requirements of this regulation (CR 8) the following shall apply:

- The fall protection plan is to be prepared by a competent person. This competent person must sign the fall protection plan.
- Contents of the fall protection plan must cover all the requirements as stated in sub-regulation CR 8.
- The fall protection plan is to be handed to the agent before work commences.
- The level of supervision is to be stated in the fall protection plan.
- Medical certificates, work near edges, presence of dew, dangerous walking areas etc. should be addressed in the fall protection plan.

12. REGISTERS

- Examples of the registers listed below must be provided in the Health and Safety Plan.
- All registers must be available at the site offices at all times for inspection by the agent.
- The list of registers to be kept is by no means exhaustive and the H&S Plan should list all the registers that are applicable and at what frequency they are going to be maintained.

ACTIVITY	FREQUENCY	FORMAT
Form work / Support work	Daily, prior to any shift	
Excavation Work	Daily, prior to any shift, after rain or blasting or after unexpected fall of ground	
Scaffolding	Daily, prior to any shift, after rain or blasting.	
Material Hoist	Daily	
Batch Plants	Daily	
Explosive Powered Tools	Daily Before Use	
Crane(s) Logbook	As per DMR 18	
Construction Vehicles and Mobile Plant	Daily	
Temporary Electrical Installation	Weekly	
Stacking	Weekly	
Fire Extinguishers	Bi – Monthly	
Ablution Facilities	Weekly	
Ladders	Weekly	
Incident Register in terms of GAR 9	As Required	Annex 1 of GAR
Fall Protection Equipment	Daily	
Portable electrical tools	Weekly	
Suspended Platforms	Daily	
Accommodation of traffic	Daily	
Fire fighting equipment	Monthly	

13. TRAINING

Each Health and Safety Plan shall indicate the following regarding training:

- Name and contents of the following training courses which have to be conducted:
  - Induction Training
  - Training regarding hazards identified and any corrective measures in place
  - Training regarding all applicable regulations
  - Specific training regarding applicable competencies
- Attendance registers must be kept as proof of training provided
- Method of informing visitors and other persons entering the site of hazards prevalent on site.
- Method of providing personal protective equipment to visitors and non-employees.
- An example of ID training card for each employee (if used).
- Methodology to be used in the issuing and communication of written instructions/safe work procedures.

14. AGENT HEALTH AND SAFETY INSTRUCTION REGISTER

- All Health and Safety instructions will be given via the resident engineer in writing
- The Principal Contractor shall be required to sign the register at the end of each day to acknowledge any instructions issued.

15. GENERAL REQUIREMENTS

- ***Personal Protective Equipment***
  The procedures for issuing and control over PPE shall be indicated in the Health and Safety Plan, as well as the enforcement for the wearing thereof.

- ***Hired Plant***
  The responsibility for the safe condition and use of all hired plant shall be that of the contractor.

- ***Transport of Employees***
  Transport of employees shall be carried out in terms of the National Road Ordinances and the OHS Act - Construction Regulations.
  The Health and Safety Plan shall detail the arrangements and methods of the transportation of workers.

- ***Signs***
  The Principal Contractor shall indicate in his Health and Safety Plan the arrangements regarding the posting of danger signs.

- ***Certificates of fitness***
  The Principal Contractor shall include in his H&S Plan copies of medical fitness certificates for the following:
  - **Crane Operators**
  - **Construction vehicles and Mobile plant operators**
  - **Pipe Jacking employees**

  - **Any other medical certificates that might be applicable in terms of the other regulations governing health & safety of construction personnel such as HCS regulations and Noise induced hearing loss etc.**

- ***Site Visitors Register***
  - A site visitor's register is to be kept on site and steps are to be taken to ensure that all visitors sign the visitors' register before entering the site.
  - A sign should also be provided directing all visitors to report to
  - the site officer.

- ***Safety of excavations***
  - Provision should be made for the utilisation of geo technical services on a monthly basis to independently evaluate the safety off all excavations
  - All excavations are to be fenced/barricaded to prevent access by inter alia children and other members of the public
  - All barricading is to be maintained and protected against theft and vandalism

- ***Blasting***
  - A separate Health and Safety Plan will be required from the blasting contractor
  - The Health and Safety Plan must also be approved by the relevant Petronet servitude supervisor
  - All the requirements of the Petronet Standard Crossing Conditions and Requirements for underground Services document (Ref P2-18 (CE8)) must be complied with. This document is attached to the back this Health and Safety Specification.

16. HAZARDOUS CHEMICAL SUBSTANCES (including Asbestos and Lead)

In addition to the requirements in the HCS Regulations, the principal contractor must provide proof in the H&S Plan that:

- Material Safety Data Sheets (MSDS's) of the relevant materials/hazardous chemical substances are available prior to use by the contractor. Mention should be made how the principal contractor is going to act according to special/unique requirements made in the relevant MSDS's. All MSDS's shall be available for inspection by the agent at all times.
- Risk assessments are done at least once every two years.
- Exposure monitoring is done according to OESSM and by an AIA and that the medical surveillance programme is based on the outcomes of the exposure monitoring.
- How records are going to be kept safe for the stipulated period of 30 years.
- How the relevant HCS's are being/going to be controlled by referring to:
  - Limiting the amount of HCS
  - Limiting the number of employees
  - Limiting the period of exposure
  - Substituting the HCS
  - Using engineering controls
  - Using appropriate written work procedures
- The correct PPE is being used.
- HCS are stored and transported according to SANS 072 and 0228.
- Training with regards to these regulations was given.
- The H&S plan should make reference to the disposal of hazardous waste on classified sites and the location thereof (where applicable).

17. ASBESTOS

Should asbestos be identified as a hazard **whilst work is carried out**, the following must be included in the health and safety plan:

- Notification to the Provincial Director in writing, prior to commencement of asbestos work.
- Proof of a structured medical surveillance programme, drawn up by an occupational medicine practitioner.
- Proof that an occupational health practitioner carried out an initial health evaluation within 14 days after commencement of work.
- Copies of the results of all assessments, exposure monitoring and the written inventory of the location of the asbestos at the workplace.
- Only proof that medical surveillance has been conducted and not the actual records itself since these areas of a confidential nature.
- How records are going to be kept safe for the stipulated period of 40 years.
- Proof that asbestos demolition (if applicable) is going to be done by a registered asbestos contractor and provide proof that a plan of work for such demolition is submitted to an Approved Asbestos Inspection Authority 30 days prior to commencement of the demolition.
- Provide proof that the plan of work was approved by the asbestos AIA and submitted to the provincial director 14 days prior to commencement of demolition work together with the approved standardised procedures for demolition work

18. LEAD

Besides the requirements listed under par. 15 should lead be identified as a hazard at the workplace, the following must be included in the health and safety plan or as soon as its available:

- Proof that an occupational health practitioner carried out an initial health evaluation within 14 days after commencement of work.
- Copies of the results of all assessments, exposure monitoring and the written inventory of the location of the lead at the workplace.
- Only proof that medical surveillance has been conducted and not the actual records since these are of a confidential nature.
- How records are going to be kept safe for the stipulated period of 40 years.

19. NOISE INDUCED HEARING LOSS

Where noise is identified as a hazard the requirements of the NIHL regulations must be complied with and the following must be included/ referred to in the Health and Safety Plan:

- Proof of training with regards to these regulations.
- Risk assessment done within 1 month of commencement of work.
- That monitoring carried out by an AIA and done according to SANS 083.
- Medical surveillance programme established and maintained for the necessary employees.
- Control of noise by referring to:
  - Engineering methods considered
  - Admin control (number of employees exposed) considered
  - Personal protective equipment considered/decided on
- Describe how records are going to be kept for 40 years.

20. LIGHTING

Where poor or lack of illumination is identified as a hazard the lighting regulations must be complied with and the following must be included in the H&S Plan:

- How lighting will be ensured/ provided where daylight is not sufficient and /or after hours are worked.
- Planned maintenance programme for replacing luminares.
- Proof of illumination levels of artificial illumination equipment.

21. HAZARDOUS BIOLOGICAL AGENTS (HBA)

Because of the possible exposure of workers to raw sewage the H&S Plan shall include details of the following:

- The conducting of Risk Assessment specifically aimed at exposure to HBA which shall include the following:
  - Nature and dose of HBA
  - Where HBA may be present and in what physical form
  - The nature of work or process
  - Steps in the event of failure of control measures
  - The effect of the HBA
  - The period of exposure
  - Control measures to be implemented

- Monitoring of exposure of workers shall be conducted to establish whether any worker is infected with an HBA associated with working or being exposed to raw sewage, in terms of the following:
  - By an occupational medical practitioner
  - Before entering the site to establish the workers baseline
  - During the period of the contract the risk assessment indicate possible exposure
  - After completion of the contract

- Medical surveillance should such be required after the above-mentioned by an occupational health practitioner.

- Indication on how all records of assessment, monitoring, etc will be kept, taking into account that records have to be kept for a period of 40 years.

- How exposure to HBA is to be controlled

- The provision of personal protective equipment

- What information and training is to be provided to employees regarding the following:
  - The contents of these regulations
  - Potential risks to health
  - Control measures to be implemented
  - The correct use and maintenance of personal protective equipment
  - The results of the risk assessment.

- End of document -

SECTION 4 : TECHNICAL SPECIFICATION

PART 8.3 : TERMINATION & CONNECTING UP OF CABLE AND CABLE ACCESSORIES

SPECIFICATION No: CG.01/1-97 – Rev 1/A

CONTENTS

1. SCOPE OF WORK INCLUDED IN THE QUOTED PRICE RATES:

The supply and installation of:

a) Cable glands and core lugs;

b) Cable and core identification labels and marking material; and

c) Cable cleats, strapping and fixing material.

The removal, drilling and re-filling of equipment gland plates, and touching-up of gland plate paint work where necessary.

The testing of glanded-off cables and the recording of test results.

The removal of surplus material.

The connecting-up of cables.

2. CABLE GLANDS

PVC SWA PVC cables shall be terminated using patent adjustable cable glands.

Unless otherwise stated all cable glands shall be of the captive cone type such that the wire armouring is held firmly by the gland, and at the same time electrically bonded via the body of the gland to the metallic gland plate.

Glands shall be supplied complete with lock nuts made of the same material as the gland.

The gland material shall be compatible with the cable armouring material.

Where cable glands are installed out doors they shall be provided with a suitable shroud or boot to prevent the ingress of moisture between the wire armouring and outer sheath of the cable where it enters the gland.

The fitting of cable glands shall be carried out in accordance with the manufacturer's instructions, copies of which shall be furnished to the Engineer.

The cost of supplying and installation of cable glands shall be included in the rates for the glanding-off of cables.

3. CORE LUGS

The individual cable cores shall be fitted with insulated crimped lugs of the size designed for the relevant cross sectional cable core size.

Fitting of the core lugs shall be carried out with an appropriate crimping tool in accordance with the manufacturer's instructions, copies of which shall be furnished to the Engineer.

The cost of supplying and installation core lugs shall be included in the rates for the connecting-up of cables.

4. CABLE AND CORE IDENTIFICATION

4.1 Cable Identification

All cables shall be marked at each end with a unique number in accordance with the Council's standard cable numbering system implemented for distribution substations.

The number shall be displayed in 4 mm high lettering.

Outdoor labels	stamped on a brass, copper or aluminium strip fixed to the cable by means of galvanised steel wire
Indoor labels	printed or embossed on a PVC identification label (in black on a white back-ground) fixed to the cable by means of self-locking PVC straps.

Cable identification labels shall be fixed around and at 90° to the axis of the cable.

The supply and erection of cable identification labels shall be included in the rates for the glanding-off of the cables.

Cables terminating in equipment shall also be marked with *Indoor Labels* as described above.

In floor mounted panels, such labels shall be located at the point where the inner sheath of the cable emerges from the gland.

4.2 Core Identification

Cable core identification shall be strictly in accordance with the general requirements in Part 1 of the Technical Specification.

5. CABLE CLEATS

Cleats may be defined as single way or multi-way clamping type units for the purpose of securing cables at a series of points on a vertical surface, typically structural steelwork or masonry.

For the purposes of securing cables to structural steel-work, the use of patent adjustable metal cleats which do not require special holes to be drilled in the steel work and which allow a vertical cable to be secured to a diagonal steel work member, are preferred. However, the use of suitable alternatives will be considered by the Engineer.

The use of steel or plastic banding or strapping as a means of fixing cables to structural steel work will only be considered where the use of a cleat is precluded.

Steel components of cleats shall be galvanised.

Where cables are to be fixed to concrete or masonry surfaces (either vertical or horizontal) the use of galvanised trays or stainless steel saddles are preferred. Saddles shall be secured to the concrete or masonry by means of expanding bolts.

The intervals at which cables are secured to vertical and horizontal surfaces shall not exceed 500mm.

The cost of supplying and erecting cable or cable cores, cleats and accessories shall be included in the rates for the installation of cables in the appropriate price schedules.

Cables run as trefoil groups shall additionally be clamped in trefoil arrangement every two metres over the entire length (including where buried in the ground).

Clamping of trefoil groups on cable supports shall be by means of wooden blocks and clamping in made trenches or in the ground shall be done by means of a stainless steel bonding strap bonded over scrap PVC serving wrapped around the trefoil groups.

Where mechanism box cables cannot be fixed to a structure, a separate galvanised support structure shall be provided to prevent the cables from hanging on the cable glands.

Where cables are to be terminated onto a 132/11kV power transformer a cable support structure of steel and hard wood shall be provided as referred to on drawing C-53.

6. GLANDING-OFF OF CABLES

Blank cable gland plates shall be supplied with the various items of plant and equipment.

The Contractor shall, unless otherwise stated:

a) Supply all cable glands.

b) Drill all gland plates (removing them from the equipment for this purpose and replacing after drilling).

c) Gland-off all multi-core control and power cables in accordance with the gland manufacturer's directions for use in a position which shall be appropriate to the points where the cable tails are to be terminated.

7. TERMINATIONS

The rates for terminations to be inserted in the Price Schedule shall allow the following lengths for preparation of tails at each end of the cable.

High voltage cables to suit equipment terminations.

PVC insulated power cables	1,5 m.
PVC insulated control cables	2,2 m.

The Contractor shall strip away all bedding or sheathing collectively surrounding the cable cores and shall leave the skins of cores neatly rolled-up inside the panel, terminal box, etc., as the case may be. The Contractor shall also replace or close any terminal box or kiosk covers or door on outdoor equipment which he might have removed or opened in order to gain access for glanding-off the cables.

The Contractor shall, in the process of glanding of the cables:

a) Fit the cable identification labels described below after having verified by means of an end-to-end check on at least 2 separate cores in the cable that both ends belong to the same cable;

b) perform the insulation and continuity checks described in the Specification and record the results in an approved manner;

c) touch-up the paint work on gland plate surfaces where this might have been scratched or damaged; and

d) remove all surplus PVC bedding, sheathing and armouring material to a scrap bin which shall be provided for this purpose on the site.

Each terminated core shall have sufficient slack to be re-terminated if required. (For example: In the event of a badly crimped lug having to be replaced).

8. TRUNKING AND WIRING CHANNELS

The connecting-up of cables shall include the whipping, strapping, lacing and harnessing of cable tails, the identification of the tails by means of ferrules or markers, the termination of each core by means of crimped lugs and the connection of cores to equipment terminals or terminal blocks (maximum of two lugs per terminal).

All wiring shall be taken to terminals and wires shall not be jointed or teed between terminal points.

After glanding the cable cores of each individual cable shall be unwound, straightened and strapped together to form a neatly bound group.

Grouped cable routes between the glands and the trunking shall be parallel to the front, back and sides of the cubicle. All bends along the grouped routes shall be at right angles. Direct routes between the glands and the trunking will not be accepted.

In cubicles the control wiring between devices and terminals shall be run in plastic, non-flammable trunking with snap-on cowers. To enable additional wires to be added in future, the channels shall not be more than 60% full at time of delivery.

Control and instrumentation / signal wires shall be run in trunking as far separated from each other and from power supply leads as possible to eliminate influence on each other.

SECTION 4 : TECHNICAL SPECIFICATION

PART 9.1 : Earthing Grid

SPECIFICATION NUMBER : EG.01/0-04

0 CONTENTS

			CoT - Signature - Contractor			

1. SCOPE

This specification shall include the design, supply, installation, connection and testing of the substation earthing system and ancillary works described below.

This specification includes the supply of copper conductor, lightning masts, earth spikes, earth mats etc. and the necessary excavation and civil works to install the earthing system and the replacement of stolen earth trails in substations.

The required general layout of the substation yard is shown on the drawings attached to this specification.

This specification describes all major components, but the Contractor shall supply and install all minor items and labour as may be necessary to complete the installation.

2. QUALITY OF WORK AND STANDARDS

All work shall be carried out strictly in accordance with the Code of Practice for earthing. (CP 1013)

The following SANS standards must be adhered to:

1. Earth rods, couplers and clamps shall be supplied and installed in accordance with SANS 1063-1985 and SANS 0199.
2. The two pack zinc-rich epoxy primer must be in accordance with SANS 926: 1968
3. The zinc and aluminium coatings for the protection of iron and steel against atmospheric corrosion must be in accordance with SANS 1391: 1983.
4. The replacement or new earth tail shall be two copper-plated steel earth rods according to SANS 1063: 1985.
5. Each earth rod shall have a diameter not less than 14.5mm, equivalent M16, according SANS 1063: 1985. The thickness of the copper plating on the earth rod shall not be less than 250μm.

3. DESIGN AND APPROVAL

The Contractor shall allow for soil resistivity tests to be performed on site. A detailed report on the resistivity tests shall be submitted to the Engineer together with a preliminary earthing scheme showing how the Contractor envisages installing the earth mat before commencing installation of the earth mat. The Contractor shall employ a specialist to investigate, plan and install the earthing installation.

The earth mat installation shall incorporate earthing electrodes at the extreme corners of the station, in the vicinity of earthing switches and transformer neutrals. The fences shall also be earthed at regular intervals. The installed maximum earth resistance shall be 1 Ω, or as agreed by the Engineer. Copper rod, 10mm² shall be used for the earth grid. The earth conductors shall generally be laid at a depth of more than 500 mm below the finished surface.

The complete earth mat design shall be submitted for written approval. The Engineer may then add or delete equipment and change the design of the earth system if he so requires. The installation of the earth mat shall be so arranged as not to cause delays in civil works.

4. EARTH RESISTANCE SURVEY

The Contractor will be responsible to have an earth resistance survey carried out on site by a specialist in this field, to be approved by the Engineer. The test shall be done on the undisturbed site, i.e. before earth works, trenching, building etc. commence.

The Engineer shall attend the survey. The Contractor shall inform the Engineer in good time when the test is scheduled to take place. If it is done without his or his representative being present, the test shall be repeated in the Engineer's presence at no additional cost to the Council.

			CoT - Signature - Contractor			

The results of this survey will be used to adjust the earthing system as specified herein, if necessary, on the basis of the quoted rates.

Payment for the services of the specialist shall be by the Contractor who may recover such costs out of the provisional amount allowed for this purpose. The recoverable amount will be the nett invoice amount charged by the specialist, plus a 5% mark-up to cover the Contractor's administrative overhead and profit.

5. STOLEN AND NEW EARTHING FOR OUTDOOR EQUIPMENT

To discourage theft of copper bar or conductor, no bare earthing copper shall be visible above ground. For all visible outdoor connections to equipment or structures, copper plated solid steel rods having an equivalent resistance as the copper it replaces, shall be used. Sizes and cross sections shall be according table 1 and be approved by the Engineer

Connections shall either be bolted directly to the earthing conductor, or bolted to a copper flag silver soldered or exothermically welded to the earth conductor to the approval of the Engineer. Alternatively, each joint shall be made with adequate bolts to the approval of the Engineer

The copper plated earth rod must be exothermic welded onto the structure as well as the copper earth mat. The reason is to enable a temperature rise up to 800°C for the copper plated earth rod. This provides for higher current capability for 3 seconds. The galvanising of the structure must be removed with a grinder and the surface cleaned where the exothermic weld is to be preformed. Failing to remove the galvanising will cause holes in the exothermic weld, which will result in poor contact and poor current carrying capability. After completion of the exothermic weld, the area on the structure, where the galvanizing was removed, must be covered with cold galvanizing. All exothermic weld joints are to be hammered tested to ensure that the mechanical strength of the joints are adequate. It is very important to use the correct weld metal power for the correct joint.

After connection the Engineer shall inspect all joints before the joints are sealed or trenches closed.

The following equipment needs to be earthed and the standard practices for earthing this equipment are as follows:

a) Transformer earthing:

   Transformers need to be earthed on the top cover on two different places and by using double earth rods.

b) Surge arresters:

   Insulated surge arrestors will be earthed on the surge arrestors base where non-insulated surge arrestors will be earthed on the structure exothermically.

c) Voltage and current transformers:

   Voltage and current transformers will be earthed on the structure exothermically.

d) Earth switches and isolator earthing:

   Earth switches and isolator earthing will be earthed on the structure exothermically on two different ends. The handle of the earth switches shall be earthed through a flexible earth.

e) Fences:

   All steel fencing must be earthed with in every 20M

f) Mechanism boxes and kiosks:

   Mechanism boxes and kiosks shall be earthed independently of the associated device or steel structure on which they are supported.

			CoT - Signature - Contractor			

6. INDOOR EQUIPMENT EARTHING AND CABLE TRENCHES

Control panels, battery chargers, cable racking and other indoor auxiliary equipment shall be bonded by earth rod.

An earth rod shall be laid in the cable trench together with the multicore cables. This earth strap shall be run into the building and serve as the building earth to which all equipment in the building is connected. The building earth shall be connected to ground rods or bonding bar at diametrically opposite ends of the building.

7. EARTHING ELECTRODES

The number and lengths of earthing electrodes shall be determined from the resistivity tests above. Earthing electrodes shall be of the extendible rod type. The rods shall be of copper clad steel and the copper to steel weld shall be a true molecular bond according SANS 1063.

8. LIGHTNING CONDUCTORS

Lightning conductor aerial masts shall be designed according to SANS 0160 with a safety factor of 2.5. They shall be hot-dip galvanised to SANS 763.

Masts shall be joined and hinged at ground level and shall be supplied complete with foundations.

9. TESTING OF EARTH RODS

SANS 1885: 2004

10. DRAWINGS REQUIRED

After completion of the Works, the Contractor shall supply the necessary drawings as agreed upon with the Engineer

11. ANNEXURES

Annexure A:

Copper earthing conductor sizes.

Fault current	**Copper area required mm^2**		**Main earth grid (Rod)**		**Connections to equipment support (50 × 3 strap)**		**Connections to equipment support (2 × 10mm rod)**	
I (kA)	**Grid**	**Earth lead**	**No. of directions**	**Actual area mm^2**	**No. of connections**	**Actual area mm^2**	**No. of connections**	**Actual area mm^2**
12.5	125	150	2	160	1	150	1	160
16	160	190	4	320	2	300	2	320
20	200	240	4	320	2	300	2	320
25	250	300	4	320	2	300	2	320
31.5	315	375	4	320	3	450	3	480
40	400	480	6	480	4	600	3	480
50	500	600	8	640	4	600	4	640

Table 1: The table above illustrates the conductor arrangements required to meet standard fault levels.

			CoT - Signature - Contractor			

SECTION 4 : TECHNICAL SPECIFICATION

PART 9.2 : EARTHING

SPECIFICATION No:

1. EXTENT OF WORK

An earthmat (copper band/conductor) needs to be installed in the new trenches and the new Control Building to match the existing earthmat configuration. The new earthmat needs to be connected to the existing earthmat by an isothermic welding process (Cad-welding). Where existing earthmat sections are damaged or removed, they should be replaced.

The substation earth resistance and bonding of equipment must be tested and proved. Where abnormalities occur, it must be rectified and tested to the approval of the Engineer.

Tenderers are referred to the applicable requirements of Section 4 Part 12.1 “Earthing Grid”, Section 4 Part 18 “Project Specification: Substation Testing and Re-Commissioning”, as well as the price items in the Schedule of Prices (Section 7 Part 2).

SECTION A: TECHNICAL SPECIFICATION

PART 10.1: MAINTENANCE OF TAP-CHANGERS

CONTENTS

1. SCOPE

a) This section of the specification provides for the complete maintenance as describe in the original equipment manufacturer manual on all various type of tap changers in use by COT. And have manufacturer accreditation to carry out maintenance on their equipment or being the original manufacture of the equipment

2. STANDARDS

The transformer tape changers shall comply with this the current editions of specification **NRS 054, TAP CHANGER ASEA TYPE: UBB ((34-1429 (ESCOM Spec)) and OEM requirements.**

3. TAPCHANGER GENERAL DETAIL

The OLTC design shall be according to the tap-selector switch principle or shall consist of a tap-selector and rotary type diverter switch of high speed transition resistor type.

The OLTC shall be in conformity with IEC 60214. All equipment related to the OLTC shall be supplied by the original OLTC manufacturer. This is also applicable for tie-in resistors, if provided. License products etc. are not acceptable.

The OLTC(s) shall be mounted into it’s own tank. The diverter switches with selector switches shall have an own oil compartment separate from the transformer oil as well as their own closed sub-section in the oil conservator.

If possible no piping or other equipment shall be arranged beyond the tap changer head to allow lifting of the diverter switch with vacuum cells without any restriction and without removing (dismantling) of any other equipment.

An oil-flow operated protection relay shall be provided for internal failure protection. This oil-flow relay shall be provided on elbow pipe on tap changer head and shall have slide valve on side piping to OLTC conservator.

The motor drive, plus all auxiliary equipment for operation of the tap changer, shall be incorporated in a rigid control of min 4mm thick aluminum alloy, protection class IP66 and shall be mounted onto the transformer tank in a convenient floor height. The driving gear shall be of the belt-type or equivalent dry-type gear. Oil filled driving gears are not acceptable.

The voltage of supply for electrical operation of the control and indicating gear shall be as specified in the Schedules.

Limit switches shall be provided to prevent over-running of the mechanism and except where modified in Clause 7.18, shall be directly connected in the circuit of the operating motor. In addition, a mechanical stop or other approved device shall be provided to prevent over-running of the mechanism under any condition.

The control circuits shall operate at 110V AC single-phase to be supplied from a transformer having a ratio of 240/55-0-55V with the center point earthed through a removable link mounted in the marshalling kiosk and supplied under this contract.

Tripping contacts associated with any thermal devices used for the protection of tap changing equipment shall be suitable for making and breaking 150VA between the limits of 30 volts and 250 volts AC and DC and for making 500VA between the limits of 110 volts and 250 volts DC.

A device shall be fitted to the tap changing mechanism to indicate the number of operations completed by the equipment.

The terminals of the operating motor shall be clearly and permanently marked with numbers corresponding to those on the leads attached thereto.

4. TAP-CHANGER DRIVING MECHANISM

The supply for the driving mechanism will be available from a 400/231 Volt ±5% 3-phase 50 Hz supply switchboard.

Thermal overload and single-phasing protection shall be provided for the drive motor. Mechanical stops are to be provided to prevent the mechanism from overrunning its end position.

For manual operation of the tap changing equipment a readily detachable handle shall be provided for manual operation. Provision shall be made to prevent the tap changer contacts from being left in an intermediate position when operated manually. A mechanical tap position indicator and operation counter shall be provided on the driving mechanism both of which shall be externally visible. Such operation counter shall have at least five digits and shall have NO provision for resetting.

The driving mechanism shall be enclosed in a dust-proof and vermin-proof cabinet provided with a separately fused heater and switch. The cabinet must be able to lock with a padlock.

A local/remote switch with raise and lower hand controls must be provided in the drive-mechanism. The tap-changer must be controlled from an 110V AC Transformer fitted in the marshalling kiosk.

A tap position encoder must be provided.

The tap position encoder must convert the tap position into a Binary Coded decimal (BCD) signal for indication purpose. The Tap position Encoder must be rail-mounted in the Tap Changer Drive Mechanism box or transformer-marshalling kiosk. Two separate potential free contacts must provide an output BCD with the following technical requirements:

a)	Rated voltage, make and break	300 V d.c./250 V a.c.	
b)	Make and Carry for 1 sec	10 Amp	
c)	Continuous carry	5 Amp	
d)	Breaking capacity for d.c. when the control circuit time constant is L/R<msec at the control voltage levels:	50V d.c.	1.0 A
		110V d.c	0.6 A
		220V d.c	0.5A
e)	Contact material	Silver, gold flashed	

The encoder must operate under the following environmental conditions:

a) Specified ambient service temperature range -10 to +55 C

b) Transport and storage temperature range -40 to +70 C

5. GENERIC MAINTENANCE ON VARIOUS TAP CHANGERS

The SP shall be responsible for and carry out the following work:

a) Execute major services on the various types of tap changers (on load or off load) 132kV/11kV. 5MVA – 300MVA outlined below in accordance with the OEM (Original Equipment Manufacturer). PM will be responsible for the minor servicing of the tap changers.

b) Inform maintenance department when equipment does not meet performance and specification requirements

c) Corrosion treatment of the tap changer and replacement of gaskets.

d) Follow the procedures for oil handling and give detail attention to prevent oil spill.

e) Not open and expose tap-changers or outdoor electrical equipment to rain, wet conditions or dust.

f) Provide a detailed typed electronic report of the assessment and corrective measures

5.1 Tap changer TYPE MR "D"

a) Remove the diverter switch insert and clean.

b) Remove the resistor and contact cylinder,

c) Replace shock absorber springs,

d) Inspect the roller and slide square bolts and energy accumulator.

e) Replace locking plates.

f) Measure contact resistance and resistors values and compare with design values.

g) Re-assemble and install diverter switch.

h) Replace gaskets with Corkrite TF 62.

I) Remove, inspect and clean Malteser gear unit and re-install.
J) Open the RS 1000, clean and test, and replace gasket.
K) Inspect drive shaft and motor drive.

5.2 Tap changer TYPE MR "V"

a) Remove and re-install the tap changer insert.

b) Clean the tap changer oil compartment and the tap changer insert.

c) Clean the oil conservator and fill with new oil.

d) Inspect the tap-changer oil compartment and the tap-changer insert.

e) Determine contact wear.

f) Measure the transition resistors.

g) Inspect the protection relay, drive shaft, motor drive unit, oil filter unit and the voltage regulator.

h) Replace gaskets with Corkrite TF 62.

i) Inspect and install spring plates on the outer screening rings of the switching columns.

j) Inspect and replace bearing bushings where required.

k) Convert inner screen to screw fixing.

6.0 SERVICING OF ON LOAD TAP CHANGERS (OLTC)

The following types of tap changers will be covered under the below procedure

a. UZ type ERN (BUFF 2)

b. MR type UBB

c. UZ type (BUFF3)

d. UBB

e. ABB

f. ATL

g. Ferranti

6.1.1 Procedure

a) Record all nameplate details and number of operations on the OLTC Report Sheet.
b) Drain the used oil into drums for disposal by MD.
c) Remove main cover.
d) Flush tap-switch compartment with clean transformer oil.
e) Inspect and determine broken or worn components.
f) Inspect arcing contacts and replace where arc damage is excessive in accordance with OEM recommendation.
g) Inspect main contacts for wear and burning. Replace or repair where required.
h) Inspect all mouldings and resistors for signs of “partial discharge”, and repair if required.
i) Where severe arcing of contacts is evident and or a transition resistor has failed, such cases shall be referred to the MD.
j) Measure transition resistor values and compare with rating plate details.
k) Inspect and tighten gaskets between main transformer tank and OLTC.
l) Inspect all bolts and cables between barrier board and sector switch panels for loose connections and tighten where required.
m) Inspect shear pins for wear between Geneva wheel and main drive shaft in switch compartment. If the moving and fixed contacts are not aligned, replace the shear pin if necessary after consultation with the MD.
n) Inspect and tighten gasket between drive mechanism and switch compartment.
o) Fit new cover gasket and close OLTC.
p) Fill with clean, dry oil complying with SANS 555.
q) Inspect mechanism operation both electrically and mechanically. Clean with FO 128.
r) Inspect Geneva wheel for wear.
s) Inspect Buchholz Relay for damage and contact operation.
t) Inspect Low Level Alarm if fitted.
u) Inspect oil gauges.
v) Inspect for leaks.
w) Replace silica gel in breather.
x) Conduct a dynamic winding resistance measurement to test the on-load tap changer.

7. WINDING TEMPERATURE INDICATION AND OIL TEMPERATURE INDICATION CHECKS AND SETTINGS

7.1 Procedure

Consult with MD before changing settings. The recommended settings are as follows:

Function	Alarm temperature in ºC	Trip temperature in ºC
Oil Temperature	95	105
Winding Temperature	110	120

a) Check the accuracy of the instrument by inserting the bulb in an oil container with heated oil and having a pencil-type thermometer to check the instrument readings.
b) Stir the oil regularly to distribute the heat evenly.
c) Take readings as various oil temperatures between 50ºC and 100ºC and note both the instrument and the check thermometer readings. Note that it may take up to 5 minutes for the bulb type instrument to stabilize.

In the event that there is a large difference between the check thermometer and the instrument, adjust the instrument by:

a) Adjusting the screw on the pointer
b) Shortening or lengthening the links on the bellows. This is a delicate operation and care must be taken to avoid damage to the linkages or the bellows.
c) If adjustment by means of the above is not possible or feasible, the indicator needle must be removed from the shaft and replaced to read correctly.
d) After adjustment, re-check the accuracy. A difference of ± 3ºC is acceptable.
e) If the WTI has a bellows heater, the action of passing current through the heater coil will cause the bellows to expand due to the I^2R watts loss and further raise the indicated temperature above the oil temperature. As we do not know what this increase in temperature must be the following check is required:-

(i) Check the heater coil for electrical continuity using a multi-meter and note the reading.
(ii) Refit the indicator bulbs after checking.
(iii) Replace all oil rings on thermal probe

8. TESTS

The dynamic winding resistance measurement of the on-load tap changer is required and the results compared with a tap changer in sound condition.

8.1 Witnessing of Tests

The Client reserves the right to appoint a representative to inspect any of the transformer manufacturing stages or to be present at any of the tests specified. Such inspection shall not relieve the Contractor of his responsibility for meeting all the requirements of the specification and it shall not prevent subsequent rejection if such material or equipment is later found to be defective.

8.2 Tests and inspections in General

The Contractor shall give the Client not less than seven (7) days' notice of when the equipment will be ready for the inspection or witnessed tests requested. Factory tests shall be regarded as an integral part of the manufacturing of the various items and shall therefore be allowed for in the unit prices quoted for supplying

For each factory inspection tests be done outside the Gauteng area, the Contractor shall allow for travelling, subsistence and training cost of 2 Engineers or Technicians to attend the tests. If tests are done overseas, the costs shall also allow for air fares and hotel accommodation.

8.3 Routine Tests

a) on-load tap changing equipment shall be subjected to the manufacturers' routine operating and voltage tests; and

8.4 Test Certificates

One (1) copy of test certificates showing the results of all routine test provide to COT.

8.5 Tests on Site

On completion of erection at site, the Contractor shall perform such tests as may be required to ensure that the transformer is ready for handing over and putting into regular commercial use.

It shall be the Contractor's responsibility to commission all control equipment when commissioning the tap changer.

The Client may also carry out any tests that are considered necessary to prove that the plant fulfils the requirements of the specification.

9.0 Oil handling

SP responsibilities:

a) MD shall be given three days' notice, and shall supervise the transfer of transformer oil.

b) Transfer of oil from the tap-changer to the storage containers.

c) Maintain the tap-changer under positive pressure using dry air after oil removal.

d) Insulating oil shall comply with SANS 555 and shall be passed through a filter before use.

e) Lubricating oil shall comply with SANS 053.

f) Supply of virgin transformer insulation oil approved by OEM.

g) Purification of the oil and shall take oil samples for testing (Oil shall comply with the following requirements before it is pumped back into the transformer: temp 62 º C; moisture content shall be less than 6ppm. Note: “refer to the section under vacuum filling before transferring oil in power transformers”).

10. Supply and installation of new gaskets

Procedure

1. Remove all traces of old gasket from both surfaces to be sealed.
2. Inspect surfaces for cracks or gouge or scour marks that will allow oil to seep through, repair using suitable filler where required.
3. Supply and install new gasket.
4. Check that new gasket fits joint and holes coincide with studs or bolt holes.
5. Assemble the joint and gasket evenly, clamp the gasket until it is compressed by about 25% to 30% i.e. clamp to about 70% to 75% of the nominal thickness.
6. Trim off excess gasket protruding from the clamped joint.
7. Take precautions to prevent equipment and tools from falling into the transformer/tap changer.

Gasketed joints shall be of the groove an 'O'-ring type. Grooves shall be dimensioned and the mating surfaces machined to the specification of the o-ring manufacturer to ensure leak free seals. The material of the 'O'- ring shall be Viton rubber.
The 'O'-rings shall be moulded or pre-joined by vulcanising to the correct diameters. Butt or chamfered joints that rely on overfill of the groove to seal are not acceptable. Gaskets shall be replaced each time a seal is broken

11. Procedures for working in “live” substation switchyards

a) In order for MD to make arrangements, an application for a Work Permit shall be submitted to the MD, together with the proposed work schedule, at least seven full working days before starting work.

b) The SP shall take cognizance of the following: De energizing/switching of electrical equipment is subject to PM operational requirements. Operational requirements may dictate that the SP shall carry out work over weekends or outside normal working hours.

c) The SP shall submit an application one week in advance for the following:

- Temporary Permit to enter a security area

- Appointment of a competent person to supervise workers near electrical equipment

Duties and responsibilities of the SP OHSA representative supervising construction

12. Barricading of equipment on site

(a) The SP must provide their own safety nets for barricading any area that needs to be barricaded.
(b) The SP is responsible for erecting of the safety nets on site according to the Health and safety act regulations and maintains the net and safety area.
(c) All personnel shall work strictly in the area that is indicated by temporary safety barriers.

13 Cleaning of site

(a) The contractor must keep the site clean at all times.
(b) The contractor shall be responsible for all importation and carting away of surplus material on his cost after completion of the work.
(c) Oil contaminated soil must be remove/clean

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Eskom	**Standard**	**Technology**

Title: **SPECIFICATION FOR POWER TRANSFORMERS RATED FOR 1.25MVA AND ABOVE AND WITH HIGHEST VOLTAGE OF 2.2KV OR ABOVE**

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Content

Figures

Tables

Executive Summary

This transformer specification document was the work produced by the Eskom SCOT Transformer Care Group in 2012 and periodically undergoing revisions. The document was compiled with intentions to align, optimise, and consolidate Eskom requirements for effective interpretation by equipment suppliers and enhance interchangeability within the organization. This was done without undermining the special requirements that are applicable in certain types and application of transformers. These are to be intentionally and adequately discussed to during design review meetings.

This document incorporates the best applicable requirements from the previous divisional documents and integrated the recent learnings from the Eskom business, the international bodies, and the experts from around the world, including suppliers from various continents. In the past Eskom purchased transformers which experienced shortened lifespans, with an average failure age of about 18 years instead of the expected 35 years and 40 years for generator-step-up and the network transformers, respectively. Three separate teams of international consultants were employed by Eskom to look at the root cause of the premature failures observed at that time. The results of the work of these consultants were incorporated into this technical specification document. These include, but are not limited to, the following:

- Composite bushings – to reduce failure and fire risks plus maintenance requirements
- Enamelled windings on certain classes of transformers – to eliminate corrosive sulphur effects and other chemical problems
- Winding arrangements – to reduce radial forces during short circuits,
- Limits on dielectric stresses and inclusion of safety margins in various aspects
- Specific oils – to reduce corrosive sulphur failures,
- Reductions in load and no load losses – to reduce life cycle costs,
- Introduction of maintenance free vacuum tap-changers technology
- Environmental considerations, including oils
- Climate change considerations

Continually as technologies evolve these are researched and considered by Eskom SCOT Transformers Care Group who are continually optimizing the designs as required. The new designs have demonstrated low failure rate and the transformer reliability has improved compared to what was experienced prior to introduction of these points.

1 Introduction

This specification document gives the requirements for all new transformers procured by/for Eskom for use in the Gx OUs, Tx Grids, and Dx OUs. This document was originally compiled and is periodically revised by the SCOT WG which is a cross divisional and multi-disciplinary team. This work was produced with the intentions mentioned below in mind, and they are:

- Acquiring transformers that are fit for purpose and can remain reliable to the expected life of beyond 40 years.
- Achieving optimized standardization thereby allowing a wide range of interchange-ability.
- The Eskom drive for low maintenance, tending towards maintenance free technologies.
- Support Eskom's drive for reducing the carbon footprint, zero harm to people and to the environment and BPP initiatives.
- Minimizing the total cost of ownership.

2 Supporting clauses

2.1 Scope

This Specification applies to all Eskom oil-filled new power transformers, having a highest voltage winding operating at or above 2.2 kV, and a rating above 1.25 MVA. This specification in not primarily intended for oil filled units like shunt and series power reactors, HVDC converter transformers, and smoothing reactors; but reference may be made to this specification when procuring those. The power transformers covered in this specification document are generally classified as follows in Eskom

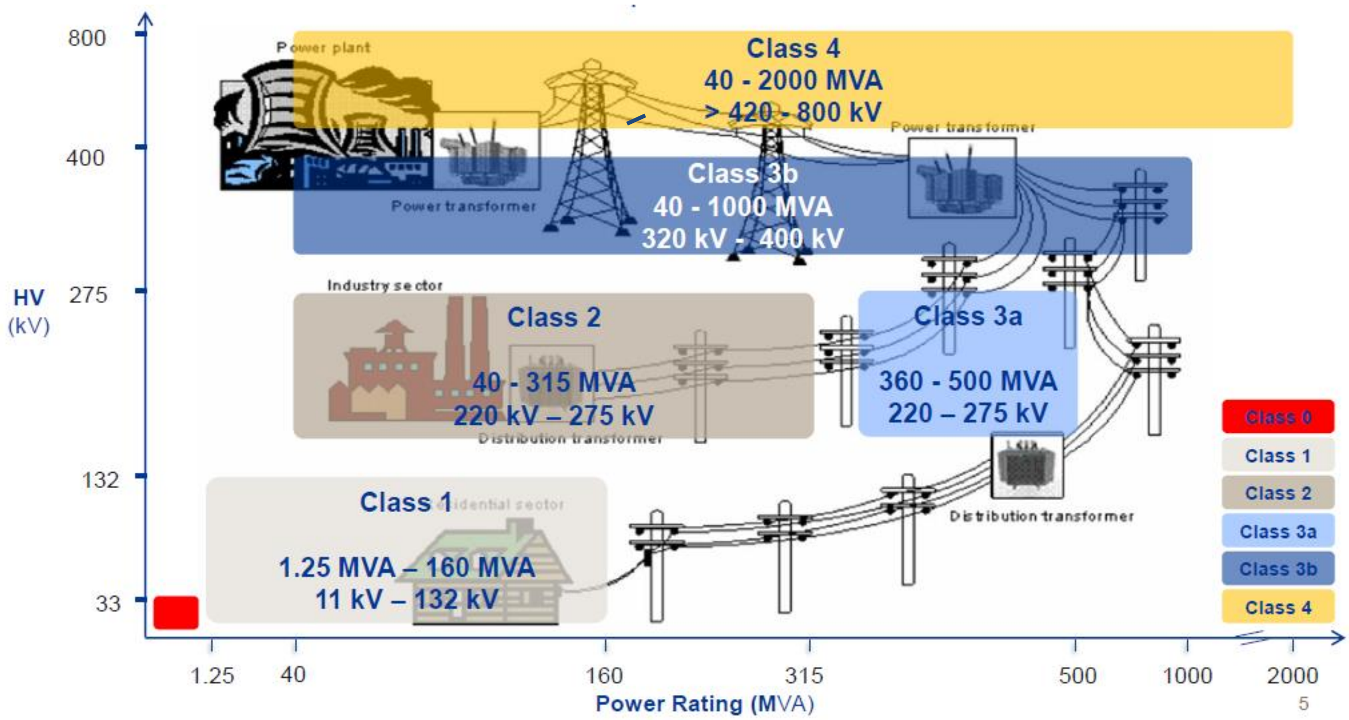


Figure 1: Classes of transformers in Eskom

2.1.1 Purpose

This document was produced in order to record the standardized requirements that shall be applied when procuring new transformers for Eskom to be used in the Eskom network. This covers transformers procured directly by Eskom, those purchased under turn-key projects or through Independent Power Producers (IPPs).

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions. It is applicable to all the *Contractors* that shall be tendering to supply transformers to Eskom.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001 Quality Management Systems.

[2] IEC 60076-1, Power transformers — Part 1 General.

[3] IEC 60076-2, Power transformers — Part 2 Temperature rise.

[4] IEC 60076-3, Power transformers — Part 3 Insulation levels and dielectric tests.

[5] IEC 60076-4, Power transformers — Guide to Lightning and Switching Impulse.

[6] IEC 60076-5, Power transformers — Part 5 Ability to withstand short circuit.

[7] IEC 60076-7, Power transformers — Part 7 Loading guide for oil-immersed power transformers.

[8] IEC 60076-8, Power transformers — Part 8: Application guide.

[9] IEC 60076-10, Power transformers — Part 10 Determination of sound levels.

[10] IEC 60076-10-1, Power transformers Part 10-1: Determination of sound levels - Application guide

[11] IEC 60076-13, Power transformers Part 13: Self-protected liquid-filled transformers

[12] IEC 60076-14, Power transformers Part 14: Design and application of liquid- immersed power transformers using high-temperature insulation materials

[13] IEC 60076-18, Power transformers Part 18: Measurement of frequency response.

[14] IEC 60085, Thermal evaluation and classification of electrical insulation.

[15] IEC 60137, Insulating bushings for alternating voltages above 1 000 V.

[16] IEC 60156, Insulating liquids – Determination of the breakdown voltage at power frequency.

[17] IEC 60185, Current transformers.

[18] IEC 60214, On-load tap-changers.

[19] IEC 60034, Rotating electrical machines.

[20] IEC 61850 (All parts) Communication network and systems in substations

[21] 32-9 Definition of Eskom documents.

[22] ESP32-644 Eskom documentation management standard

[23] 474-65 Operating Manual of the Steering Committee of Technologies (SCOT)

[24] 240-56063843 Winding and oil temperature specification

[25] 240-56063908 Oil and gas actuated (buchholz) relays fitted to transformers and reactors

[26] 240-56063886 Dehydrating breathers fitted on transformers, reactors, and on-load tap changers

[27] 240-56356191 Transformer and reactor oil level indicators

[28] 240-56063867 Rapid Pressure Rise Relay Specification

[29] 240-56063871 Pressure Relief Devices (PRD) Fitted to Transformers and Reactors Specification

[30] 240-56356202 Bag Leak Detector Specification

[31] 240 – 56535946 Transformers and Reactors cooling fans standard

[32] 240 -64917195 Technical standard for dissolved gas analysers for application in power transformers for all Eskom divisions.

[33] 240-59083215 Permanent online oil drying system used on transformers and reactors.

[34] 240-56062799 Technical Specification for Capacitor Bushings for Application in Power Transformers and Shunt Reactors in Eskom

[35] 240-56030674 Corrosion Protection of new and in-service power & station auxiliary transformers

[36] 32-406 Mineral insulating oils (uninhibited and inhibited) part 1: purchase, management, maintenance and testing

[37] 240-56062726 Standard for Intrusive work and Oil filling, under vacuum of transformers and reactors on site

[38] QM 58 Eskom Quality Procedure

[39] D-DT-3202 Eskom Drawing MV and LV cable box

[40] EST32-136: Contractor Health and Safety Requirements

[41] Eskom 10TB-018: Technical Bulletin for Loss Evaluation

[42] TPC 41-246: Management of manufacturers and suppliers equipment drawings

[43] 240 – 53902530 Substation automation – data concentrator for data retrieval and remote access

[44] 240 – 64038621 Remote device communication standard for data retrieval and remote access

[45] 240 – 46264031 Fibre optic design standards – Part 2 – Substations

[46] 240-56062720 Oil Sample point labelling standard

[47] TB 204 Cigre Publication, Guidelines for transformer design reviews

[48] South African National OHS act

[49] Eskom ORHVS

[50] TPC 41-246 Management of manufacturers and suppliers equipment drawings

2.2.2 Informative

[51] TSP 41-87

[52] DSP 34-1092

[53] GGS 1074

2.3 Definitions

2.3.1 General

Definition	Description
Appointed bodies	Refers to persons, beside Eskom employees, appointed by Eskom to provide professional services to Eskom.
Contractor	This refers to the party that received a purchase order from Eskom
Employer / Purchaser	These refer to Eskom and it is interchangeably used to refer to the customer
Partial Drain	The phrase refers to draining the transformer or reactor is such a way that the HV insulation and the active part remains fully immersed in oil and vacuuming will not be necessary after completion of work
Power Transformer	This refers to all the transformers from class 1 and to class 4 as detailed in this specification, including the generator-step-up transformers.
Service Life	This refers to the expected lifetime of the transformer operating incident free.
Network Transformer	This refers to a transformer typically used in a transmission and distribution network for coupling different voltage levels, these transformers typically are configured in redundant pairs.
GSU	Generator Step Up transformer, a transformer used at power stations to step up the output voltage of the generator to a transmission line voltage for power evacuation. These units tend to be loaded to 100%.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
A	Amperes
BPP	Business Productivity Program
CT	Current Transformer
CW	Common Winding (also called PW – Parallel Winding)
DGA	Dissolved Gas Analysis
GIC	Geomagnetically Induced Currents
GSU	Generator Step-Up transformer
HVDC	High Voltage Direct Current
HV	Highest Voltage / High Voltage
kW	Kilo Watt
LV	Lowest Voltage / Low Voltage
MV	Medium (Middle) Voltage
MW	Mega Watt
MVA	Mega Volt Ampere

Abbreviation	Description
ODAF	Oil Directed Air Forced
ODAN	Oil Directed Air Natural
ONAF	Oil Natural Air Forced
ONAN	Oil Natural Air Natural
PRD/V	Pressure Relief Device / Valve
RW	Regulating Winding (Tapping Winding)
SFRA	Sweep Frequency Response Analyses
SW	Series Winding
THD	Total Harmonic Distortion
TOV	Temporary Over Voltages
TW	Tertiary Winding (also called TV for Tertiary Voltage)
UV	Ultra Violet

2.5 Roles and responsibilities

All the Eskom employees and/or appointed bodies involved in the procurement of transformers and/or the associated accessories shall ensure that the product meets the requirements of this specification. Any deviation from these requirements shall constitute a non-conformance, unless it was agreed to in advance by a delegated Eskom transformer specialist in writing and is based on sound engineering judgement.

All the Contractors supplying transformers to Eskom must be conversant with the requirements of this specification, and shall comply with the requirements. All the deviations shall be clearly listed in the deviation schedule as part of the tender deliverables.

No deviations will be accepted unless approved by Eskom in writing. The Contractor shall ensure that he gets clarity where required and that he has all the supporting information or documents necessary for the contractor to comply with this document.

The Eskom Transformer Corporate Specialist shall be responsible for ensuring the validity of this document.

2.6 Process for monitoring

This document and its relevance will be annually evaluated by the relevant SCOT Care Group.

2.7 Related/supporting documents

The schedule A of the relevant AB schedules shall form part of this specification and they shall take precedence over this specification in case the two documents are conflicting.

3 Specification Minimum Requirements

This specification defines the minimum requirements for the site survey and assessment, design, design-review, manufacturing, factory testing, transporting, delivery to site, off-loading, assembly, installation, in-transit and on-site testing, and commissioning, and performance of the said transformers. The transformer shall at a minimum be designed for the environment where it will be utilized. The transformer manufacturer shall apply the best internationally benchmarked engineering and manufacturing practices to produce a transformer, including accessories, which in conjunction with minimal maintenance, will result in a safe and reliable service throughout the expected lifespan under the rigors of service in the Eskom power system. The transformer, when in service, shall not exhibit unsafe or any uncertain condition, e.g. stray excessive gassing, partial discharge, etc. Engineering practices or techniques that have no measurable quality control shall not be accepted for correction of deviations. Brand new transformers must be presented as brand new units in all aspects, including but not limited to, materials, appearance, DP value, criterion, and other measures.

The transformer and the associated accessories shall be risk free to Eskom.

3.1 Design Reviews

A design review shall be done on the first transformer of each type. A design review in a planned exercise is envisaged to ensure that there is a common understanding of the applicable standards and specification requirements, and to provide an opportunity to scrutinize the design to ensure the requirements meet the Employer’s requirements.

The objective is to review specific aspects of the electrical, mechanical, magnetic and thermal design to:

- Ensure there is a clear and mutual understanding of the technical requirements.
- Verify the system and project requirements and to indicate areas where special attention may be required.
- Verify that the design complies with the technical requirements.
- Identify any prototype features and evaluate their reliability and risks.

A design review meeting is required before the procurement of any materials or manufacturing proceeds. The purpose of the design review is to allow Eskom to understand the basic design, construction and installation of the transformer and to make sure that interchangeability requirements are met. Eskom shall not be obliged to accept components and/or materials procured prior to the design review and without a written agreement from Engineering. The design review shall follow an internationally benchmarked process.

The manufacturer shall design the transformer such that it performs satisfactorily under all service conditions specified in this document, and without it exhibiting signs of having defect, e.g., abnormal gassing.

The manufacturer has to demonstrate that all the decisive design parameters are well within the manufacturer’s design limits based on proven research, or relevant limits specified in standards or internationally benchmarked criteria.

Eskom reserves the right to reject the design when the manufacturer fails to demonstrate the capability for design and manufacturing of the transformer under review. This can happen when the presented design does not meet internationally and Eskom’s accepted criteria and the manufacturer cannot prove his design by previously tested transformers of the same concept and voltage class.

The manufacturer shall inform Eskom twelve (12) weeks prior to the design review. All the discussions and final decisions taken during the design review must be recorded, signed by all the parties, and submitted to Eskom.

Eskom’s participation in the design review will in no way relieves the manufacturer of any of their duties in terms of any contract.

Preliminary design review details must be supplied to Eskom at the latest of two weeks before the design review meeting date.

3.2 Site Conditions

The *Contractor* shall take note that the equipment shall operate under the following site conditions

- Outdoor installation
- Altitude above sea level – 1800m
- Ambient temperatures
  - Maximum + 40°C
  - Monthly average +28°C
  - Yearly average + 25°C
  - Minimum - 10°C
- Average humidity of 90%.
- Solar radiation 2500kWh/m^2
- Atmospheric UV radiation = High
- Seismic conditions at a minimum of 0.3g, this requirement must be proved by calculation.
- Symmetrical three phase network supply voltages, negative and zero phase sequence voltages up to 2%.
- Pollution level: Very Heavy

In special cases the site conditions, when different from these, it shall be indicated in the AB schedules.

NOTE: The yearly average for South Africa is 23°C according to the SA Weather Services website, which is 3K higher than that in IEC 60076-7. A further 2K was added for climate change reasons and hence the yearly average is considered 25°C. This information is important when considering the temperature rise limits.

3.3 Network Conditions

3.3.1 Frequency

The system nominal frequency is 50Hz.The transformer shall be designed for a rated frequency of 50Hz +/- 2.5Hz. The under frequency condition may last for 30 minutes and the over frequency for 10 minutes.

3.3.2 Voltage Unbalances

The transformer must be capable of normal operation without any deleterious effects when exposed to unbalanced voltages of 2% for the life of the unit.

3.3.3 Harmonic Pollution

The transformer must be capable of normal operation when subjected to harmonic pollution levels up to THD 3% throughout the life of the transformer.

3.3.4 Geomagnetic Induced Currents

This section is applicable to 400kV and above transformers where the Neutral of the transformer is solidly earthed and/or if GIC compatibility is specified in Schedule AB.

For the reason of GIC compatibility of 3 phase transformers, 3 limb cores are the requirement and where this is not possible, the return limbs must be optimized to achieve a good design for GIC withstand. The *Contractor* shall in details, during a design review demonstrate how he has taken care of the GIC effect on the design of the affected steel components.

The transformer shall be able to withstand a GIC of 10A in the neutral terminal for 30 minutes under the following operating conditions:

- Continuous Maximum System Voltage,
- Nominal System Frequency,
- Continuous Maximum Load,
- With a tap position such that the maximum number of turns are between the HV terminals and Neutral.

Under these conditions, the transformer must not be damaged. Thermal excursion during GIC phenomena must not shorten the transformers lifespan. For during the presence of the GIC storms special consideration must be given to effects such as vibration increases, increased magnetic forces, hot spot temperature rises, and localized heating due to stray flux changes. The effect of GIC currents on the transformer design must be quantified and the mitigation techniques used by the *Contractor* must be highlighted and submitted to the *Employer* as stipulated in Schedule AB. The *Contractor* includes a description of the intended design to be applied in the tender documentation. During the high-level initial design review phase, the *Contractor* presents the results of his studies of the GIC impact on his design and illustrates that the transformer withstands the criteria specified in this document and Schedules AB to the *Employer* for his approval. In addition, he shall include the proposal for the testing the transformer during the FAT to demonstrate its response to GIC and that the thermal excursions are not exceeded as per the design.

In the interest of being able to measure and monitor, the *Contractor* shall provide externally on the neutral terminal connection a proper CT that will enable the *Employer* to both measure and monitor the GIC level during service life. The proposal for this measurement shall be part of the tender returns and shall form part of the design review.

3.4 Ratings

3.4.1 Rated Power

The values of rated power specified in Schedule A of the enquiry document are the continuous ratings, in MVA, at which each of the windings of the transformer can operate on all tap positions at a voltage equal to the appropriate nominal system voltage, U_n, without exceeding the temperature rise limits specified in this specification.

Where mixed-cooled (transformers with radiators forming the base cooling, but also having fans and pumps that can increase cooling capability if switched on) transformers are specified, (the naturally-cooled rating (ONAN) of each of the main windings shall be at least 0.60 pu of the rated power of these windings. Class 1 transformers will have a 0.7pu ONAN rating due to their high load factor.

If a tertiary winding is specified, this shall be capable of operating under the naturally-cooled condition at any loading up to the rated power specified in Schedule A provided that the loading in the input winding does not exceed its naturally-cooled rating.

3.4.2 Rated Current

The rated current corresponds to the rated power at rated voltage on the principal tap position. Power transformers shall have overloading capabilities in accordance with IEC 60076-7.

3.4.3 Rated Voltage

The rated voltage of each winding of the transformer on the principal tapping as specified in Schedule AB unless otherwise stated corresponds to the system nominal voltage, U_n.

3.4.4 Maximum Continuous Rated Voltage

Regardless of the actual location of the tap changer in the HV winding, the rated voltage of the HV winding on any tapping is to be equal to the rated voltage on the LV winding multiplied by the voltage ratio on that tapping. For auto transformers, the LV winding refers to the secondary winding.

3.4.5 Maximum Temporary Overvoltages

Under switching conditions, the power frequency voltage may exceed the maximum system voltage (U_m). The transformers are designed to withstand the following over-voltages without harm:

1.05 U_n continuously for 400kV and above, and below 400kV – 1.1 U_n continuously (this is U_m) .

1.05 U_m	for	10 minutes
1.25 U_m	for	1 minute
1.5 U_m	for	5 second: and
1.75 U_m	for	1 second

Also see the additional requirement to comply with IEC 60076-3.

3.4.6 Overfluxing

Within the prescribed maximum equipment voltage (U_m) the transformer is able to operate continuously without damage at an overflux value as stated in IEC 60076. The U_m value shall be specified in Schedule AB.

3.4.7 Impedance

The Impedance value shall be as per Schedule A of the ordering specification based on Table 1: **Standard MVA ratings and impedances for transformers of class** of this document. The impedance for the nominal tap position and tolerance on the specified value shall be within the range of ±7.5%. The rest of the range shall be as per IEC specification.

For transformers with tertiary windings, to achieve the specified impedance values from the main windings to the tertiary winding, as specified in the schedule A in order to drop the fault level, the application of a current limiting reactor will be acceptable. The verification of the capability of such a reactor is mandatory and short circuit test results from similar units must be submitted. The reactor must be situated in such a position that failure of the reactor will not impact, nor damage the rest of the unit. The current limiting reactors must be without a magnetic core and it must not saturate during the fault conditions.

Table 1: Standard MVA ratings and impedances for transformers of Class 1

Nominal Voltage			Impedance Type	Standard MVA Rating								HV/MV Impedance (%) referred to primary power rating		HV/Ter Impedance (%) referred to tertiary power rating		Vector Group
Primary	**Secondary**	**Tertiary**		**160**	**80**	**40**	**20**	**10**	**5**	**2.5**	**1.25**	**Nom @ tap 5**	**Min @ tap 17**	**Nom @ tap 5**	**Min @ tap 17**	
132	88	22	STD	160/2	80/2	40/2	20/2					9	8			YnA0d1
132	66	22	STD	160/2	80/2	40/2	20/2					10	9			YnA0d1
132	44	22	STD		80/2	40/2	20/2					11	10			YnA0d1
88	44	22	STD		80/2	40/2	20/2					9	8			YnA0d1
132	11		HIGH			X						22	20			YNd1
132	6,6		HIGH				X					22	20			YNd1
88	11		HIGH			X						22	20			YNd1
88	6,6		HIGH				X					22	20			YNd1
66	6,6		HIGH				X					22	20			YNd1
44	6,6		HIGH				X					22	20			YNd1
132	33		STD		X	X	X					11	10			YNd1
132	33		STD					X				10	9			YNd1
132	22		STD			X	X					11	10			YNd1
132	22		STD					X				10	9			YNd1
132	11		STD			X	X					11	10			YNd1
132	11		STD					X				10	9			YNd1
132	6,6		STD					X				10	9			YNd1
132	6,6		STD				X					11	10			YNd1
88	44		STD			X	X					11	10			YNd1
88	33		STD		X	X	X					11	10			YNd1
88	33		STD					X				10	9			YNd1
88	22		STD			X	X					11	10			YNd1
88	22		STD					X	X			10	9			YNd1

Nominal Voltage			**Impedance Type**	**Standard MVA Rating**								**HV/MV Impedance (%) referred to primary power rating**		**HV/Ter Impedance (%) Referred to tertiary power rating**		**Vector Group**
Primary	**Secondary**	**Tertiary**		**160**	**80**	**40**	**20**	**10**	**5**	**2.5**	**1.25**	**Nom @ tap 5**	**Min @ tap 17**	**Nom @ tap 5**	**Min @ tap 17**	
88	11		STD			X	X					11	10			YNd1
88	11		STD					X	X			10	9			YNd1
88	6,6		STD				X					11	10			YNd1
88	6,6		STD					X	X			10	9			YNd1
66	22		STD			X	X					11	10			YNd1
66	22		STD					X	X			10	9			YNd1
66	11		STD				X					11	10			YNd1
66	11		STD					X	X	X		10	9			YNd1
66	6,6		STD				X					11	10			YNd1
66	6,6		STD					X	X			10	9			YNd1
44	22		STD				X					11	10			YNd1
44	22		STD					X	X			10	9			YNd1
44	11		STD				X					11	10			YNd1
44	11		STD					X	X	X		10	9			YNd1
44	6,6		STD					X	X	X		10	9			YNd1
33	22		STD					X	X	X	X	6	5			YNyn0
33	11		STD				X	X	X	X	X	6	5			YNyn0
33	6.6		STD					X	X	X	X	6	5			YNyn0
22	11		STD				X	X	X	X	X	6	5			YNyn0
22	6.6		STD					X	X	X	X	6	5			YNyn0

Table 2: Standard MVA and impedances for Class 2 and above transformers used in the transmission voltage level applications

	Nominal Voltage (kV)			**Ratings Main/Tertiary (MVA/MVA)**							
Standard Number	**HV**	**MV**	**Tertiary /LV**	**1**	**2**	**3**	**Impedance (%)**			**Tolerance, on nominal tap**	**Vector Group in a bank**
							Extr +	**nom**	**Extr -**		
A9	765	400	33	2000/3[2]	1000/3[2&3]	-	13.9	14	14.4	± 7.5 %	YNa0d1
A8	400	275	22	1000/3[2]	-	-	12.25		10.25	± 7.5 %	YNa0d1
A7	400	275	22	800/2	400/2	-	12.25		10.25	± 7.5 %	YNa0d1
A6	400	220	22	630/2	315/2	160/2	12		12.2	± 7.5 %	YNa0d1
A5	400	132	22	500/2	250/2	125/2	13.5		15.5	± 7.5 %	YNa0d1
D6	400	88	22	315/2	160/2	80/2	13.5		17	± 7.5 %	YNyn0d1
A4	275	132	22	500/2	250/2	125/2	11.6	11.4	12.6	± 7.5 %	YNa0d1
A3	275	88	22	315/2	160/2	80/2	12.5	13	15.4	± 7.5 %	YNa0d1
A2	220	132	22	500/2	250/2	125/2	10.3	10.5	11.7	± 7.5 %	YNa0d1
A1	220	66	22	160/2	80/2	40/2	10.6	11.2	13.3	± 7.5 %	YNa0d1
D5	400		50	60	40	-	13.7	13.47	13.3	± 7.5 %	YNd1
D4	400		30	250	-	-	15			± 7.5 %	YNyn
D3	400		15	45	-	-	12.3		11.9	± 7.5 %	YNd1
D2	275		50	60	40	-	13.7	13.47	13.3	± 7.5 %	YNd1
D1	275		22 or 11	65 [4]	40	-	12.3	12.5	12.2	± 7.5 %	YNd1

[2] The units are banks of single phase transformers

[3] Based on the sizes already requested by the customer

[4] SVC transformer 275/11kV

For Generator Step-Up transformers, unit transformers, and service transformers the sizes vary from power station to power station and will be indicated in the relevant schedules AB

3.4.8 Ability to Withstanding Short Circuit

The ability of a transformer to withstand short circuit forces shall form part of the discussion of the design review meeting.

3.4.8.1 General Requirements

For network transformers, and notwithstanding the over current limits tabulated in IEC 60076-5, the transformer with the standard minimum percentage impedances given in tables 1 and 2 of this specification, shall be capable of withstanding the thermal, mechanical and other effects using the following criteria for calculating the short circuit withstand condition:

a) Pre-fault voltage of $1.1U_n$;

b) Source impedance shall be assumed to be infinite bus;

c) Fault duration of 2s

d) The inner winding shall be designed to withstand the free buckling criteria. However, the specific stress ($\sigma_{average}$) of the inner winding shall not exceed 50% of the copper conductor yield strength. For conductors with a radial thickness of 5mm and below, the stress shall not exceed 30% of the copper conductor yield strength. Whenever a reasonable application of Epoxy Bonded CTC is possible, this would be the preferred solution. The conductor yield strength that shall provide safety margins of more than 50% (i.e. > 1.5pu) of the corresponding stresses. See also 3.6.7.

e) All material used for the radial build up of the insulation system between windings shall be pre-dried and pre-impregnated with oil prior to use.

f) The blocks located above the clamping rings, which are used to apply the axial compression shall be pinned to the clamping ring/system. All other axial pressure transition elements shall be fixed (which can be by gluing or pinning) to positions

The manufacturer shall submit with its tender a complete listing of similar transformers that have been short circuit tested and manufactured by the facility where the tendered transformers will be manufactured, the list to include the outcome of the short circuit test, the facility where tested and the date of the test. The *Contractor* shall also include a typical test certificate for a unit similar to the unit to be purchased. Upon request a complete description of the transformer characteristics shall be provided. Calculations for short circuit withstand capability shall be submitted with the tender. All the internal current limiting reactors shall be able to withstand the magnitude of the short circuit currents without damage; this must be verified by short circuit testing and calculation.

3.4.8.2 Heavy Duty (Arc Furnace) Type Transformers

If so specified in schedule 'A', the transformer windings and leads shall be mechanically braced accordingly to the manufacturer's specifications in order to cater for all additional loadings. The specific requirements and provisions shall be evaluated during the transformer design review.

3.4.9 Clearances in Air

When assembled with the connections as in service, electrical clearances in air shall be adequate to withstand the assigned impulse withstand test voltages and TOVs at the prescribed altitude. This is to be demonstrated by impulse voltage type tests specified in Schedule AB, during the performance of which all relevant fittings are in position as for service conditions. Care is to be taken to ensure that fittings are located such that there is no interference with the external connection to the bushing terminals, and the clearances to such connections are not less than the appropriate minimum phase-to-earth clearance given in IEC 60076-3.

For class 1 transformers, care shall be taken to ensure that fittings are located so as not to interfere with the external connection to the bushing terminals, and the clearances to such connections shall not be less than the appropriate minimum phase-to-earth clearance given in column 2 of Table 3. The lines of approach of these connections may lie anywhere within the limits indicated in Figure 2, and the required phase-to-earth clearance shall apply at all points along these lines, as shown at the points marked 'L'. In addition, the minimum vertical working clearances from floor level to live metal shall be as listed in column 3 of Table 3

For other transformers not listed above, this shall be specified in schedules AB and be clarified during the mechanical design review meeting.

The voltage rating for the insulation external to the transformer should be assumed to be the same as the insulation ratings internal to the transformer.

Table 3: Electrical clearances in air

System highest voltage Um (kV)	Minimum phase-to-earth clearance 'L' (mm)	Minimum vertical working clearance from ground level to live metal (see note 1) (mm)	'X'-Dimension (2,5 x L) (*Min 3 000 mm) (mm)	'Y'-Dimension (L + 3000) (mm)
3,6	80	2 580	3 000	3 080
7,2	150	2 650	3 000	3 150
12	200	2 700	3 000	3 200
17,5	230	2 730	3 000	3 230
24	320	2 820	3000	3 320
36	430	2 930	3 000	3 430
48	540	3 040	3 000	3 540
72	770	3 270	3000	3 770
100	840	3 340	3 000	3 840
145	1 200	3 700	3 000	4 200
NOTES:				
1) The minimum distance from the transformer base or ground level to the flange base of a bushing (or surge arrester) shall be 2 500 mm.				

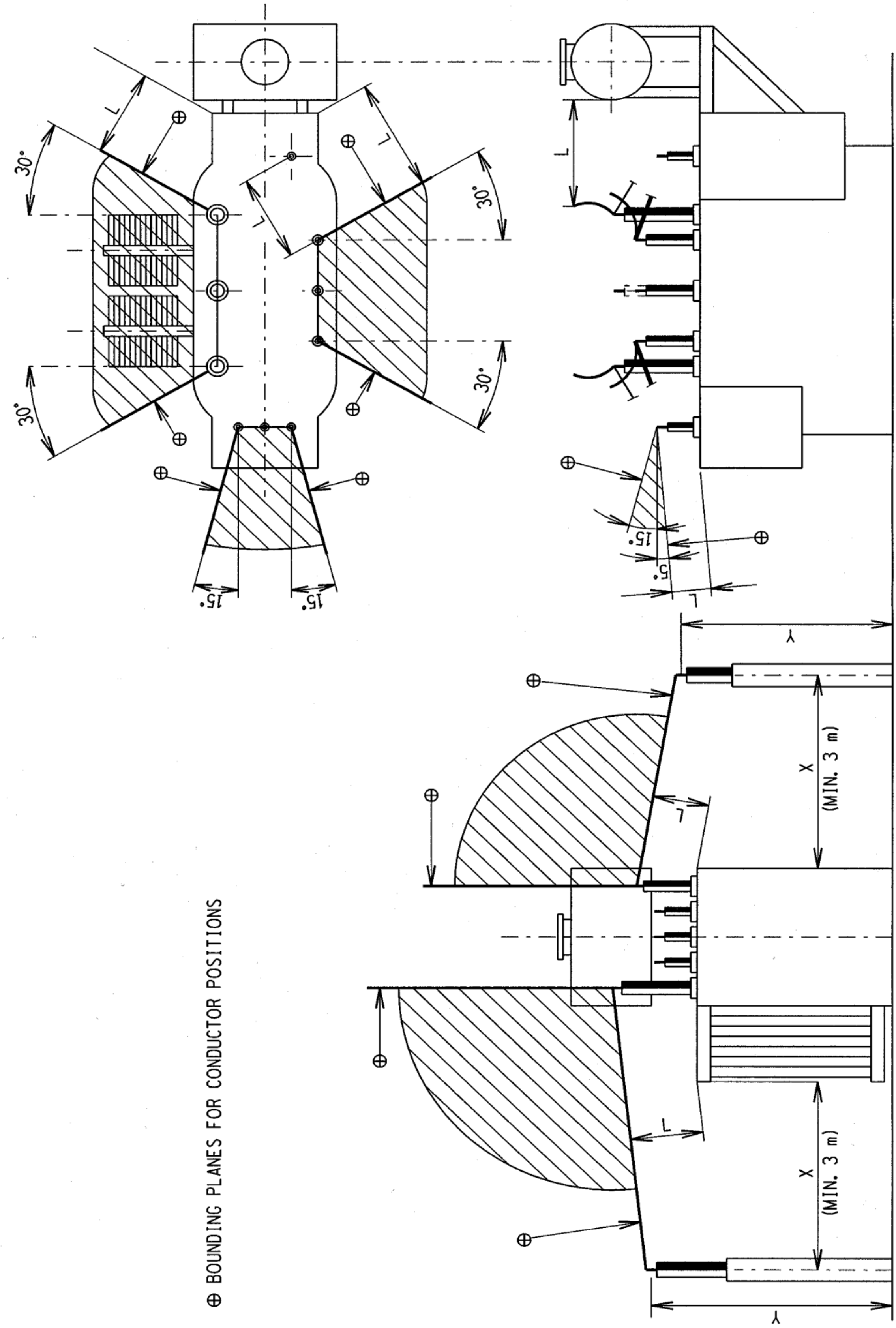


Figure 2: External connections, clearances from lines of approach

3.5 Core

3.5.1 Design

For the 3 phase power transformers the 3-limb core designs are the requirement for GIC control. In the cases where this is not possible, it shall first be agreed to by the *Employer***,** and the *Contractor* shall demonstrate that the return limbs have been optimized for GIC purposes.

For rated voltage and rated frequency, the maximum core flux density in the limbs and in the yokes shall not exceed 1.75 at nominal tap. For transformers used in the compensator circuits e.g. STATCOMs and SVCs, care should be taken that the flux density does not exceed the above value at nominal voltage and taking into consideration the fully capacitive mode of operation.

The maximum temperature rise of the core surface in contact with oil and cellulose insulation above the average ambient temperature of 25°C should not exceed 80K for all possible rated in service conditions. The core surface temperature must be limited to the temperature capability of the material in contact with the core using average ambient specified. The material used in core cooling ducts, and between the core and frames, and between the core and the tie plates shall have a continuous temperature rating of 150°C minimum.

3.5.2 Materials

The core shall be manufactured of high permeability; non-ageing cold rolled grain oriented steel sheet laminations having smooth, insulated surfaces. The maximum allowable size of burrs on the slit or cut edge of the electromagnetic steel shall not be capable of causing damage to the insulation between sheets. For all transformers core shall be of mitred construction. The core sheets shall be properly stacked in the step-lap configuration and all the insulation designed in a way that no detrimental changes in physical or electrical properties will occur during the lifetime. All materials shall be brand new and presented in quality and condition that reflect such.

3.5.3 Clamping

For the core clamping, no bolts through the limbs and yokes shall be used. The limbs should be fastened with non-metallic bands/belts. Non continuous steel straps or rods used around the yokes must be insulated from the yokes to prevent short circuits to the core and circulating currents. The pressure of the yokes shall be adequate to prevent movement of the lamination during shipping accelerations. All the return limbs shall be vanished to improve the mechanical stability during shipment/ transportation.

3.5.4 Stack-stack Resistance

The resistance between the core stacks shall be such that no dangerous or detrimental voltages arise. The control of the stack to stack resistance shall be done using engineering techniques where quality control is measurable and adjusting is possible. Scratching of the core laminations to reduce the inter-stack resistance is not allowed.

3.5.5 Earthing

The main magnetic core shall be directly grounded via a bushing on top of the cover with a removable external ground connection. The core shall be bonded to the core clamping structure at one point only, which is easily accessible, and protected to allow testing after installation of the transformer.

No core earthing connection shall have a cross-sectional area smaller than 80 mm², with the exception of the connections inserted between laminations which may be reduced to a cross-sectional area of 20 mm², where they are clamped between the laminations.

The core earth grounding point shall be clearly marked with a permanent label. The factory core insulation resistance value(s) shall be permanently marked at the core earth grounding point together with **"CORE EARTH MUST ALWAYS BE CONNECTED WHEN EQUIPMENT IS ENERGISED"** and indicating the terminal identification.

3.5.6 Temperature Rise

Hotspot rise above ambient of metal parts in contact with oil shall not exceed 80K under the most extreme operating circumstance. Also, the most onerous temperature of any part of the core and its supporting structure in contact with insulation or other thermally non-conducting material should not exceed the safe operating temperature of that material. Adequate safety margins should be included when determining these criteria.

3.5.7 Electrical Continuity

Where the core laminations are divided into sections by insulating barriers or cooling ducts parallel to the plane of the laminations, tinned copper bridging strips shall be inserted to maintain electrical continuity between sections.

3.6 Coils/Windings

3.6.1 Design

Core form windings shall be of circular concentric type. All the conductor joints within the winding must be minimized and are only permissible at locations on the outer surface of windings. Multiple strand joints shall only be applied in areas of low stray flux density. Shell form windings are not preferred and can only be considered in special circumstances and when approved by Eskom in writing.

3.6.2 Materials

All windings shall be constructed with copper conductors only. Continuously Transposed Conductors (CTC) shall be free from inter-strand shorts after the winding has been completed. For all the transformers of class 2 and above the windings shall be vanished/enamelled conductor to prevent corrosive sulphur effects between the insulation and the conductor. Where the varnish is removed to make joints in the conductor, special arrangements must be made to ensure no corrosive sulphur damage can take place. The shear or tear strength of the bond and base of enamel/ epoxy shall not be less than 40% of the room temperature strength when heated to 125°C after curing. This requirement excludes the tertiary windings of the auto transformers made from non-CTC conductors, and there non-enamelled conductor can be used.

3.6.3 Hot Spot Calculations

The calculated hot spot shall be based on the maximum calculated localized losses in the windings, the insulation on the points with maximum losses, and the oil rise in the windings. If the designer is not able to determine the oil rise in the windings, an added 5K will be made at the design review to allow for the difference between the oil rise in the windings and bulk top oil in the tank.

The maximum hot spot in the leads shall not be more than 1K above the maximum calculated hot spot in the windings.

Winding hot spot shall be measured directly during a heat run test at the factory before release.

3.6.4 Insulation

When determining the equivalent power frequency for impulse voltages i.e. Design Insulation Level (DIL) for analysis of insulation stresses, the ratio of full wave impulse voltage to the power frequency is desirably 2.5, however, the Employer considers values and ranges indicated in Table 4 below as reasonable. The minimum acceptable margin in oil spaces shall be 20% based on the Weidemann® oil strength data for gas saturated oil. For the purpose of controlling the oscillations in the windings, especially the regulating windings, the use of adequate metal oxide surge arrestors is acceptable. Such a design must ensure that the surge arrestors are clamped using a spring loaded mechanism to ensure that they remain intact for the expected life. For the Extra High Voltage (EHV) and Ultra High Voltage Units (UHV) units, it must be taken into consideration that switching surges can reach to about 3.0 pu.

Table 4: Conversion factors for insulation stresses analysis

Type of waveform	Conversion factor
Lightning impulse	2.5 – 2.9
Switching Impulse	1.8 – 2.1
Power frequency	1.633Um
AC Long duration	1.22Utest

All conductor insulation shall be thermally upgraded paper, except when it is otherwise stated.

The expected life of the paper insulation is 35 to 40 years and the processes implemented in the factory during the manufacturing of the transformer shall not reduce the paper life to less than 950 DP value. The *Contractor* shall demonstrate this for each transformer using a direct DP measurement method. The test must be done using an adequate paper sample. The *Employer* may from time to time request a physical paper sample for verification purposes by an independent or internal laboratory. This must be catered for during the production activities. DP values below the indicated value will entitle the *Employer* to a compensation event.

3.6.5 Joints and Internal Connections

Copper conductor shall be used throughout, for the windings and for the leads.

There shall be no soldered joints or terminals in the transformer. All internal lead connections shall be brazed, welded, or compression type. If compression type is used, then the method employed must be approved by the *Purchaser*.

No joints are permitted internal to the windings unless it involves a single strand of a multiple strand (5 or more strands) conductor. Joints shall be permitted at crossovers and leads external to the windings. The manufacturer shall have an established quality assurance program to detect, prevent and repair nicks, dents, burrs and other imperfections in the conductor material. The manufacturer shall have an established quality assurance program to ensure that all joints comply with the requirements.

All internal connections shall be designed so that bushings can be removed or installed without exposing the paper/ winding block. Inspection covers must be available to enable verification of tightness of connections. Where there are joints in adjacent leads they may not overlap but must be staggered. All leads must be securely supported and braced.

Table 5 — Minimum insulation, fault and creepage levels for Class 1 power transformers – These should match IEC requirements

System highest voltage U_m (kV_{rms})	System nominal voltage U_n (kV_{rms})	System fault level (kA)	Lightning/switching impulse voltage withstand level at sea level (BIL) / (SIL) (kV peak)		60 s power frequency voltage withstand level at sea level (60s 50Hz)		Bushings					Tap changer		
							Line		Neutral					
			Line Terminal	Neutral Terminal	Separate source	Induced	BIL (kV peak)	60s 50Hz (kV_{rms})	BIL (kV peak)	60s 50Hz (kV_{rms})	Creepage (31mm/kV)	System nominal voltage (U_n) (kV_{rms})	BIL (kV peak)	60s 50Hz (kV_{rms})
3.6	3.3	20	40	40	10	6,6	200	70	200	70	110	3.3	45	16
7.2	6.6	25	75	75	20	13,2	200	70	200	70	220	6.6	75	22
12.0	11	25	95	95	28	22	200	70	200	70	375	11	95	28
17.5	16	20	125	110	38	32	200	70	200	70	540	16	110	38
24	22	20	150	150	50	44	200	70	200	70	740	22	150	50
36	33	20	200	200	70	66						33	200	70
48	44	20	250	200x	70x	95						33	200	70
72	66	20	350	250x	95x	140						44	250	95
100	88	25	450	250x	95x	150	**See 240-56062799 for full requirements**					44	250	95
145	132	40	550	250x	95x	230						44	250	95
145	132	40	550			230	NOTE 1: Phase-to-phase values specified in this table for all transformer windings shall be designed to withstand the appropriate test voltages, and shall be tested as specified in IEC 60076.					16	110	38
245	220	65	1050 /840			460						To be discussed during design review meeting and to meet IEC requirements		
300	275	65	1050 /840	110+	38+	460								
420	400	65	1425 /1050			630	NOTE 2: 145kV values specified in the last table are for Auto Transformers only.							
800	765	50	1950 /1425			900								

Non uniform insulation + Fully graded insulation

x Partially graded insulation

Surge protection of non earthed HV neutral of YNd1-connected transformers

The neutral ends of the HV windings of all YNd1-connected transformers with partially graded HV winding insulation (132 kV, 88 kV, 66 kV and 44 kV HV windings) shall have surge arrester protection in cases where their neutral terminals are not earthed (see note below).

Arrester rating

This following information shall appear on the rating and diagram plate and shall bear the following cautionary instruction:

"HV winding insulation partially graded. HV neutral shall be solidly earthed or protected by a .... kV r.m.s. continuously rated (MCOV) metal oxide surge arrester with a .... kV peak residual voltage (10 kA)".

The continuous voltage rating and residual voltage (10 kA) of the required surge arrester shall be inserted as follows:

a) For a 66 kV, 88 kV and 132 kV partially graded insulation transformer the values shall be a minimum of 48 kV r.m.s. and shall not exceed 165 kV peak, respectively.

b) For a 44 kV partially graded transformer the values shall be a minimum of 36 kV r.m.s. and shall not exceed 125 kV peak, respectively.

NOTE: This reduction in insulation has been adopted in order to effect a worthwhile saving in the cost of these transformers, whose neutrals would generally be earthed but may occasionally be unearthed.

The insulation levels chosen are adequate to meet the voltages impressed on the neutrals of these transformers during the works tests, but may be inadequate to ensure the safety of these windings in the case of transformers whose neutrals are unearthed in service, e.g. In the case of simultaneous voltage surges entering the star windings from two or more HV line terminals. For this reason provision is made for surge arrester protection.

3.7 Transformer Construction and Assembling

3.7.1 Winding Arrangement

The transformer winding arrangement shall be indicated in the schedules AB issued with the enquiry and it shall take precedence to the arrangements indicated below. The preferred winding arrangements are as in Table below

Table 6: Winding Arrangement configurations

Transformer Class	**Winding Arrangement**
Two-winding transformers	Core/LV/HV/RW
Three-winding transformers	Core/TW/CW/RW/SW

3.7.2 Sizing and Compressing

Each winding shall be compacted with a minimum pressure of 7.5N/ mm² on the spacers, for helical and disc windings. It is expected that the windings will be dried under constant pressure. All windings shall be sized using a maximum tolerance of -0 + 2mm. The sizing pressure after final vapour phase drying shall not be less than 5N/ mm² on the transformer board spacers.

The manufacturer will be responsible for proposing methods for checking the pressure on the windings after the assembly is completed to ensure that it is not less than 5N/mm^2 on all spacers.

The *Contractor* shall fully demonstrate the adequate clamping of the windings as required at all stages of manufacturing. The clamping pressure shall be sufficient even for the maximum forces assumed occurring during the coldest conditions of the unit.

3.7.3 Terminal Arrangement

The interchangeability of transformers requires that main terminals are arranged in a standard layout.

All terminal groups shall be arranged so that when viewed in the direction of power flow, the neutral terminal appears on the left, followed by the line terminals in alphabetical order, as shown in the illustration below. The power shall always be assumed to flow from the winding having the highest voltage rating towards all other windings.

LV winding terminals shall appear on the right-hand end of the transformer when viewed from the HV side. In the case of delta-connected stabilising windings, the "T" - terminal shall occupy the indicated position. For Generator step up transformers, this shall be indicated in the schedules AB and be discussed during the design review meeting.

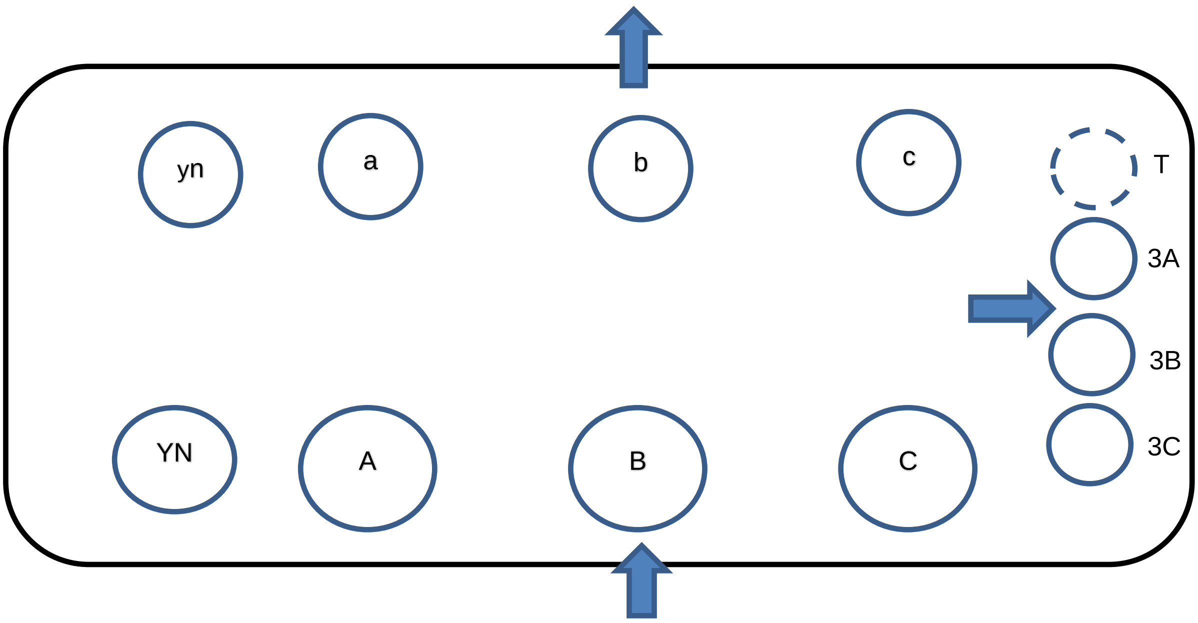


Figure 3: Illustration of terminal positioning

3.7.4 Termination on bushings

Winding termination interfaces with bushings shall be designed to allow for repeatable and safe connection under site conditions without jeopardizing the in-service integrity of the transformer.

The winding-end termination, insulation system and transport fixings shall be so designed that the integrity of the insulation system is not easily compromised during repeated work in this area.

Allowances shall be made for accommodating up to 100 mm tolerance on bushing axial dimensions and the fact that bushings may have to be rotated to get oil level inspection gauges to face in a direction that allow easy inspection from ground level. In particular, rotation or straining of insulated connections shall be avoided during the fastening of conductor pads from the winding onto the termination surfaces of the bushing.

Suitable inspection and access facilities into the tank shall be provided to minimize the possibility of creating faults during the installation of bushings.

3.7.5 Clamping

The *Contractor* shall fully demonstrate that adequate clamping of the windings as required at all stages of manufacturing is controlled.

3.7.6 Drying

The *Contractor* shall fully demonstrate that adequate drying and moisture ingress into the winding as required in all stages of manufacturing is controlled.

3.8 Bushings

The bushings used shall be of technology that provides safe operation of the transformer, maintenance free or at most minimum maintenance, environmentally friendly, and as far practically possible does not add fire risk. Only the dry technology of bushings is acceptable except in exceptional cases which shall be agreed with Eskom during a tender stage and shall be indicated in Schedules AB. One such case is when such a technology does not exist at all or is not mature enough in the category of the required bushings. The outer body shall be made with composite insulator in grey colour.

The bushings shall comply with the requirements of the bushings specification 240-56062799 and as stipulated in schedules AB of a given purchase order. For units going to long-term storage (spares) the bushings shall be sealed on the oil side as a preparation for such a storage.

3.9 Tap Changers

3.9.1 Type of tap changers

Tap changers can be specified as both On-Load Tap Changers (OLTC) and Off-Circuit Tapping Switches (OCTS). The required tap changer shall be indicated in the relevant schedules AB.

3.9.2 On Load Tap Changers

On load tap changing equipment shall be designed and constructed in accordance with the latest revision of IEC 600214. The OLTC should be of the resistance bridging type. The tap changer supplied must present no risk to the transformer during any operating condition, albeit on load or on no-load, both oil type and vacuum type will be considered. The offered solution is desired to provide 300 000 intrusive maintenance free operations All tap changers must have undergone adequate testing to demonstrate their capability to perform under expected operational and loading conditions as per IEC. Eskom, in its discretion and based on the experience, may require additional testing to the ones specified in IEC 600214.

3.9.3 Off Circuit Tapping Switches

When specified, the transformer shall be provided with a ganged off-circuit tapping switch, operated by an external handle situated in an unobstructed position, not more than 1,5 m above ground level.

The contacts shall be positively self-locating in each tapping position without constraint from the operating mechanism, which shall provide for padlocking in each position.

The tapping positions shall be indelibly marked to correspond with the data given on the rating-and-diagram plate and these markings shall be legible by a person standing at ground level.

Off circuit tap switches shall be fitted with direct or gear driven operating mechanisms.

3.9.4 Tapping Range

The tapping range is specified taking into consideration the requirements of standardizing and interchange-ability. The required tapping range shall be specified in Schedules AB of the ordering specification. For transmission and distribution class transformers, the regulation is normally selected as:

All on-load regulated transformers have on-load taps from +5% to -15% of the HV terminal voltage in 16 equal steps of 1,25% each. This excludes the transformers with the HV of 400kV and above, for these transformers no plus (+) range is required and only -15% is required.

When an off-circuit tap switch is specified, the range shall be +5% to –5% of the HV terminal voltage in 4 steps of 2,5% each.

For each transformer enquiry, the requirements shall be indicated in schedules AB

3.9.5 Electrical Location (Positioning) of the Tap Changer

For double-wound transformers (Y-connected and Primary assumed to be the HV winding) the tap changer shall be positioned on the neutral side of the primary winding.

Tap-changers shall be installed in the H.V. series winding (MV potential) at the line end of common winding (auto transformers only).

3.9.6 Ratings

3.9.6.1 Current Rating

The rated through current of the tap changer, as defined in of IEC 60214, shall not be less than that resulting from the highest value of continuous maximum load in the tapping winding of the transformer (It shall be able to operate at the emergency and overload ratings of the transformer without harm.

It is permissible that tap changing be inhibited during transformer overload conditions above 1,5 p.u.

3.9.6.2 Short Circuit Currents

In addition to the requirements of 8.3 of IEC 60214 for on-load tap changers, tap changing equipment shall be capable of carrying the same currents, due to external short-circuit, as the transformer windings with which they are associated.

3.9.6.3 Insulation Level Requirements

Notwithstanding the requirements of 8.6 and table V of IEC 60214, on-load tap changing equipment, including all insulating and barrier boards, shall withstand the impulse and dielectric test voltages applicable to the part of the transformer windings with which they are associated, as specified in schedule A & B of this Specification.

If any specific critical phase to phase insulation situations exist in the transformer it should be noted that the Employer's surge arresters will only limit incoming surges on a phase to ground basis and that phase to phase insulation will therefore be protected by two arresters in series. This particularly applies to three-phase line end tap changers and their leads, as well as the leads of single-phase tap changers. The Contractor must design for this situation.

3.9.7 Design Requirements

The voltage class of tap changers located at the line end terminals shall be a minimum of one voltage class higher than the class of the terminal.

The rated current shall comply with the requirements of IEC 60076-7 loading guide. The tap changer should not limit the overload design of the transformer.

The OLTC voltage ratings shall be specified in the schedule B of the ordering specification. The voltage withstand capability of the OLTC has to be selected by the transformer manufacturer.

3.9.8 Other Tap Changer Requirements

3.9.8.1 Replacement of current switching contacts

The current breaking contacts of diverter switches shall be easily replaceable.

3.9.8.2 Diverter and selector switch compartments

Drop-down tanks that necessitate the provision of pits in the foundations are unacceptable.

Each diverter and selector switch compartment shall be provided with an oil drain valve or plug.

Care shall be taken to close the drain valve or plug of the diverter compartment before operating the tap-changers on load in the factory or after installation. Failure to do so will require full reprocessing of the oil in the transformer at the Contractor's cost.

Current breaking switches (e.g. diverter and selector switches as distinct from tap selectors and change-over selectors) shall not operate in the insulating oil of the main transformer.

The insulating oil for these switches shall be completely segregated in a oil and gas-tight compartment separate from that in the main transformer tank and the oil conservator for maintaining the oil level in the compartments containing such switches, shall be separated from the main transformer oil conservator. Where a common conservator tank construction is employed to serve both the main tank and the tap-changer switching compartment, the two bodies of oil shall be segregated by an oil and gas tight steel partition. Each body shall have its own separate dehydrating breather and oil level indicator, that shall be clearly labelled to relate it to the corresponding oil body. A protection for the loss of oil in the tap changer compartment of the conservator shall be provided.

3.9.8.3 Protective devices for diverter and selector switch compartments

Protective functions provided for the diverter switch and selector switch compartments shall effect the tripping of the circuit-breakers controlling the transformer in the case of:

low oil level (may be omitted if a surge relay, that fulfills this function, is provided).

a surge of oil produced by a fault inside the compartment, or a rise in pressure or temperature resulting from such a fault, whichever one of these three is most appropriate to the design of the apparatus.

Where a pressure sensitive device is provided, the associated contacts shall close under a steady increase of pressure. The operating pressure level shall not be less than 100 kPa or as recommended by the manufacturer, taking the static head of oil into consideration.

3.9.8.4 The Breather

The oil in the diverter switch and selector compartments shall only communicate with the atmosphere through a dehydrating breather containing a silica gel charge of at least 1 kg. The breather shall comply with the requirements of the breather specification 240-56063886. Self dehydrating breathers are acceptable.

3.9.8.5 Buchholz relay/Surge Protection for selector compartment

Where tap selectors and change-over selectors are contained in compartments separate from current breaking switches, those compartments shall be protected by the Buchholz relay serving the main transformer tank, unless separate oil surge and low-oil level relays are provided. Provisions shall be made for filtering and draining the oil in those compartments.

3.9.8.6 Alarm and tripping contacts for protective devices

These contacts shall comply with the requirements of 3.9.10.2.

The requirements are that for all trip and alarm information to be duplicated (2 x potential free contacts per function). E.g. Buchholz Trip, Buchholz Alarm, Winding Temp Trip, Winding Temp Alarm, Pressure Relief Trip, Rapid Pressure Relief Trip, etc.

3.9.8.7 Strength of tap-changer compartments and insulating barriers

Tap-changer compartments and insulating barriers shall have adequate strength to resist, without suffering permanent distortion or damage of any sort, from the forces resulting from the application of a full internal vacuum at sea level.

In the case of insulating barriers, the vacuum is unequalized (i.e. applied from one side only, against atmospheric and oil pressure on the other side), and applied internally from either side, with the following provisions:

a) in the case of tap-changers energized at voltages below 88 kV, the vacuum requirement applicable to the tap-changer compartment will be limited to that which produces a pressure differential between the tap-changer compartment and the atmosphere of not more than 65 kPa; and

b) where such insulating barriers serve tap-changers mounted wholly within the transformer tank, (e.g. diverter switch cylinder) the application of the vacuum or pressure may be equalized on both sides of a diverter switch compartment by interconnecting the two conservators.

3.9.8.8 Sealing of tap-changer parts for transport

Where it is necessary to remove parts or the whole of the on-load tap changer for transport purposes, it shall be possible, unless otherwise approved, to complete erection on site with the transformer windings and terminal insulation covered with oil.

3.9.9 Driving mechanism, control and indicating equipment

3.9.9.1 Enclosures of apparatus

The driving mechanism shall be enclosed in a ventilated, dust-proof, weather-proof and vermin-proof cubicle provided with an adequate 50Hz supply, separately fused, anti-condensation heater and switch (with a solid withdrawable link in its neutral lead), and, at its lowest point, with a 25 mm diameter gauze covered drain hole. The internal surface corrosion proofing and finishing shall comply with 240-56030674 Corrosion Protection of new and in-service power & station auxiliary transformers.

Where a gland plate for cables is provided, ample space shall be allowed from the terminal strip for arranging the entry of the cable cores (see also 3.10)

Note: Unless specified to the contrary, the automatic and remote control panels and equipment for the on-load tap-changer (those to be installed in the Eskom control room only) will be supplied and installed by the *Purchaser*.

3.9.9.2 Design of driving mechanism: synchronism and limit stops

The driving mechanism shall be so designed that once a tap-changing operation has been initiated, the diverter switch or selector switch contacts will not remain in an intermediate position should the power supply for the driving unit fail.

The design shall include means to ensure that tap-changers fitted to three single-phase units, or units operating in parallel, remain in step. Mechanical stops shall be provided to prevent the mechanism from overrunning its end position.

3.9.9.3 Manual operation

For maintenance and emergency operation of the tap-changing equipment, a readily detachable handle shall be provided for manual operation. Adequate provision shall be made to prevent the diverter switch or selector switch contacts being left in an intermediate position when operated manually.

To prevent power operation with the handle in position, a normally closed contact in the control or motor circuits shall be provided that opens when the handle is inserted.

The tap-changer controller shall be accessible from ground level (± 1,2 m from base plate), i.e. all operating inspection points shall not be positioned higher than 1.8 meters from base as to ensure that the operator does not have to leave ground level.

All risks or special requirements related to this operation shall be clearly indicated in the manual and on the physical box such that they catch the attention of the reader or operator.

3.9.9.4 Electrical operation

The following are the minimum requirements which shall be mounted in the driving mechanism enclosure or other suitable kiosk, mounted near the transformer (see also Figure 4).

Control relays shall only respond to control initiation pulses of 150 ms duration or longer.

The rating of control relay contacts shall be in accordance with 3.9.10.2.

All contactor operating coils and trip coils shall be rated at dual voltage of 220V d.c. and 110 V d.c, unless otherwise specified.

a) Tap-changer drive motor

See motor “a” on **Figure 4.**

A tap-changer drive motor rated at:. 400 V a.c, three-phase, 50 Hz shall be fitted.

b) Tap-in-progress indication

A terminal shall be provided for the neutral of the 400V a.c supply and one terminal of the motor shall be connected to an external terminal for a "tap-in-progress" lamp. (Refer to **Figure** 4)

Or alternatively, a "tap-in-progress" indication contact similar to contact 'A' of 0, shall be provided.

c) Circuit-breaker for motor protection

See "b" on Figure 4.

1) For a three-phase drive motor, a circuit-breaker fitted with three-phase thermal overload protection and single-phasing protection and a separate d.c. shunt trip coil shall be provided. The trip coil shall be provided with a contact to break its own current if the coil rating exceeds 50 W. The trip coil rating in watts shall be stated on the OLTC drive schematic diagram.

2) Where "raise" and "lower" contactors are fitted, both the circuit-breaker and the d.c. shunt trip coil shall be provided.

d) Protection of tap-changer during system faults

A self-resetting contactor shall be provided in the motor circuit for overcurrent blocking of the tap-changer drive under system fault conditions. The contactor shall be fitted with a d.c. operating coil, and normally closed contacts capable of interrupting motor starting currents. Contactors with normally open contacts that require the coil to be continuously energized are not acceptable.

e) Local control

"Raise" and "Lower" push-buttons or a control switch for the local control, mechanically or electrically interlocked, shall be provided (see "d" on Figure 4).

As shown in Figure 4, these raise/lower control devices shall be connected to separate terminals for use in the *Purchaser*’s control scheme. They shall not be connected for direct control of the OLTC drive.

f) "Raise and Lower" motor-operating contactors

Direct-current operated "Raise" and "Lower" contactors for controlling motor direction shall be provided (see "e" on Figure 4.

g) Completion of tap-change operations

Auxiliary contacts shall be provided for sealing "Raise" and "Lower" contactors and mechanism contact "A" for controlling the sealing of the "Raise" and "Lower" contactors (see "f" and "g" in Figure 4) (see d)).

h) Step-by-step and parallel operation

See "h" and "i" on (Figure 4). The manufacturer shall provide and install all the appropriate equipment and circuitry inside the driving mechanism i.e. contacts, relay(s) etc. in order to perform within the mechanism box the full step-by-step function (see fig. 8 step-by-step typical circuit). For operation of step-by-step relay(s) and single or two contacts shall be provided. When single contact is used this must close in either “Raise” or “Lower” direction, when two contacts are used, one contact shall close only when the drive moves in the "Raise" direction and the other shall close only when the drive moves in the "Lower" direction.

These contacts may take the form of mechanism contacts or, alternatively, auxiliary contacts on the "Raise" and "Lower" contactors may be used.

In the latter case an additional mechanism contact, similar to 'A' in g) above shall be provided for the step-by-step circuit if the 'A'-contact is the normally open type, i.e. if the mechanism contact through which the "Raise" and "Lower" contactors are sealed is the type that is open in the rest position and closed during operation.

The essential features of the contacts provided for the step-by-step circuit are that they shall not operate the step-by-step relays before the "Raise" and "Lower" contactors have had time to seal themselves in, and that they shall remain closed throughout a tap-change operation, and, preferably, also throughout a transition step. If they do not remain closed throughout a transition step, then a spare mechanism contact shall be provided and wired to separate terminals.

i) Tap position indication, supervision and monitoring

Two spare sets of coded, voltage free contacts shall be provided (see Figure 5).

Tap position switch for use in parallel checking circuit. This switch may take the form of either a change-over switch that changes its position at the end of each tap-change operation or a multi-position rotary switch with as many contacts as there are taps on the transformer. These switches shall be of the break-before-make type. (see l on Figure 5).

j) Limit switches

See “n” on Figure 4

Limit switch contacts, to prevent the tap-changer from overrunning the end positions, shall be provided.

These contacts shall be provided where indicated in the initiating circuits and shall preferably be provided in the motor circuits as well if, in the case of single-phase motors, motor contactors are provided.

Note: The preceding clauses list the *Purchaser*’s minimum requirements, but if the *Contractor* wishes to add further relays (e.g. for step-by-step control), this is acceptable though not desirable.

k) Approval of components

All contactors, switches, circuit-breakers, relays and contacts incorporated in the electrical control of tap-changers, shall be subject to the *Purchaser*’s approval.

3.9.9.5 Mechanical tap position indicators

An externally visible mechanical tap position indicator shall be provided on the driving mechanism.

3.9.9.6 Diverter and selector switch compartments

Maximum and minimum tap position indicators arranged for manual resetting shall be fitted to the driving mechanism to register the operating range encountered in service.

3.9.9.7 Operation counters

Externally visible mechanical counters (e.g. cyclometers) shall be provided to register the number of tap-change operations. These recorders shall have at least six (6) digits, and shall have no provision for resetting. These counters shall be of suitable quality for at least 10^6 operations. This shall be supported by a type test certificate.

3.9.10 Drawings and technical data

a) Details on transformer outline drawings

The main features of tap-changers, including the fittings and protective devices specified, shall be indicated on the transformer outline drawings.

b) Schematic diagrams

Transformer on-load tap changer drive schematic diagrams showing the rating in watts of the d.c. shunt trip coils fitted to the driving motor circuit breakers, shall be supplied. The *Contractor* shall indicate on this diagram which of the requirements, detailed in 3.9.9.4 above, each device will fulfil.

c) Timing charts

A diagram or chart showing the relative timing of all contacts during both a regular tapping step and a transition step shall be provided.

3.9.10.1 Tap position numbering

For both off-circuit and on-load tapping arrangements the tap position shall be numbered so that an increase in tap position number represents an increase in the controlled, or outgoing voltage. Controlled secondary voltage is defined as the voltage that is changed as a result of the change in tappings. In the case of interconnection or coupling transformers involving power flow in both directions the controlled voltage will be specified in schedule A of an enquiry document

Note: Transition steps that give the same outgoing voltage should all take the same tap position number, distinguished in each instance by a lower case letter; e.g. 9(a), 9(b) and 9(c) where there are three transition steps.

3.9.10.2 Alarm, control and tripping contacts

Alarm and tripping contacts shall be provided with electrically independent and unearthed circuits and shall be insensitive to vibration and earth tremors. This insensitivity shall not depend on the method of mounting, but shall be an inherent feature of the contact assembly.

Auxiliary relays shall not be used.

a) Alarm and control contacts

Contacts providing alarm output shall be rated as follows:

Make and carry for 200 ms:	5 A @ d.c. 250 V
Carry continuously	2 A @ d.c. 250 V
Break (inductive L/R = 40 ms):	30 W or 0.2A @ d.c. 250 V

b) Tripping contacts

Contacts providing trip outputs shall be rated as follows:

1)	Make and carry for 200 ms	30 A @ d.c. 250 V
2)	Carry for 1s:	10 A @ d.c. 250 V
3)	Carry continuously:	5 A @ d.c. 250 V
4)	Break (Inductive L/R = 40 ms):	30 W or 0.2A @ d.c. 250 V

c) Tests

Devices fitted with alarm and tripping contacts shall be tested as specified in 3.17 and as per IEC 60076 applicable parts.

Standard on-load tap-changer control schemes: minimum requirements for driving mechanisms:

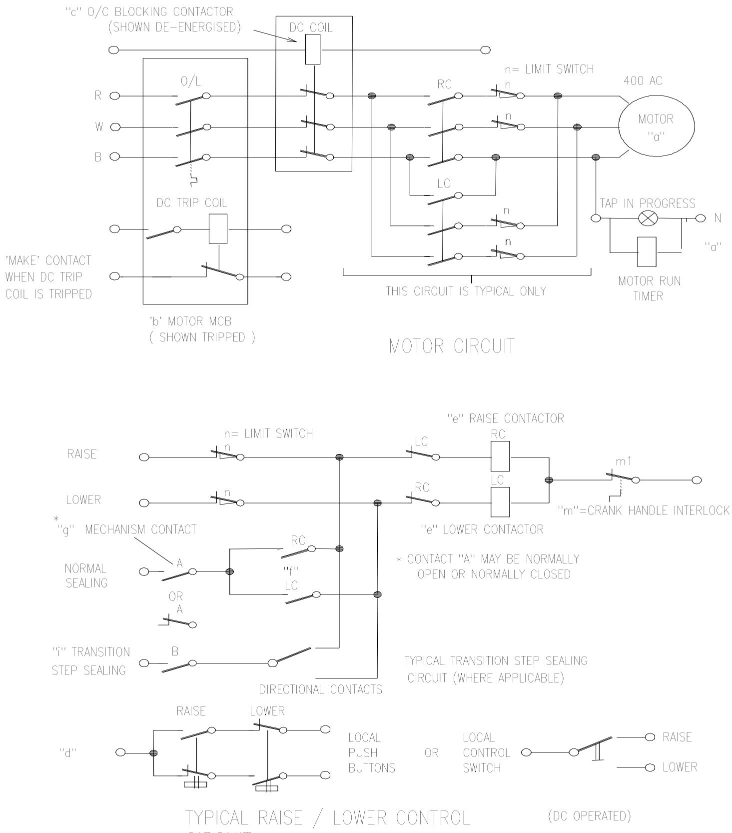


Figure 4: Control circuits for all three-phase OLTC motor drives

Notes to Figure 4

1) If the motor is continuously rated for the stalled condition, the thermal overload protection may be omitted.

2) Where 'raise' and 'lower' contactors are not provided and the motor current does not exceed 5A when starting or running, the separate d.c. shunt trip coil may be omitted.

3) In the case of single-phase motors continuously rated for the stalled condition and with a motor current not exceeding 5 A when starting or running, the circuit-breaker may be omitted entirely, provided no 'raise' or 'lower' contactors are fitted.

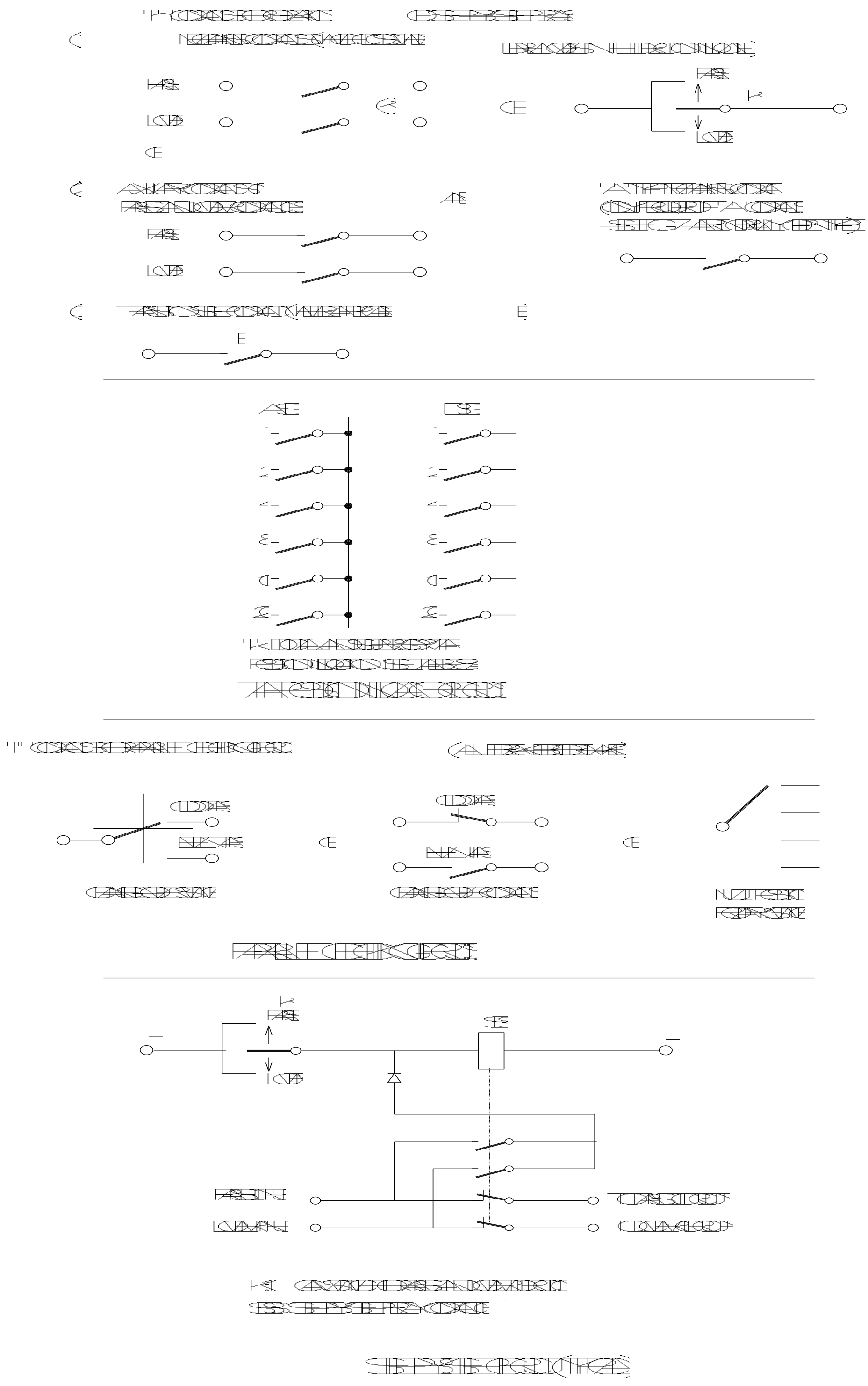


Figure 5: Common circuits for OLTC control

Table 7: Tap position encoder contact state at each tap position

Position	**20**	**10**	**8**	**4**	**2**	**1**
1	0	0	0	0	0	1
2	0	0	0	0	1	0
3	0	0	0	0	1	1
4	0	0	0	1	0	0
5	0	0	0	1	0	1
6	0	0	0	1	1	0
7	0	0	0	1	1	1
8	0	0	1	0	0	0
9	0	0	1	0	0	1
10	0	1	0	0	0	0
11	0	1	0	0	0	1
12	0	1	0	0	1	0
13	0	1	0	0	1	1
14	0	1	0	1	0	0
15	0	1	0	1	0	1
16	0	1	0	1	1	0
17	1	1	0	1	1	1
0 = contact open		1 = contact closed				

3.10 Tank and Parts

3.10.1 Tank Design

The shape of the transformer tank and fittings, including the underbase shall be such that no water can be retained at any point on their external surfaces. Furthermore the lid on the inside shall be shaped to ensure that all free gas generated inside the transformer escapes to the conservator by way of the gas and oil actuated relay.

The tank and cover shall be designed so that local heating due to stray flux in any structural part shall not exceed the top oil temperature limit specified for the transformer, by more than 10 °C.

Heating, due to stray flux, shall also not cause local temperature elevations of more than 15 °C relative to the oil temperature at that level.

Thermometer pockets shall be located so as to avoid errors in temperature indication due to the heating effects resulting from stray flux. Thermometer pockets shall be located in a position where the least traffic is during activities such as OLTC maintenance and bushing replacements.

The general design of the tank and the turrets must be always be such that the maintenance activities and replacement of components (e.g. all bushings, PRVs and etc) can be carried out by only partially draining the unit. This must be demonstrated during a design review.

3.10.2 Tank Base

The underbase shall be suitable for the movement of the transformer in any direction, by sliding on greased rails. For the class 1 transformers, the tank base shall be provided with four hauling eyes not less than 50 mm in diameter, as near as possible to the extremities of the length and width of the tank.

Unless otherwise approved, transformer underbase shall be of a thickness not less than that specified in this document. Fabricated bases shall not retain water. Skid bases are not accepted, except in special cases where they may be needed, it shall be so indicated by the *Employer.* The position of the axial and transverse centre lines as shown on the dimension and foundation drawings shall be accurately stamped onto the tank at the base level, on both sides and at both ends, and indicated by means of a red enamelled mark at each point.

Table 8: Minimum thickness of transformer tank base plates — mild steel

Length of tank (m)	**Minimum plate thickness** (mm)
Fabricated bases,	
not exceeding 2,5	10
exceeding 2,5	12
Flat bases,	
not exceeding 2,5	12
over 2,5m but less than 5	20
over 5m but less than 7,5	26
exceeding 7,5	32

3.10.3 Tank Main Top Cover

The top cover of the tank shall be the welded type unless stated otherwise in the schedule AB or during the mechanical design review. The positioning of the auxiliary components and pipes on the top cover must take into considerations the need to walk on the top of the tank during the maintenance activities. Preferably the conservator tank should not be on the top cover as it makes movement extremely difficult to almost impossible during inspection and maintenance activities. The top cover shall be painted with a non-slippery paint to enhance safety of personnel.

3.10.4 Tank Strength and Oil Tightness

3.10.4.1 Rigidity

Transformer tanks and their associated components shall have adequate mechanical strength and rigidity to permit the complete transformer, filled with oil, to be lifted, jacked and hauled in any direction, and to be transported without structural damage or impairment of the oil tightness of the transformer, and without the necessity for the special positioning of sliding rails in relation to the tank. Tank stiffeners shall not cover welded seams, to enable the repair of possible oil leaks. The tank and transformer as a whole shall be suitable for transport by low-bed or beam wagon.

3.10.4.2 Internal Pressure and Vacuum

Transformer tanks, complete with all fittings and attachments normally in contact with the transformer oil, and filled with oil of the specified viscosity, shall withstand the pressure and the leakage tests. When empty of oil they shall withstand the full vacuum test. In the case of type tests for strength and oil tightness the fittings (e.g. pressure relief devices and bushing stems) may be tested separately. The ability of the tank to withstand overpressure shall be co-ordinated with the pressure relief valves.

The tank shall be designed to withstand full vacuum for vacuum filling. If barrier boards are installed between the main tank and any other tank (selector tank) the barrier board shall be designed to withstand full pressure of the main tank filled with oil on the one side of the barrier board with full vacuum on the on the other side of the board

3.10.4.3 Joints

A transformer tank and accessories shall be designed and constructed in such a manner that minimum points of possible leaks exists. Only valves and inspection covers of specific purpose shall be provided.

a) All gasketed joints shall be designed, manufactured and assembled to ensure long term leak-free and maintenance free operations.

b) Joints that need not be removed for normal maintenance or transport shall be welded.

c) Details of all gasketed joints shall be submitted for approval during the mechanical design review meeting.

3.10.4.4 Gasket Types

a) Subject to clause b), all gasketed joints shall be of the O-ring and groove type. The O-ring shall be manufactured from nitrile rubber or better.

b) Bolt-on type tap-changers and selector tanks that have to be removed for transport or maintenance are specifically excluded for the use of O-ring type gasket joints. In these applications rectangular cord and groove joints where the nitrile rubber cord is not joined but passed twice around the perimeter with the loose ends at the bottom, are acceptable. Alternatively a flat nitrile rubber gasket with stoppers to prevent over compression will be acceptable.

c) Approved non O-ring gaskets that need re-tightening in order to avoid oil leaks as a result of shrinkage, shall be retightened in the second 6 months of service by the *Contractor* at no extra cost to the *Purchaser*. All costs to maintain the system leak free shall be for the *Contractor*'s account during the guarantee period.

3.10.4.5 Attachments to the transformer tank

Attachments to the transformer tank shall only be fixed by bolting them to the prepared flat surface of a flange facing, either integral with or welded to the tank and sealed by a gasket or O-ring to the mating flange of the attachment. Joints dependent on the sealing of screw threads, and direct welding of fittings to the tank will not be accepted.

3.10.4.6 Pipe joints

Oil pipes above 15 mm bore shall have flanged, gasketed and bolted joints. Flexible compression joints will not be accepted unless specifically approved. Joints dependent on the sealing of screw threads will not be accepted.

3.10.4.7 Drilling of pipe flanges

Except where otherwise stated, the drilling and bolting of pipe flanges and the mating flanges of fittings shall comply with BS 4504 or DIN 2631.

3.10.5 Access openings and covers

An appropriate number of suitably proportioned handholes and manholes shall be provided for easy access to the upper portions of the core and windings assembly, the lower ends of bushings, internal current transformers and the oil side of their terminal boxes (see 3.6.3). Manholes for the purpose of internal inspection are preferred to be as close as to ground level as necessary to eliminate the need of climbing.

The following minimum inspection covers shall be provided on the main tank:

- At each bushing terminal where the bushing is connected to the winding
- On the tank wall, a minimum of one accessible from ground level to allow access for active part inspection at least 600 mm in diameter. The inspection cover shall be located to allow for maximum access to the active part and the tap changer. Where this is not possible more than one inspection cover shall be provided.
- On the top cover, a minimum of one to allow access for active part inspection at least 600 mm in diameter.

3.10.6 Handles

Manhole covers shall be provided with stout handles to facilitate their removal.

3.10.7 Lifting lugs

Covers with a mass greater than 25 kg shall be provided with symmetrically arranged lifting lugs.

3.10.8 Valves and oil sampling devices

3.10.8.1 Isolating valves

Suitably dimensioned isolating valves shall be provided:

a) at each point of connection to detachable cooling apparatus; and

b) at each point of connection to tap-changer compartments, cable disconnecting chambers and cable sealing boxes supplied from the transformer tank.

c) Isolating valves shall provide effective sealing at 100 kPa pressure and full vacuum at sea level.

d) Radiator isolating valves shall be freely accessible for opening and closing with the transformer fully assembled.

e) No special tools or tools shall be required to open or close radiator valves.

f) Radiator valves shall be fitted to allow replacement of individual radiators.

3.10.8.2 Filtering and drain valves

Two 50 mm double-flange valves shall be provided for filtering purposes. At least one valve shall be located at the top of the tank adjacent to the oil conservator, and another at the bottom of the tank on the opposite end to give a cross current of oil during filtration. The lower valve shall be a combined drain and filtering valve and, as such, shall be positioned so that it drains, as far as possible, all the oil from the transformer tank. For class 2 and above transformers, the top filtration valve shall be routed inside the transformer tank and be brought out on ground level, and shall be clearly marked**.** The intake of the pipe for the top filtration valve shall be positioned at the allowable partial drain level.

All valves shall be painted with the same colour as the transformer tank.

No valves shall be fitted by means of stud welding or welding to the main tank.

The tap-changer diverter chambers shall be fitted with 20 mm (¾ inch) drain valves for maintenance purposes. If inaccessible from ground level, they shall be piped down to 1,5 m above ground level.

All drain valves shall be protected against mechanical damage. The means of mechanical protection shall be indicated on the general arrangement drawing.

3.10.8.3 Oil sampling devices

If specified in AB schedule, an oil sampling device consisting of a flange and drain plug as per the Oil sampling specification 240-56062720 or other approved device shall be provided in the following locations where applicable:

a) at the bottom of the transformer tank, bolted and fitted with O-rings to the free flange of the 50 mm drain valve specified in 3.10.8.2;

b) at the bottom of each separate tap-changer selector compartment;

c) on the free flange of the tap-changer diverter chamber; and

d) at the end of the main Buchholz relay sample pipe. A ¼” needle valve shall be provided on the Buchholz pipe for oil sampling.

These points shall all be numbered on the sampling point with the number corresponding to the same point on the valve function plate (see 3.10.8.8).

The tap changer diverter chambers shall be fitted with 25 mm individual drain valves for maintenance purposes. If inaccessible from ground level, they shall be piped down to 1.5 m above ground level.

Each diverter shall be fitted with individual sampling points.

The sample pipes shall be copper tubing with an ID of at least 7 mm (3/8” or 10 mm copper tubing). All fittings used shall be 3/8” brass or stainless steel. Only SAE 45-degree flares must be used on the copper tubing - compression fittings are not acceptable. The tubing shall be protected against physical damage by appropriate routing, fastening and / or protective conduit. Provision shall be made to secure oil sample copper tubing with rails welded to the tank and structures. At no point shall the copper tubing make contact with any steel surfaces.

A sample valve shall be provided and located approximately 1.5 m above ground level and be easily accessible from the transformer plinth. The sample valve shall be a needle type valve of 3/8” or 10 mm size – ball valves may not be used. Only brass or stainless steel needle valves shall be used. A stopper plug shall be provided to seal the open end of the sample valve.

All oil sampling devices to be accessible from ground level.

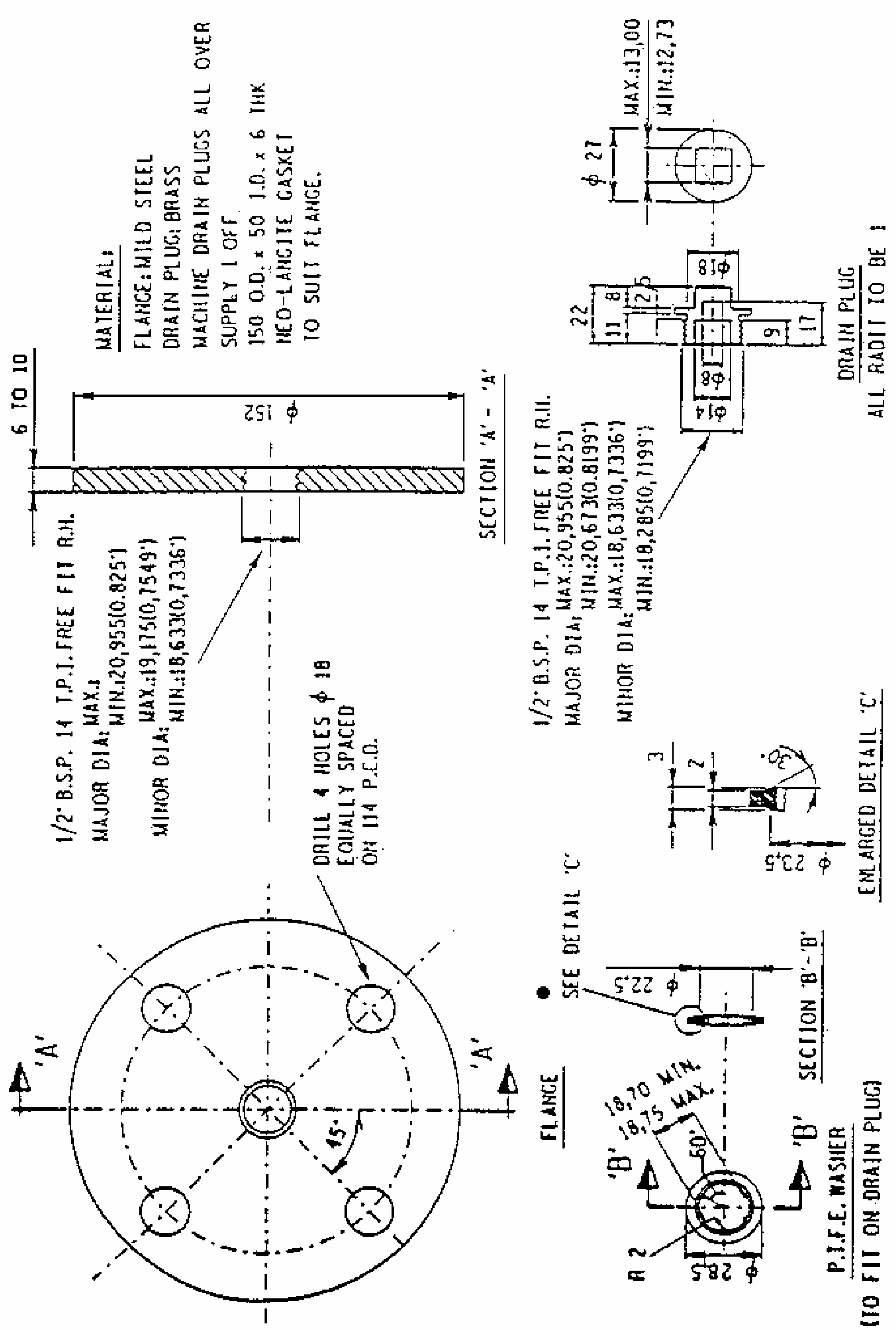


Figure 6: Oil sampling flange interfaces

3.10.8.4 Strength and oil tightness

Valves and oil sampling devices shall be of adequate strength to withstand the hydraulic and mechanical loads imposed upon them during testing, processing and transporting of the transformer and in service. Pewter and similar low strength materials will not be accepted.

Valve discs, wedges, wedge facing rings, seats and seat rings, stems and spindles shall be of approved non-corrodible material. Valves and oil sampling devices shall withstand the 3.18 test requirements,

3.10.8.5 Valve stem seals

Valve stem seals shall be capable of adjustment in service without draining the transformer oil. In this connection, and generally, aluminium (or aluminium alloy) threads shall not mate with threads of brass valve stems.

3.10.8.6 Padlocking

Suitable means shall be provided for padlocking valves in both the open and closed positions. This is applicable only to class 1 transformers.

3.10.8.7 Blanking plates

All valve entries communicating with the atmosphere shall be sealed using bolted and gasketed (“O” rings accepted) blanking plates, or captive screwed caps, or plugs as the case may be. The O rings of viton material or type are preferred to the traditional nitrile ones.

3.10.8.8 Valve function plate

A schematic diagram plate indicating all valves, vent plugs and sampling points shall be provided in the same manner as the rating and diagram plate. This plate shall also indicate the position of all valves in operation, and out of operation.

3.10.8.9 Valve position indication

The position of each valve, i.e. either fully open or fully closed, shall be clearly and unambiguously visible on inspection. Where this is not so, e.g. in the case of lever operated valves, the “open” and “closed” positions of the lever in relation to a clearly recognizable part of the transformer shall be depicted on the valve function plate specified in 3.10.8.8.

3.10.8.10 Labelling of oil sampling devices

All the oil sampling points shall be numbered the same as on the valve function plate with exception of the two routine sampling points that shall also be labelled. The labels shall comply with the requirements of the labelling specification 240-56062720

3.10.9 Jacking Pads

Four suitably and symmetrically placed jacking pads shall be provided in positions that shall be accessible when the transformer is loaded on to the transport vehicle, except where jacking pads are used as transport pads on vehicles with built-in jacking.

The position of the jacking pads shall be such that they do not restrict the direction in which the transformer could be moved (forward, backward and sideways) once off-loaded on site.

Each jacking pad shall be designed to support, with an adequate factor of safety at least half of the total mass of the transformer filled with oil, allowing maximum possible misalignment of the jacking force in relation to the centre of the working surface.

Unless otherwise approved, the heights of the jacking pads above the bottom of the transformer base, and the unimpeded working surface of the jacking pads shall be as in **Table 9** (read in conjunction with **Figure 7**).

Table 9: Jacking pad dimensions

Transformer mass complete with oil (metric tons)	**Min/max height of jacking pad above base "A"** (mm)	**Overhang to centre of jacking pad "B"** (mm)	**Unimpeded working surface of pad "C"** (mm)	**Width of symmetrical unimpeded access to jacking pad "D"** (mm)
60 and below	460/530	115	170 x 170	230
Above 60	650/700	150	210 x 210	300
Access in direction 'E' shall be unrestricted.				

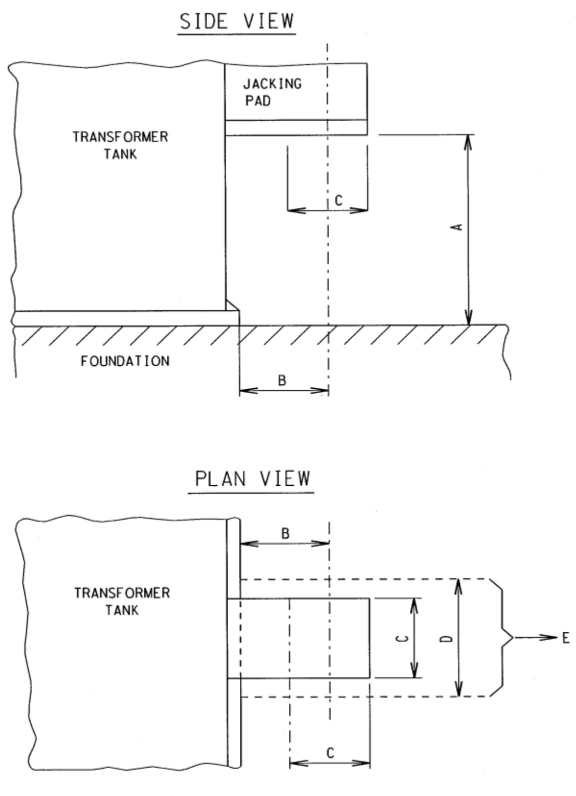


Figure 7: Arrangement of jacking pads

3.10.10 Lifting Lugs

Four symmetrically placed lifting lugs shall be provided so that it will be possible to lift the complete transformer when filled with oil without structural damage to any part of the transformer. The factor of safety at any one point shall not be less than 2.

The lifting lugs shall be so arranged and located as to be accessible for use when the transformer is loaded on the transport vehicle, and so as not to cause fouling of any of the transformer fittings and accessories.

3.10.11 Centre of Gravity

Centre of gravity shall be clearly visible and indicated on all sides of the transformer tank.

3.10.12 Manholes and Handholes

At least one manhole shall be provided on the sidewall, to allow access for internal inspections not higher than 500 mm from the base of the tank. Manholes shall be round with a diameter of not be less than 600 mm.

Hand holes shall be provided to facilitate the removal and installation of bushings. Lesser dimensions are acceptable for class 1 transformers due to their physical size.

3.10.13 Provisions for earthing

Provision shall be made for earthing the transformer and associated apparatus as follows:

3.10.13.1 Transformer tank earthing

At a height not less than 300 mm from the base of the transformer tank and near each end of each of the two major sides of the tank (i.e. in four positions).

These provisions shall take the form of earthing pads integral with the tank walls; where the pads are attached by welding, such welding shall be continuous around the perimeter of the pads. Earthing pads shall be stainless steel and allow installation of 50 x 3 mm flat copper straps.

3.10.13.2 Transformer neutral(s) earthing (direct)

A stainless steel pad having the same clamping arrangement as the transformer earthing pads and integral to the transformer tank shall be provided for each transformer neutral terminal for earthing.

1) This pad shall be mounted as near as possible to its corresponding neutral terminal in order to ensure a short and steady connection to earth. The pads shall be mounted on the side of the tank from the top to ground at 800 mm intervals.

2) The manufacturer shall supply a suitably rated corrosion protected connection between the neutral bushing and the earth, insulated from the tank and metal.

3.10.13.3 Transformer surge arrester earthing (line and neutral surge arresters)

The surge arrester mounting brackets shall be used as the earth path for surge arrester discharging to earth via the transformer tank (i.e. copper earth tails shall not be used for surge arresters).

Where brackets for phase and neutral surge arresters are to be fixed to the tank using tank mounted bolts, stainless steel pads (similar to the transformer tank earthing pads that form an integral part of the tank) shall be used. When these pads are attached by welding such welding shall be continuous around the perimeter of the pads.

Where brackets are not directly mounted onto the tank (on radiators) a separate suitably rated corrosion protected connection shall be provided to the earthing pad on the tank.

Note: Bolted down surface contact areas of transformer surge arrester support brackets and earthing pads shall be free of any paint or metal spray coatings.

- All tank attached apparatus, including cable marshalling boxes, tap-changer operating gear and mechanism boxes, pipes, fan and pump motors shall be bonded to their supporting structures.
- Earthing pads, as specified in 3.10.13, shall also be provided on each end of the supporting structures for all separately mounted cooler banks and oil conservators and on all free-standing cubicles.
- No copper shall be used as connections for the purpose of earthing.

Note: Integral pads to suit the fault levels specified.

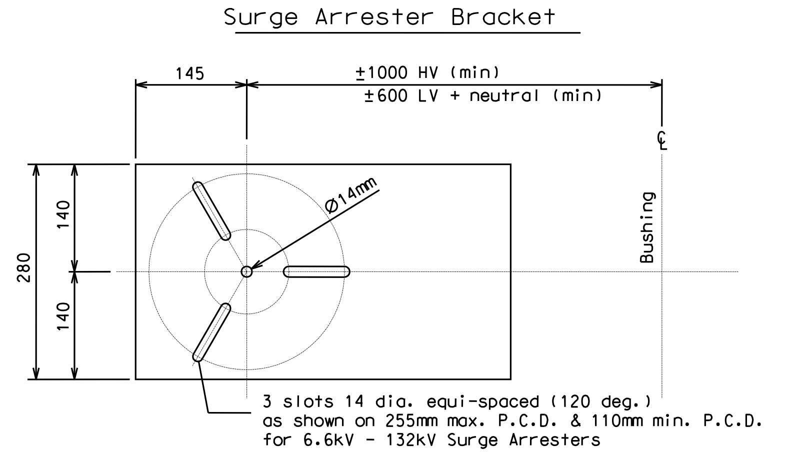
3.10.14 Brackets for Surge Arrestors

For terminals of 132kV and below, the surge arrestor brackets used to mount the Primary, Secondary and Tertiary surge arrestors to the transformer shall comply with the following requirements:

a) The surge arrester mounting brackets shall be provided to suit the dimension shown in **Figure 8: Surge arrester bracket dimensions** The outline and dimension drawings provided in terms of a contract, shall show the surge arresters mounted on the transformer with all necessary clearances and sizes dimensioned.

b) Universal surge arrester mounting details, fully dimensioned, shall be shown in an inset on these general arrangement drawings.

c) Refer to 3.10.13 for the earth continuity requirements of the surge arrester brackets.



Notes :

1. All steel work shall comply with SABS 1200H.
   All steel work shall be hot dip galvanised to SABS ISO 1461.
   no cutting, welding or drilling shall be done after
   the galvanising process is completed.
   Tolerance - on dimensions +/- 2
   - on hole centres +/- 1
2. Steel plate 10mm thick.

Voltage	No.off	Phase spacing	HV / MV
132 kV	3	*	HV
88 kV	3	*	HV
66 kV	3	*	HV
44 kV	3	*	HV
33 kV	3	700mm C/C	MV
22 kV	3	700mm C/C	MV
11 kV	3	700mm C/C	MV
6.6 kV	3	700mm C/C	MV

*\= Centre phase inline outer phases, bushing centres + 450mm min.

Figure 8: Surge arrester bracket dimensions

The surge arrestor bracket arrangement must be finalised during the mechanical design review meeting.

3.10.15 Permanent Ladder

A permanent steel ladder shall be welded to the main tank in a position to provide unrestricted access to the top of the transformer with the unit fully assembled. The ladder shall not interfere with or restrict maintenance activities and routine inspections. It shall not cover or restrict access to inspection / manhole covers and interfere with fitting of monitoring and on-line drying equipment.

A safety harness securing point shall be positioned at the landing space immediately above the steel ladder on the top cover.

3.10.16 Partial Draining

To facilitate oil leak repairs on inspection covers and header pipes, transformers shall be designed to allow partial draining to a level of at least 150 mm below the top lid cover without exposing any cellulose insulation. Refilling of the transformer shall not trap air under inspection covers or top lid. Where necessary, bleeding points shall be provided to vent trapped air.

The tank side wall shall be permanently marked by welded sign or labelling to indicate the minimum oil level allowed for partial draining without exposing any cellulose insulation. The labelling shall be submitted to the purchaser for approval. This mark shall be located on the side wall i.e. same face where the bottom drain valve is located.

3.11 Auxiliary Supplies, Terminal Boxes, Wiring and Cabling

3.11.1 Supply Voltage

The auxiliary power supply will be rated at 400/230 Vac, three phase, 4-wire, 50 Hz. The unearthed DC supply will be 110 V or 220 V nominally as specified in Schedule A. If any device is using supply other than 110V or 220V DC, a converter that will provide such voltage shall be supplied by the *Contractor*, e.g., Seal-in relay for rapid pressure devices.

3.11.2 Marshalling and Terminal Boxes

The Marshalling box shall be mounted on the transformer main tank. It shall be mounted in a position that it can remain fitted to the transformer tank during transport and installation. The Marshalling box shall be mounted on vibration reducing mountings to prevent damage or malfunction of internal accessories. The base of the Marshalling box shall not be lower than 300 mm form the base of the transformer but limited to 400 mm. All parts inside the marshalling box must be accessible from ground level.

Marshalling boxes and terminal boxes shall be vermin-, dust- and weather-proof and shall be provided with easily removable covers fixed by not more than two screws.

Covers for terminal boxes may be of the slip-on type, and those for Marshalling boxes shall be hinged in a vertical plane. Marshalling kiosk access doors shall open to a minimum angle of 120 degrees and shall be provided with a door open retainer. The door retainers must be strong enough to hold the cover in the presence of wind stresses.

Covers in a vertical plane shall, in addition to a gasketed seal, be provided with a double-curved flange along the top edge and sides. The door opening in the box shall have a double-curved flange around its entire perimeter, the outer face of which shall form the gasketed joint. The top of the box shall be made to overhang the cover, except in the case of slip-on covers. These shall be double-curved and fitted with drip ledges for internal corrosion proofing.

Marshalling boxes and terminal boxes, arranged in a vertical plane, shall be provided with a 25 mm vent and drain hole covered by a fine mesh of non-corrodible wire, fitted at the lowest point. This fitting shall be flush inside to permit total drainage.

The glass windows must be made of adequate material such that they do not fade at the specified ambient conditions.

3.11.2.1 Transformer Standard Interface box

A marshalling interface box (MIB) with a standard terminal layout that includes all transformer terminals and tap change drive terminals shall be provided. The MIB shall consist of a single box that houses at least 170 terminals and shall be mounted on the side of the transformer. The supplier shall supply and terminate a cable between the tap-change drive and the MIB to transfer the tap change functions, as specified in the MIB layout, to the MIB. All normal transformer functions as specified in the MIB layout below shall also be cabled to the MIB either directly or through a transformer terminal box. A 25A 380V triple pole circuit breaker shall be supplied and wired from the Cooler Supply as specified in the MIB layout, for the tap-change drive and the supplier shall supply and terminate a cable between the tap-change drive and the MIB to provide a three phase AC supply to the tap-change drive. Earth Leakage Protected 16 Amp double pole 230V AC supply Circuit Breakers for the Permanent Online Dryers and Online Gas Analyser units shall also be supplied inside the MIB.

Spare terminals may be used by the manufacturer to terminate any extra functions that will not normally be used in an Eskom application. *The Contractor* may however not deviate from the prescribed terminal allocation. Terminals indicating functions that are not provided by the manufacturer shall be left open. The manufacturer shall fit partitions between terminals X1.26, X1.27, X1.28, X1.29, X1.30, X1.31, X1.32; X1.34, X1.35, X1.36, X1.37, X1.38; X5.1, X5.2, X5.3, X5.4, X5.5, X5.6, X5.7, X5.8, X5.9, X5.10, X5.11 and X5.12.

Eskom will supply and terminate two 37-core 2,5mm2 and two 10-pair twisted pair telephone cables between the MIB and the transformer protection and tap change control cabinet, in the substation control room and one 4-core 35mm2 cable between the MIB and the transformer distribution board. The supplier of the Permanent Online Dryer will supply and install one 4-core 2,5mm2 cable between the MIB and the Permanent Online Dryer. The supplier of the Online Gas Analyser will supply and install one 3-core 2,5mm2, one 4-core 2,5mm2 and one 2-core 1,5mm2 cable between the MIB and the Online Gas Analyser unit.

Table 10: Standard layout for Marshalling Interface Box fitted to transformers

Device	**Abbreviation**	**Terminal number**	**Wire Marking**	**Application**
Gas and oil relay 1	G.O.R. 1	X1.1 - X1.2 X1.3 - X1.4	X1.1 - X1.2 X1.3 - X1.4	Trip 1 Alarm 1
Pressure relief valve 1	P.R.V 1	X1.5 - X1.6 X1.6 - X1.7	X1.5 - X1.6 X1.6 - X1.7	Normal open contact Normal closed contact
On Load Tap Change Protection	O.L.T.C. Prot	X1.8 - X1.9 X1.9 - X1.10	X1.8 - X1.9 X1.9 - X1.10	Normal open contact Normal closed contact
Oil temperature indicator	O.T.I	X1.11 - X1.12 X1.13 - X1.14	X1.11 - X1.12 X1.13 - X1.14	Trip alarm
HV Winding temperature indicator	H.V.W.T.I	X1.15 - X1.16 X1.17 - X1.18	X1.15 - X1.16 X1.17 - X1.18	Trip alarm
MV Winding temperature indicator	M.V.W.T.I	X1.19 - X1.20 X1.21 - X1.22	X1.19 - X1.20 X1.21 - X1.22	Trip alarm
Tertiary Winding temperature indicator	L.W.T.I	X1.23 - X1.24 X1.25 - X1.26	X1.23 - X1.24 X1.25 - X1.26	Trip alarm
Oil level indicator	**O.L.I**	X1.27 - X1.28	X1.27 - X1.28	Oil level alarm High/Low
Tap-change oil level indicator	**O.L.T.C.O. L.I**	X1.29 - X1.30	X1.29 - X1.30	Oil level alarm High/Low
		X1.31 – X1.32		Spare
Cooler abnormal	CFA	X1.33 - X1.34	X1.33 - X1.34	Common alarm for cooler
Fans/Pumps/ Thermometer AC Supply	ACF(Temp)	X1.35 - X1.38	R, S, T ,N	3 ϕ Control supply (WFF35 stud terminals)
Fans/Pumps/ Thermometer DC Supply	DCF(Temp)	X1.39 - X1.41	X1.39+ X1.40- X1.41	110/220Vdc Cooler stop and thermometer supply
MIB Heater / Earth Leakage Supply	MCB(AC-H)(EL)	X1.42 – X1.43	X1.42 – X1.43	AC supply for MIB heater / Plug Socket
Drykeep Earth Leakage Supply	MCB(AC)-(DKP)	X1.44 – X1.45	X1.44 – X1.45	AC supply for Drykeep
DGA Earth Leakage Supply	MCB(AC)-DGA	X1.46 – X1.47 X1.58	X1.46 – X1.47 90	AC supply for DGA Earth terminal
Thermometer failure	Therm-FA	X1.48 – X1.49	X1.48 – X1.49	Thermometer failure alarm
Analogue output – Oil temperature	mA(OT)	X1 50 – X1.51	X1 50+ – X1.51-	Analogue output 4- 20mA (IDC Terminals)
Analogue output – HV Winding temperature	mA(HVWT)	X1.52 – X1.53	X1.52+ – X1.53-	Analogue output 4- 20mA (IDC Terminals)

Analogue output – MV Winding temperature	mA(MVWT)	X1.54 – X1.55	X1.54+ – X1.55-	Analogue output 4- 20mA (IDC Terminals)
Analogue output – Tertiary Winding temperature	mA(LVWT)	X1.56 – X1.57	X1.56+ – X1.57-	Analogue output 4- 20mA (IDC Terminals)

Device	**Terminal number**	**Wire Marking**	**Application**
HV “A” phase CT	X2.1 – X2.2	1AS1 - 1AS2	Protection
HV “B” phase CT	X2.3 – X2.4	1BS1 - 1BS2	Protection
HV “C” phase CT	X2.5 – X2.6	1CS1 - 1CS2	Protection
MV “a” phase CT	X2.7 – X2.8	1aS1 - 1aS2	Protection
MV “b” phase CT	X2.9 – X2.10	1bS1 - 1bS2	Protection
MV “c” phase CT	X2.11 – X2.12	1cS1 - 1cS2	Protection
HV neutral CTs	X2.13 – X2.14 X2.15 – X2.16	1YNS1 - 1YNS2 2YNS1 - 2YNS2	Protection Protection
MV neutral CTs	X2.17 – X2.18 X2.19 – X2.20	1ynS1 - 1ynS2 2ynS1 - 2ynS2	Protection Protection
Tertiary “a” Phase CT	X2.21 – X2.22	1-3AS1 - 1-3AS2	Protection
Tertiary “b” Phase CT	X2.23 – X2.24	1-3BS1 - 1-3BS2	Protection
Tertiary “c” Phase CT	X2.25 – X2.26	1-3CS1 - 1-3CS2	Protection
HV “A” phase CT	X2.27 – X2.28	2AS1 - 2AS2	Protection
HV “B” phase CT	X2.29 – X2.30	2BS1 - 2BS2	Protection
HV “C” phase CT	~~X2~~.31 – X2.32	2CS1 - 2CS2	Protection
MV “a” phase CT	X2.33 – X2.34	2aS1 - 2aS2	Protection
MV “b” phase CT	X2.35 – X2.36	2bS1 - 2bS2	Protection
MV “c” phase CT	X2.37 – X2.38	2cS1 - 2cS2	Protection
Tap Changer Motor	X3.1 – X3.4	R,W,B,N	3 ϕ Motor supply/ HEATER AND LIGHT
Tap Change AC Supply	X3.5 – X3.6	L, N	Tap Change Control and AC Supply
Voltage Monitoring Relay DC Supply	X4.1 – X4.2	+, -	Voltage Monitoring Relay DC Supply
Tap Position Device	X4.3 – X4.4	X4.3 – X4.4	Parallel check for even taps
Tap Position Device	X4.5 – X4.6	X4.5 – X4.6	Parallel check for odd taps
LOCAL RAISE OR LOWER SWITCH	X4.7 – X4.9	X4.7 – X4.9	Local control Switch (7 Com, 8 Raise, 9 Lower)
RAISE (SI)	X4.10 – X4.11	X4.10 – X4.11	Seal In for raise operations (When required)
LOWER(SI)	X4.12 – X4.13	X4.12 – X4.13	Seal in for lower operations (When required)
RAISE OPERATION	X4.14	X4.14	Initiate raise operation
LOWER OPERATION	X4.15	X4.15	Initiate lower operation

Overcurrent Block Supply	X4.16 – X4.17	X4.16 – X4.17	Energize O/C block contactor (Negative may be commoned)
MOTOR SUPPLY MCB	X4.18 – X4.2	X4.18 – X4.2	Trip motor supply MCB (Negative may be commoned)
MOTOr TRIP/HEATER AC FAIL/TAP CHANGE MONITORING SUPPLY	X4.20 – X4.21	X4.20 – X4.21	Motor supply MCB has tripped/HEATER SUPPLY FAIL/TAP CHANGE MONITORING SUPPLY FAIL
Tap Change In Progress	X4.22 – X4.23 - X4.24	X4.22 – X4.23 – X4.24	Indication for tap-change in progress (raise, lower)
Motor Running Timer	X4.25	X4.25	Motor running timer
Encoder Supply	X4.26 - X4.27	X4.26 - X4.27	Encoder Supply
BCD OUTPUTS - LOCAL	X5.1 – X5.6	X500, X501, X502 X504, X508, X510	Binary coded decimal output to tap position LOCAL indicator
BCD OUTPUTS - REMOTE	X5.7 – X5.12	X600, X601, X602 X604, X608, X610	Binary coded decimal output remote indication

Additional Functions

Device	**Abbreviation**	**Terminal number**	**Wire Marking**	**Application**
Gas and oil relay 2	G.O.R. 2	X11.1 – X11.2 X11.3 – X11.4	X11.1 – X11.2 X11.3 – X11.4	Trip 2 Alarm 2
Rapid pressure rise relay 1	R.P.R. 1	X11.5 – X11.6	X11.5 – X11.6	Trip 1
Rapid pressure rise relay 2	R.P.R. 2	X11.7 – X11.8	X11.7 – X11.8	Trip 2
Conservator bag leak detector	C.B.L.D	X11.9 – X11.10	X11.9 – X11.10	Alarm
Sudden flow valve	S.F.V.	X11.11– X11.12	X11.11-X11.12	Alarm 1
Pressure relief valve 2	P.R.V 2	X11.13- X11.14	X11.13-X11.14	Normal open contact
Pressure relief valve 2	P.R.V 2	X11.15– X11.16	X11.15– X11.16	Normal closed contact
Digital Gas Analyser	DGAUA	X11.17– X11.18	X11.17– X11.18	Unhealthy Alarm
Digital Gas Analyser	DGAGC	X11.17-X11.19	X11.17-X11.19	Gas Caution Alarm
Digital Gas Analyser	DGAGA	X11.17-X11.20	X11.17-X11.20	Gas Alarm
Digital Gas Analyser	DGAACF	X11.21-X11.22	X11.21-X11.22	AC Fail Alarm (N/C contact)
Auxiliary Transformer Gas and oil Relay	AT G.O.R.	X11.23- X11.24 X11.25-X11.26	X11.23- X11.24 X11.25-X11.26	Trip Alarm
Auxiliary Transformer Oil Temp Indicator	AT O.T.I.	X11.27- X11.28 X11.29-X11.30	X11.27- X11.28 X11.29-X11.30	Trip Alarm

3.11.3 Earthing terminal

An earthing terminal of M12 to M16 shall be provided in each terminal and marshalling box with a stud on both the inside and outside.

3.11.4 Spare terminals

Each marshalling box shall be provided with not less than 10% spare terminals with a minimum number of twelve, unless otherwise agreed.

3.11.5 Incoming auxiliary circuits

To prevent entry of water, the auxiliary wiring from the gas- and oil-actuated relay, current transformers and other auxiliary apparatus, shall be arranged for side or bottom entry into the marshalling or terminal box. If bottom entry is adopted, the gland plate used shall be independent of that provided for the *Purchaser*'s outgoing cables. If cables enter the terminal boxes or marshalling kiosk from the side, drip-loops shall be provided to prevent water from entering the cable gland.

3.11.6 Provision for outgoing cables

The marshalling box shall be provided with a separate, removable, undrilled plate to take the *Purchaser*'s cable glands, mounted at least 100 mm below the bottom of the terminal blocks, or other equipment, in such a manner as to facilitate the entry or the *Purchaser*'s cables. The gland plate shall be of 6 mm thick brass sheet. Steel plates are not accepted

The gauze covered drain and vent hole may be fitted to this gland plate. The gauze covered drain hole must be in the lowest part of the kiosk and must not be on the gland plate.

3.11.7 Cabling and Wiring

Only UV stable, heat and oil resistant PVC SWA (steel wire armouring) cable shall be used on transformers. Only corrosion resistant cabel glands for armoured cables shall be used. Plastic compression type cable glands shall not be used on armoured cables. Heat, oil and UV restant cable shrouds shall be fitted to all cable glands.

All cable terminations shall be provided with cable numbers fitted to the cables on both ends. Only permanently engraved, non-corrodible, UV, oil and heat resistant material shall be used for cable numbering. These labels shall be permanently fixed to the cable ends just before the glands on the outside of the terminal box.

The cable armouring shall be earthed at least one side. Earthing shall be by means of the steel cable gland.

3.11.8 Insulation

Wiring insulation shall be oil- and moisture proof, and, where affected by temperatures above that of the ambient air, shall have thermal characteristics at least equal to class ‘A’ of IEC 85.

3.11.9 Insulation test voltage

All auxiliary circuits shall withstand a test voltage of 2 kV DC for 60 seconds to earth and to all other circuits.

3.11.10 Type of conductor

All secondary wiring used on the transformer for current transformer secondary and other auxiliary equipment shall have a minimum cross-section of 2, 5 mm^2 , and shall be limited to 30 strands per cable, flexible, 660/1000 V grade wire in accordance with SABS 1507 or to the *Purchaser*'s approval.

As far as possible, only cables with the correct number of strands shall be used. Where this is not possible the free stands shall not be cut, but effectively earthed on one side of the cable.

3.11.11 Supporting and securing of cables

All cables shall present a neat appearance and shall be supported on cable rails elevated 20 – 30 mm from the tank surface. The rails shall be welded to the transformer tank surface. Similar rails shall be provided to route and secure cables to auxiliary components, i.e. oil level indicators, Buchholz relays, cooling fans, etc.

Cables shall be secured to cable rails by means of stainless steel strapping with a minimum width of 6 mm and not exceeding 10 mm.

Routing of cables shall be done to eliminate the cable from touching sharp edges on the transformer tank structure.

No cables in steel conduit will be accepted.

3.11.12 Identification of wiring

All equipment boundary/interface terminals and the equipment wires connected to those terminals shall have a unique wire/terminal number in accordance with the manufacturer's drawings approved by the *Purchaser*'s. The wires shall be marked with black letters impressed on a white background or black letters on a yellow background providing that the colour selected is consistent throughout the panel and/or suite of panels and is to the *Purchaser*'s approval.

For heavy conductors and very light wiring (telephone type) where the preferred type of marking ferrules is not available, other methods may be approved.

Ferrules shall be arranged to read upright on cable terminal strips and to read from terminal to insulation in the case of relay apparatus and instrument connections.

3.11.13 Cabling by the Purchaser

Multi-core cabling to the remote control point will be provided by the *Purchaser*. Where a separately mounted outdoor control cubicle is provided near the transformer and where the *Contractor* is responsible for erection, he shall provide and connect all cabling between this control cubicle, the transformer marshalling box and the auxiliary apparatus on the transformer together with all necessary cable fittings, attachments and identification of cables and cable cores.

3.11.14 Identification of fuses and circuit breaker

All fuses and circuit breakers shall be labelled indicating the rating and circuit.

3.11.15 Identification of equipment

All equipment identification labels in marshalling kiosks and control cubicles shall be fixed on permanent surfaces next to the equipment (above, underneath or next to) and not on removable covers or on the equipment itself.

3.12 Rating and Diagram Plates

3.12.1 General

Rating and diagram plates shall comply with the requirements of IEC 60076 except where otherwise stated in this specification.

3.12.2 Materials and methods of marking

Rating and diagram plates shall be of stainless steel not less than 1,2 mm in thickness.

The required information shall be engraved on the plate and the engraving filled with glossy black, baked enamel.

Other arrangements shall be specifically approved.

3.12.3 Mounting

The rating and diagram plates shall be mounted on the door of the marshalling interface box for all tank mounted boxes. If otherwise, the plates must be mounted on the tank. The plates must be finished in accordance with 240-56030674 situated in an accessible position not more than 1,5 m above ground level, and secured by stainless steel screws.

3.12.4 Information to be displayed

The minimum information to be displayed on the rating and diagram plate shall be in accordance with the requirements of IEC 60076 with addition of the following as detailed in **Figure 9**.

a) the tapping current values shall be shown for HV, MV and tertiary terminals for all tapping positions;

b) the capability of the transformer (including bushings and tap-changers) to carry overloads in accordance with the emergency duties detailed in IEC 60076-7 shall be shown;

c) the system fault levels in kA for which the transformer is designed

d) the zero sequence impedances in the case of three-winding auto transformers;

e) the current transformer data shall be shown;

f) a statement that the manufacturer deems it necessary for the transformer to be oil-filled under vacuum;

g) a statement that the transformer will withstand full vacuum at sea level;

h) the *Purchaser*'s reference number shall appear on the rating and diagram plate;

i) values for all relevant parameters used by the digital temperature gauge for the winding hot-spot and transformer lifetime calculations as per IEC 60354 or IEC 60076-7

j) The temperature probe hole diameter/s and depths.

k) a blank space for the *Purchaser*'s asset number shall be provided;

l) the type, make and designation numbers of all bushings, to enable full identification (relating to stock spares) while the transformer is energised;

m) the valve and oil sampling point functions and positions;

n) a warning statement that the conservator contains a bag or other sealing systems if it is the case; and

o) the type of corrosion protection: Corrosive or low corrosive.

p) Initial DP value

q) Tie-in resistor schematic and value (if used).

r) Vector Group

s) Surge Arrestors on regulating winding

t) Tertiary Reactor

Whilst a single plate is preferred, separate plates mounted adjacent to the main plate are acceptable for the information required by items (f), (g), (h), (m), (n), and (o).

MANUFACTURER

POWER TRANSFORMER

3 PHASE 50 HERTZ SPECIFICATION DISSCAAD3 REV 7

TRANSFORMER SERIAL No.	30432	ONAN RATING (MVA)	24	CORE & WINDING MASS (kg)	26 300	SYSTEM FAULT LEVELS (kA PER PHASE)	HV	40
ESKOM ASSET No.	-	ONAF RATING (MVA)	40	OIL MASS (kg)	15 560		LV	25
ESKOM ORDER No.	4500239975	MAXIMUM ALTITUDE (m)	1800	TOTAL MASS (kg)	57 220	DESPATCHED MONTH/YEAR	/	

PERCENT IMPEDANCE VALUES AT 75° C AND AT STATED CURRENTS SHOWN BELOW			INSULATION LEVELS (IMPULSE/POWER FREQUANCY)			
					TYPE OF CORROSION PROTECTION	LOW/TO SCSSCAAP9
					TRANSFORMER MUST BE OIL FILLED UNDER FULL VACUUM	
NORMAL POSITION TAP 5	%	175 AMPS	HV LINE (kV)	550/230	SUITABLE FOR FULL VACUUM AT SEA LEVEL	
					CONSERVATOR FITTED WITH PRESERVATION BAG	YES
MAXIMUM VOLTAGE TAP 1	%	175 AMPS	HV NEUTRAL (kV)	250/95	SUITABLE FOR ARC FURNACE DUTY	NO
			LV LINE (kV)	95/28	INITIAL DEPOLYMERISATION VALUE OF INSULATION	
					TRANSFORMER NOISE LEVEL (IEC 60076-10) db	
MINIMUM VOLTAGE TAP 17	%	175 AMPS	LV NEUTRAL (kV)		THIS TRANSFORMER IS SUITABLE FOR OVERLOADS IN ACCORDANCE WITH IEC 60354	

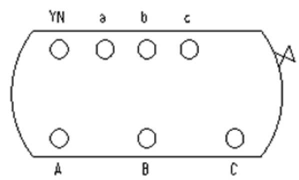
DETAILS OF CURRENT TRANSFORMERS TO SABS IEC 60044-1 AND DSP0013

APPLICATION	EF	REF	REF	REF	REF	O/C	O/C	O/C	WTI					
NUMBER	1YN	2YN	1A	1B	1C	1a	1b	1c	1W					
SERIAL No.														
RATIO OR IP	200	300	300	300	300	2400	2400	2400	1470/1,5					
TURNS RATIO	200/1	300/1	300/1	300/1	300/1	2400/1	2400/1	2400/1						
ACROSS	S1-S2	S1-S2	S1-S2	S1-S2	S1-S2	S1-S2	S1-S2	S1-S2	S1-S2					
VA OR Vk/Im	200/0,50	300/0,33	300/0,33	300/0,33	300/0,33	750/0,042	750/0,042	750/0,042	10					
CLASS & ALF	TPS	TPS	TPS	TPS	TPS	TPS	TPS	TPS	10P					
kA / sec														
AT/ MINUTES														
Rs AT 75°C	< 0,8	< 1,2	< 1,2	< 1,2	< 1,2	< 4,8	< 4,8	< 4,8						

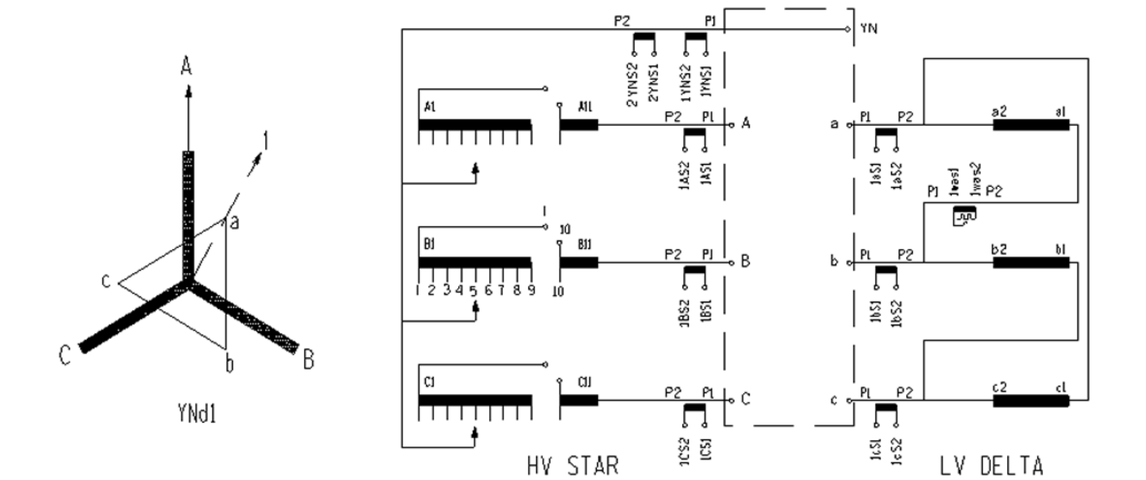
VOLTS	AMPS	ON LOAD TAPCHANGER CONNECTS		POSITION	ACROSS	VOLTS	AMPS	ACROSS
138 600	166,6	10-9	1-N	1			2099,16	
136 950	168,6	10-9	2-N	2			2099,07	
135 300	170,7	10-9	3-N	3			2099,61	
133 650	172,8	10-9	4-N	4			2099,52	
132 000	175,0	10-9	5-N	5	A - B - C	11 000	2100	a - b - c
130 350	177,2	10-9	6-N	6			2099,82	
128 700	179,4	10-9	7-N	7			2099,98	
127 050	181,6	10-9	8-N	8			2099,79	
125 400	184,2	10-9	9-N	9A			2099,88	
125 400	184,2	10-9	9-N	9B			2099,88	
125 400	184,2	10-9	10-N	9			2099,88	
125 400	184,2	11-1	10-N	9C			2099,88	
125 400	184,2	11-1	1-N	9D			2099,88	
125 400	184,2	11-1	1-N	9E			2099,88	
123 750	184,2	11-1	2-N	10			2099,88	
122 100	184,2	11-1	3-N	11			2099,88	
120 450	184,2	11-1	4-N	12			2099,88	
118 800	184,2	11-1	5-N	13			2099,88	
117 150	184,2	11-1	6-N	14			2099,88	
115 500	184,2	11-1	7-N	15			2099,88	
113 850	184,2	11-1	8-N	16			2099,88	
112 200	184,2	11-1	9-N	17			2099,88	

BUSHING DETAILS (TYPE & RATING)

POSITION	MAKE & TYPE	INS.LEVEL	AMPS
HV LINE	ABB, GOB 750 / 1250	750	1 250
HV NEUTRAL	ABB, GOB 380 / 800	380	800
LV LINE	ABB, CED 36 / 2500	200	2 500
LV NEUTRAL			



RELATIVE POSITIONS OF TERMINALS AND MAIN DRAIN VALVE



HV WINDING INSULATION PARTIALLY GRADED. HV NEUTRAL SHALL BE SOLIDLY EARTHED OR PROTECTED BY A 48 kV CONTINUOUSLY RATED METAL OXIDE SURGE ARRESTER WITH A 163 kV PEAK RESIDUAL VOLTAGE (10 kA)

Figure 9: Typical Rating and Diagram plate

3.13 Painting of Tanks and Parts

The painting of the transformer tank, the conservator tanks, the piping, the covers, the turrets and all other items that need to painted or galvanized shall done according to the requirement of the Eskom painting specification 240-56030674. The following items shall also be painted:

- the flange facing surfaces.
- the blanking plates that are used during transportation.

3.14 Special Auxiliaries

All auxiliary components used in the Eskom transformers shall comply with the relevant specification and must be approved by Eskom. An auxiliary component will be declared approved when it has been technically evaluated by relevant specialist and the approval is in writing. Auxiliary components shall comply with 240-62773019 as applicable.

3.14.1 Buchholz Relay

An oil and gas actuated relay suitable for operation in transformer oil as specified over the temperature range from - 10°C to + 115°C shall be interposed in the connecting pipe between the oil conservator and the transformer tank. The relay shall be fitted in such a manner that all the gasses from the tank pass through and are trapped by the relay as the gasses move towards the oil conservator. The mounting angle shall be as per the relay OEM instruction so as not to compromise the reliability of the relay.

For the purpose of redundant protection, transformers and reactors having a voltage rating of 220 kV and above or a rating of 100 MVA(r) and above shall be provided with two Buchholz relays. The relays shall be installed in series in the connecting pipe between the oil conservator and the transformer tank, mounted at least five pipe diameters apart - measured from facing flanges.

The oil and gas actuated relay shall comply with the requirements of 240-56063908. A valve must be fitted between the Buchholz relay and the conservator.

3.14.2 Pressure relief devices

Transformers rated below 100 MVA shall be equipped with one spring operated pressure relief device and those of 100MVA and above shall have two devices.

Pressure Relief Devices (PRD) shall comply with the requirements of 240-56063871 and shall be mounted so as not to entrap gases that may be generated or released inside the transformer. These devices shall be fitted directly to the side walls of the transformer tank at a level as near as possible to the top of the windings. Where one device is fitted it shall be positioned as close as possible to the centre phase. Where there are two devices they shall be arranged on opposite sides of the transformer, i.e. between 'A' and 'B' phases on one side and between 'b' and 'c' phases on the other. Alternative mounting positions, such as on the tank cover, may be considered if adequate mechanical protection can be provided to avoid inadvertent damage by erecting personnel. All mounting positions shall be such that the PRD(s) is(are) positioned above the partial drain mark. This shall be subject to approval by the *Purchaser* and be discussed during a mechanical design review meeting.

A combined weather guard and oil deflector shall be fitted to ensure free deflection of the oil towards the ground and provide adequate protection from the environmental elements. These must however not reduce the oil evacuation capability of the device.

Despite any testing requirements in this specification the overpressure device shall not be influenced to generate invalid trip signals by tank vibrations and the magnetic fields generated during normal operation and through faults.

3.14.3 Rapid Pressure Rise Relay

Each new transformer and reactor rated ≥ 80 MVA and ≥ 132 kV shall be provided with at least one rapid pressure rise relay. In the case of large units ≥ 500 MVA and ≥ 400 kV, two units, one on each of the longitudinal end shall be fitted. The function of the rapid pressure rise relay is to detect dynamic over-pressure conditions caused by abnormal activity inside the main tank and to provide a trip signal to remove the equipment from service. A suitable double flanged gate valve shall be fitted between the relay and the transformer tank to allow for maintenance without the need to drain the transformer oil. The position of the relay shall be such that maintenance and/or replacement of the components (valve and relay) can be done with partial drain. The position shall be discussed during a mechanical design review and submitted for approval. The relay shall be provided with seal in and reset feature and test facilities.

This component shall comply with the requirements of 240-56063867.

3.14.4 Thermometers for Oil and for Winding Temperatures

Oil temperature indicators (OTI's) and winding temperature indicators (WTI's) are fitted to transformers to measure the oil and winding temperatures. The indicators do not only display the temperature but are also used to start / stop forced cooling, provide high temperature alarm and trip signalling. The winding temperature gauges shall be provided for all the windings i.e HV, MV, and LV, where applicable.

These shall comply with the requirements of 240-56063843.

Class 1 Transformers shall be fitted with a Digital Temperature instrument in accordance with 240-75763120 for ambient, and oil and winding temperature measurements, fan control and alarm/tripping. The digital instrument shall be augmented by a conventional device as per 240-56063843 for oil temperature measurement and alarm and tripping.

The choice of the instrument technology shall be concluded during a design review meeting.

3.14.5 Fibre optic temperature probes

For all transformers when specified in the Schedules AB, for identification of hot spot temperatures, fibre optic temperature probes must be positioned based on mutual agreement between the *Contractor* and Eskom during the design review sessions. The sensors will be installed permanently for future use, with the connection points easily accessible 1.5m from ground level. A redundant sensor will be installed near the primary sensor.

For all the units fitted with fibre optic sensors, the units should have a through wall plate fitted at the top of the transformer tank (above the partial drain level) and extensions pre-fitted (factory supplied) terminating in to the marshalling kiosk. The position of the through wall plate and the internal extensions pathway within the tank must not follow a path whereby personnel entering the interior of the transformer would easily be able to damage them; furthermore the cover used for the plate must be a dedicated one and not an inspection cover.

3.14.6 Oil Level Indicators

Each conservator tank (main tank and OLTC) shall be provided with a dial-type oil level indicator that will show the correct oil level inside the tank. Direct reading fluid type oil level indicators shall not be used.

The indicators shall be suitable for the design of the conservator, i.e. free-breathing or bag type conservators.

Expected design life of the oil level indicator shall match the design life of a transformer, at least 40 years.

The oil level indicator shall comply with all the requirements of 240-56356191

3.14.7 Fans, Pumps and Radiators

Transformers and reactors are fitted with radiators to reduce operating temperatures. Where forced air cooling is required, fans are installed beneath the radiators and air is forced in a vertical direction to increase cooling of the oil. The fan motors shall be of the standard induction motor. The GSUs will be fitted with coolers. Pumps may be fitted in the event of forced oil cooling.

All radiators shall be mounted onto the main tank of the transformer. Each radiator shall be provided with top and bottom shut-off valves and shall be detachable from the main tank. The radiators shall be hot dipped galvanised only. The galvanising shall comply with SANS 1461. Radiators shall not be positioned over manholes, hand holes or inspection covers.

Radiators shall be equipped with stainless steel type DIN 42 558 bleeding and drain plugs. Seals shall be UV, heat and oil resistant. The bleed points shall have a double seal system.

Radiators shall have the necessary lifting eye connections. For shipping and storage, all flanged openings shall be permanently sealed by means of a blank, bolted and gasketed cover.

The fans and the radiators shall comply to the requirements of 240-56535946 and the requirements indicated in Schedules AB.

The transformer shall be supplied with cooler control equipment including:

a) an isolating switch rated to carry and break full-load current for each group of fan and pump motors;

b) a "manual"/"auto" change-over switch;

c) a contactor for each group of fan and pump motors. A set of normally open contacts shall be provided to initiate an alarm circuit if the contactor is tripped by its overload element. All such contacts of the various groups shall be paralleled and wired to a pair of terminals in the control cabinet.

d) contactors shall maintain supply to motors at supply voltage down to 0,85 pu of the rated supply voltage at their terminals. Tripping shall only occur on a controlled basis and there shall be automatic restarting in the staggered mode if the voltage recovers while the transformer is in service; and

e) provision for disconnection of all cooling pumps and fans on the closure of a contact provided by the purchaser. The “fan/pump stop” facility shall be provided via a latching relay, with the operate coil set by the application of 110V or 220Vdc (user selectable) via the purchaser’s Master trip relay. A reset push button shall be prvided in the Marshalling Interface Box for resetting the latching relay. The operating coil of the latching relay shall be continuously rated as it will be activated by a latched input function.

3.14.8 Air Bag

As indicated in Schedules AB certain units shall be fitted with an air bag in the conservator. The details of the airbag, including the dimensions shall be included in the manual and the drawings documentation. This should be such that it makes it easier for Eskom to order a replacement bag, should it become necessary, in the future.

3.14.9 Air Bag Leak Detector

Each transformer and reactor fitted with an air bag shall be provided with a bag leak detector. The function of the bag leak detector is to detect a leaking air bag. The abnormality will be detected by this detector and an alarm will be signalled to the control panel of the respective transformer or reactor. A contact will provide an alarm signal that the bag leak detector has operated to alert maintenance staff.

The air bag leak detector shall comply with the requirements of 240-56356202, and its intake shall be positioned about 100 mm from the top of the conservator tank, without compromising its reliability. The proposal for the installation shall be submitted at tender stage and shall form part of the mechanical design review. A bleed pipe and valve must be brought to ground level and fitted with a locking device to prevent unauthorised opening of the valve. A tag complying with the requirements of 240-56062720 shall be provided written **: “BAG LEAK DETECTOR AIR RELEASE”.**

A second valve to get the trapped air from the conservator must be provided. The associated text should read “**CONSERVATOR TANK AIR RELEASE”.** Both valves should have mechanical tamper proof covers.

3.14.10 Dehydrating Breathers

The dehydrating breathers used in the transformers shall comply with the requirements of 240-56062529. Self dehydrating breathers are acceptable and can be discussed during a mechanical design review.

3.15 Insulating Oil

The *Contractor* shall approve the oil to be used, and such oil must comply with the requirements of the latest revision of the Eskom Oil specification 240 - 75661431 and must be from the list of the approved oils. The list is available from Commercial. In support of the Eskom drive for environmentally friendly products, the so called green oils shall be considered for acceptance and they must comply to IEC 62770.

The *Contractor* shall also ensure that the oil used during manufacturing and testing at the factory is mixable with the intended oil for use in service. The mixing of the two oils should not expose Eskom to any risk and this must be approved during design review.

3.16 Cooling

3.16.1 General

Temperature limits as specified in IEC 60076. Unless otherwise specified differently in Schedule A of the purchasing specification, the weighted annual average ambient temperature of 30°C has to be taken into account.

With reference to 30 °C ambient temperature the temperature rise specified in IEC has to be reduced by 10°C.

3.16.2 Cooling Systems

Depending on the MVA rating and as specified in Schedule A of the specification, the following cooling systems can be applied: ONAN, ONAN/ONAF, ONAN/ONAF/ODAF, ONAN/ODAN, and ONAN/ODAF.

In cooling systems where forced oil cooling (OF) is in combination with natural oil cooling (ON), the core cooling has to be incorporated in the forced oil flow system.

When directed oil (OD) cooling is incorporated in the cooling system, low oil speed pumps (i.e. propeller pumps with low hydraulic resistance) have to be applied to ensure the directed oil flow.

Oil flow indicators shall be located so they are visible and can be easily read from the ground level.

Where only ONAF cooling is used, it must be capable of 100% of the capacity requirements.

Where ONAN as a cooling combination is used, natural cooling must be capable of at least 70% of the cooling capacity requirements.

For Generator-step-up transformers the cooling combination is either OFAF or ODAF as specified in Schedule AB. For special applications OFWN or OFWF type cooling may be specified. In order to eliminate the possibility of ingress of water into the oil, the maximum total pressure head of water at any point within the primary oil/water heat exchanger is kept below the static head of the oil at that point. In the case of OFWN (or ODWN) cooling, this can be achieved by providing pressure break tanks open to the atmosphere and fitted with balance type float valves for water level control. In the case of OFWF (or ODWF) cooling, the two stage cooling is provided in the form of double tube primary oil/water heat exchangers whose cooling water is circulated through low/high pressure heat exchangers (intercoolers).

Note: The water side of the water to water and / or water to oil cooling are provided with sacrificial anodes in the water boxes

3.17 Current Transformers

All current transformers shall comply in all respects with the requirements specified in Schedule AB and/or the following

3.17.1 Number and Location

The specification defines requirements for built-in CT's to be used by the purchaser.The Contractor shall specify, design and install any additional CT's required to meet other requirements(e.g.WT).The positioning of the CTs in the transformer turret must not compromise the safe operation of the transformer. The Contractor shall demonstrate by field calculations that the CTs and the associated wiring are positioned / traversing in a very low field or no field area.

The number, ratings and location of current transformers associated with each power transformer, shall be as specified in Table 11: Built-in CTs for 12B for Auto transformers and 20 MVA configuration, Table 12: Built-in current transformers for star-delta units above up to 20MVA (12D), Table 13 Built in Current Transformers for star-star transformers (12F), and Table 14: Built-in current transformers for star - Delta units above 20MVA(Class TPS "PX"core details).

All Current Transformers specified by the purchaser shall be (Class “PX”, as per latest IEC 61869-2 specification. Tests certificates shall be provided.

3.17.2 Transformer Short-circuits and Overload

Current transformers shall be capable of withstanding mechanically and thermally the same loading and overload, as specified in this document for the power transformer.

3.17.3 Insulation levels and short circuiting for testing.

Current transformers shall withstand all dielectric tests applied to the power transformer windings, and shall be in position and in circuit during the power transformer voltage withstand and impulse tests. Open circuits shall be avoided during testing of the transformer. All current transformers shall be short circuited in the factory and so delivered to site.

3.17.4 Terminal Connections

Current transformer secondary terminals, where applicable, shall comply with the requirements described below, and they shall be indelibly marked for identification. All current transformer terminals inside the power transformer shall be of the stud type and all connections shall be securely locked by means of lock nuts or locking plates. Steel lock washers are not acceptable.

3.17.5 Termination of Leads - Internal

Particular attention shall be paid to the termination of leads inside the transformer tank with a view to ensuring secure connection of current carrying lugs, and the elimination of all possible tension in the leads plus any possible risk due to the presence of the electric field as stated in 13.14.1 of this document.

3.17.6 Required Data

The following information relating to protective current transformers shall be submitted for approval:

- magnetization curve;
- secondary winding resistance (temperature compensated to 75°C); and
- secondary winding leakage reactance.
- insulation resistance

3.17.7 CT Designation

Where more than one protective current transformer is provided in any one phase, the current transformer designated "main protective current transformer" shall be located furthest from the transformer windings. In addition, protective current transformers together with current transformers in general, shall be given designations as indicated in figures 9 and 10 below

3.17.8 CT for Winding Temperature Indication for Delta Windings

Where the current transformer for a winding temperature indicator is associated with a delta-connected winding, it shall be located inside the delta so that it can detect all over current conditions of the delta winding, including those circulating current conditions resulting from external earth faults on the associated power systems.

3.17.9 Type and Accessibility

Current transformers shall preferably be of the bushing type. Separately mounted CT's shall be located above the transformer core and winding assembly and be provided with adjacent hand holes in the tank side or cover of a size adequate for their removal and replacement, which must be capable of taking place without the lowering of the oil and exposure of the paper insulation. The terminal box shall be positioned in the area outside the zone of high electric field of the associated bushing. This shall be demonstrated during a design review meeting and be verified during production.

3.17.10 Data for Rating and Diagram Plates

Where current transformers are built into the transformer, the combined rating and diagram plate shall provide full details of each current transformer's location, polarity, secondary terminal markings and also all the information required by IEC 61869-2 as applicable, with the provision that no information be duplicated.

The following symbols may be used on rating and diagram plates:

- IL = Secondary insulation Level (2 kV DC)
- Hz = Rated frequency
- Ith = Rated short-time current and rated time kA-s;
- Rs = Secondary winding resistance at 75 ºC;
- N = Turns ratio
- Vk = Kneepoint voltage
- Im = Magnetising current
- Ip = Primary current
- Is = Secondary current
- VA = Output in (VA).

3.17.11 Terminal Markings

The system of marking for identifying the terminals for current transformers supplied with power transformers, shown in figures 9 and 10, indicates: the polarity of the primary and the secondary terminals, or, where no primary terminals exist as such, the orientation of the current transformer; and the current transformer designation, viz. the connection in which it appears (e.g. a phase or neutral connection); the sequence relative to other current transformers appearing in the same connection. The current transformer winding (primary and/or secondary) and its polarity shall be denoted by the letter P and/or S and the Annexure 1 & 2 as specified in IEC 61869-2. The convention to be used always places P1 (and/or S1) nearer the external terminal of the transformer and P2 (and/or S2) nearer the winding.

The winding alpha-numerics and the polarity alpha-numerics shall be prefixed by letters denoting the phase or neutral connection in which the current transformers appear and these alpha-numerics shall be prefixed by numerals giving the sequence of the current transformers relative to other current transformers in the particular phase or neutral connection, as indicated below. These numbers shall be counted in the case of star-connected windings, from the power transformer external terminal towards the neutral point connection, and in the case of delta-connected windings in a direction from the external terminal through the particular phase winding towards the junction with another phase.

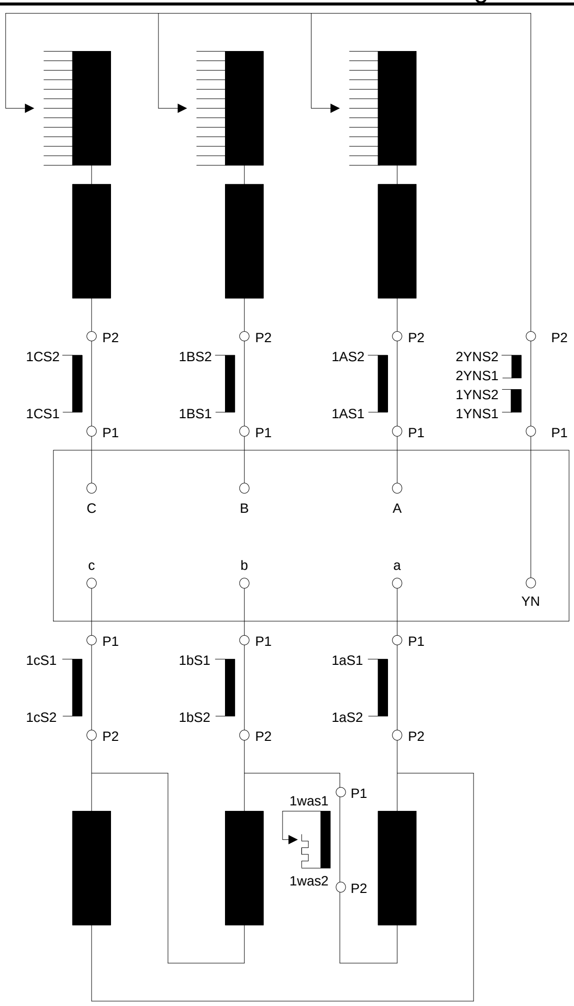


Figure 10 : Terminal Markings for ‘Class 1’ 2-winding transformers

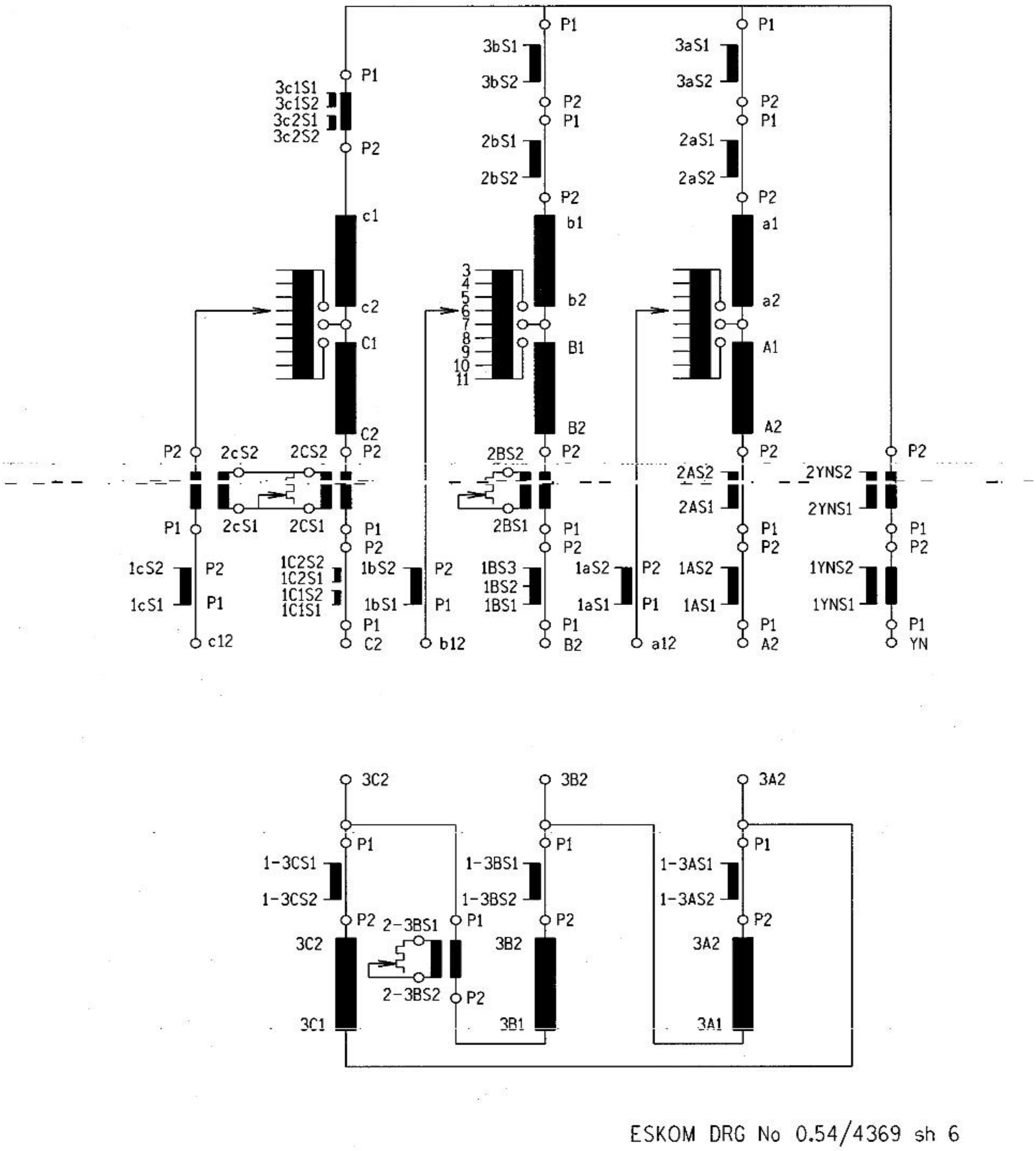


Figure 11: CT Terminal Markings for 3 winding auto transformers

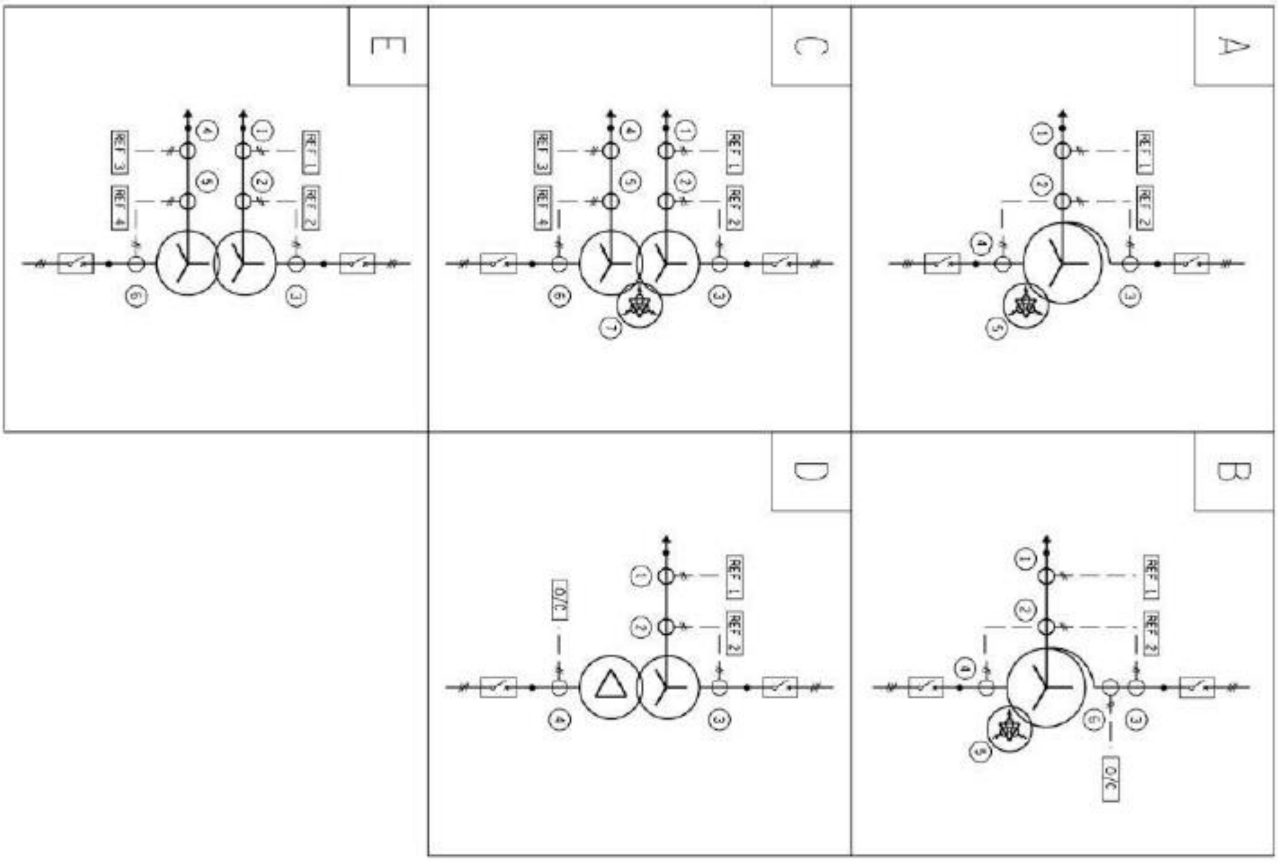


Figure 12: Built-in Current Transformers

Table 11: For Autotransformers of 12B and 20MVA

TRANSFORMER		IN-BUILT CURRENT TRANSFORMERS RATIOS		
kV	MVA	Cores 1, 2, 3 and 6 (class PX)	Core 4(class PX)	Core 5 (class PX)
132/44	20/5	400/1	200/1	100/1
88/44	20/5	400/1	200/1	200/1

Table 12: In-built current transformers for 12D (Star/delta transformers up to 20 MVA)

Transformer		**In-built current transformer ratios**		
kV	**MVA**	**Core 1** (Class "PX")	**Core 2, 3** (Class "PX")	**Core 4** (Class "PX")
132/33	20 10	200/1 200/1	400/1 400/1	400/1 200/1
132/22	20 10	200/1 200/1	400/1 400/1	600/1 400/1
132/11	20 10	200/1 200/1	400/1 400/1	1200/1 600/1
132/6.6	20 10	200/1 200/1	400/1 400/1	2400/1 1200/1

Transformer		**In-built current transformer ratios**		
88/44	20	200/1	400/1	400/1
88/33	20 10	200/1 200/1	400/1 400/1	400/1 200/1
88/22	20 10 5	200/1 200/1 200/1	400/1 400/1 200/1	600/1 400/1 200/1
88/11	20 10 5	200/1 200/1 200/1	400/1 400/1 200/1	1200/1 600/1 400/1
88/6,6	20 10 5	200/1 200/1 200/1	400/1 400/1 400/1	2400/1 1200/1 600/1
66/22	20 10 5	200/1 200/1 200/1	400/1 400/1 200/1	600/1 400/1 200/1
66/11	20 10 5 2,5	200/1 200/1 200/1 100/1	400/1 400/1 200/1 200/1	1200/1 600/1 400/1 200/1
66/6.6	20 10 5	200/1 200/1 200/1	400/1 400/1 200/1	2400/1 1200/1 600/1
44/22	20 10 5	200/1 200/1 200/1	400/1 400/1 400/1	600/1 400/1 200/1
44/11	20 10 5 2,5	200/1 200/1 200/1 200/1	400/1 400/1 400/1 400/1	1200/1 600/1 400/1 200/1
44/6,6	20 10 5 2,5	200/1 200/1 200/1 200/1	400/1 400/1 400/1 200/1	2400/1 1200/1 600/1 400/1
NOTE: For these ratings the 200/1 ratio has been selected as the lowest ratio to avoid wound primary current transformers on the basis that modern low burden protection can be set with adequate sensitivity using these current transformers.				

Table 13: Built-in CTs for 12A configuration

TRANSFORMER		**IN-BUILT CURRENT TRANSFORMER CORES**	
kV	**MVA**	**Cores 1, 2, 3 (class "PX")**	**Core 4 (Class "PX")**
400/275	800/40 400/40	2400/1 1000/1	1600/1 1600/1
400/220	630/40 315/40	2400/1 1000/1	1600/1 1600/1
400/132	500/40 250/40 125/20	2400/1 1600/1 1000/1	1600/1 1600/1 800/1

275/132	500/40 250/40 125/20	2400/1 1600/1 1000/1	1600/1 1600/1 800/1
275/88	315/40 160/20 80/10	2400/1 1600/1 1000/1	1600/1 800/1 400/1
220/132	500/40 250/40 125/20	2400/1 1600/1 1000/1	1600/1 1600/1 800/1
220/66	160/20 80/10 40/10	2400/1 1600/1 400/1	800/1 400/1 400/1
132/88	315/40 160/20 80/10	2400/1 1600/1 1000/1	1600/1 800/1 400/1
132/66	80/10 40/10	1600/1 1000/1	400/1 400/1
132/44	80/10 40/10	1600/1 1000/1	400/1 400/1
88/44	80/10 40/10	1600/1 1000/1	400/1 400/1

Table 14: Built-in current transformers for star-delta units above 20MVA (12D)

Transformers		In-built current transformer ratios		
kV	**MVA**	**Core 1**	**Cores 2,3**	**Core 4**
132/33	80 40	400/1 200/1	600/1 400/1	1 600/1 800/1
132/22	40	200/1	400/1	1 200/1
132/11	40	200/1	400/1	2 400/1
88/44	40	200/1	400/1	600/1
88/33	80 40	400/1 200/1	600/1 400/1	1 600/1 800/1
88/22	40	200/1	400/1	1200/1
88/11	40	200/1	400/1	2 400/1
66/22	40	200/1	400/1	1 200/1

Table 15: Built in Current Transformers for star-star transformers (12F)

Transformer		In-built current transformer turns ratio				
kV	**MVA**	**Core 1 (Class "PX")**	**Cores 2 & 3 (Class "PX")**	**Core 4 (Class "PX")**	**Cores 5 (Class "PX")**	**Core 6 (Class "PX")**
132/11	40	200/1	200/1	2400/1	2400/1	2400/1
	20	200/1	200/1	1200/1	1200/1	1200/1
66/11	40	400/1	400/1	2400/1	2400/1	2400/1
	20	200/1	200/1	1200/1	1200/1	1200/1
33/22	5	200/1	200/1	200/1	200/1	200/1

33/11	20 10 5 2,5	400/1 200/1 200/1 200/1	800/1 400/1 200/1 200/1	1200/1 600/1 400/1 200/1	1600/1 800/1 400/1 200/1	1200/1 600/1 400/1 400/1
33/6,6	10 5 2,5	400/1 200/1 200/1	800/1 400/1 200/1	1200/1 600/1 400/1	1600/1 800/1 400/1	1200/1 600/1 400/1
22/11	20 10 5 2,5 1.25	400/1 200/1 200/1 200/1 200/1	800/1 400/1 200/1 200/1 200/1	1200/1 600/1 400/1 200/1 200/1	1600/1 800/1 400/1 200/1 200/1	1200/1 600/1 400/1 400/1 400/1
22/6,6	10 5 2,5	200/1 200/1 200/1	400/1 200/1 200/1	1000/1 600/1 400/1	1000/1 600/1 400/1	800/1 400/1 200/1
33/3,3	5 2,5	200/1 200/1	200/1 200/1	1000/1 600/1	1000/1 600/1	300/1 400/1
22/3,3	5 2,5	200/1 200/1	200/1 200/1	1000/1 600/1	600/1 600/1	400/1 400/1

Table 16: Built-in current transformers (Class “PX” core details

	CLASS "PX" CORE SPECIFICATION		
TURNS RATIO Np/Ns	**Im (mA) (MAX)**	**Vk(Volts) (MIN)**	**Rs(Ohms) (MAX)**
1/ 100	500	150	0,4
1/ 200	500	200	0,8
1/ 300	330	300	1,2
1/ 400	250	400	1,6
1/ 500	200	500	2
1/ 600	170	600	2,4
1/ 800	125	600	3,2
1/1000	100	650	4
1/1200	83	650	4,8
1/1400	71	650	5,6
1/1600	63	700	5,6
1/2000	50	700	8
1/2400	42	750	9,6
1/3000	35	780	12
1/4000	25	860	16
Im = CT excitation current Vk = knee-point voltage			
The knee-point of the excitation curve is the point where an increase of 10 % of the secondary emf results in a 50 % increase of excitation current.			
Class PX -to meet requirements of the latest revisions of NRS 029-CT’s rated for AC voltages from 3,6-420Kv as well as IEC 60044 Part 1 and Part 6.			

3.18 Transformer Testing

3.18.1 Active Part and General testing

All transformers shall be tested to the latest IEC requirements. Special requirement is however applicable for the switching impulse test. Rated switching impulse withstand voltages are assigned to the winding with highest U_m. Test stresses in other windings are proportional to the turns ratio and are adjusted by selecting appropriate tappings to come as close as possible to the assigned value in Table of the addendum. The switching impulse stresses in other winding shall be limited to approximately 80% of the assigned lightning impulse withstand voltages at those terminals. Lightning impulse shall include chopped wave testing, unless it is otherwise stated.

The Employer shall indicate in the schedules AB the required tests and the classification thereof. Eskom representative shall participate in the testing of each transformer as shall be indicated in the applicable document viz, Inspection and test plan, Product/Process Quality Plan or any equivalent. It is required that for the non-South African factories, the notification of such tests be given in writing at the latest of 10 weeks before date of testing. This date will be a preliminary date that can change by a few days as the time gets closer.

After a successful testing, it is required that the Contractor carries out an internal inspection on each unit and where it is possible, and shall confirm through a report to the Employer that he is satisfied that all is still in order. This inspection shall be carried out when a transformer is in a cold condition. The transformer can only be shipped or transported once an official release from Eskom has been obtained by the Contractor in writing.

3.18.2 Transformer Tank Testing

3.18.2.1 Tank and fittings

Each transformer tank complete with all the fittings and attachments normally in contact with the transformer oil, and filled with oil with a viscosity not greater than that specified in 32-406, shall withstand, for 24 h, at room temperature, without leakage, a hydraulic pressure that is not less than 35 kPa above the maximum working pressure at every point in the transformer.

3.18.2.2 Pressure relief valve

One pressure relief valve of each make and type, set to open at the specified pressure, shall withstand, for 24 h, at room temperature, an internal pressure of oil of 20 kPa above the maximum working pressure at the position of the valve, without leakage.

3.18.2.3 Internal hydraulic pressure withstand

One tank, radiators and oil conservator of each type and size shall be subjected, for 1 min, to an internal hydraulic pressure equal to 70 kPa or the maximum operating pressure plus 35 kPa whichever is the greater, without suffering permanent deflection, measured after a first application greater than the amounts specified in the schedules of this specification.

After a second application no further permanent deflection shall be measurable.

3.18.2.4 Vacuum withstand

One tank, radiators and oil conservator of each type and size, both empty of oil, shall be subjected, for 1 min, to an absolute internal pressure of 1,5 kPa, against atmospheric pressure at sea level on the outside, without suffering permanent deflection, measured after a first application greater than the amounts specified in Table 14 of this specification. After a second application no further permanent deflection shall be measurable.

NOTE: The above two tests may, by agreement, be combined.

Table 17: Maximum permanent deflection of steel tank panels between stiffeners

Maximum permanent deflection (mm)	Major dimension of fabricated assembly (mm)
16	> 3 000
14	> 2 700 ≤ 3 000
12	> 2 300 ≤ 2 700
10	> 2 000 ≤ 2 300
8	> 1 650 ≤ 2 000
6	> 1 300 ≤ 1 650
4	> 950 ≤1 300
3	> 750 ≤ 950
2	> 600 ≤ 750
1	> 450 ≤ 600
0	≤ 450

3.18.2.5 Dye-penetration testing

To avoid leaks, dye-penetration testing shall be done prior to corrosion proofing of the tank and other manufactured fittings after any welding.

3.19 Transformer Transportation

3.19.1 General Conditions

It shall be the *Contractor*'s responsibility to make all arrangements for transport with the appropriate authorities. Eskom will only accept delivery from the *Contractor* on site. It shall be the *Contractor*'s responsibility to co-ordinate the arrangements for all stages of the transport of the transformer from the manufacturer's works to site, including trans-shipping where necessary. Where off-loading is required, all apparatus, materials and packages shall be addressed to the *Contractor*, who shall take delivery of the same at site.

The dimensions of the transformer shall be such that when packed for transport, it will comply with the requirements of the loading and clearance restrictions for the approved route. The max transport dimensions are limited to the following, otherwise indicated in the relevant purchase order.

Height 5 000 mm

Width 4 300 mm

Length 10 500 mm

All metal blanking plates and covers which are specifically required to transport the particular transformer, shall be considered part of the transformer and be handed over to Eskom after completion of erection. A listing of all these items and relevant drawings shall be included in the manuals, to enable Eskom to have the plates manufactured if required. The dimensions and quantity of each item required for transport shall be on the drawings. Where the supply of oil is included in the contract and where transport weight limitations permit, the transformers shall be transported with sufficient oil to cover the core and windings during all transport and storage conditions. The tank shall be sealed for transport to prevent all breathing.

Alternatively, where the above method is not applicable, the transformer shall be maintained continuously under positive pressure of dry air of at least 20 kPa during transport and storage until final installation. The pressure and the temperature at the time of filling shall be documented as part of the quality system. A pressure gauge, suitably protected shall be fitted to each transformer to facilitate checking of gas pressure during transit and on site. The pressure gauge shall be situated at ground level not higher than 1.5 m. The gauge, pipework and other accessories shall be protected against transportation and handling damage. The pressure gauge shall be clearly visible for routine checks without having to remove protective covers. A non-return valve shall be provided at the point of entry into the transformer to prevent loss of dry air due to pressurising equipment failure. The dry air cylinder shall be located at ground level fixed to the side of the main tank.

The total duration that the unit is filled with dry air shall be limited to six months where after the transformer must be appropriately processed and filled with oil as for service. Every precaution shall be taken to ensure that the transformer arrives at site in a satisfactory condition so that after proper oil processing and filling it may be put into service without the necessity for extensive drying out.

Full details of the proposed method of transport shall be submitted for approval.

The costs of any necessary extensions and/or improvements to existing facilities for transporting to site and escort and permit fees shall be included in the *Contractor*'s prices.

3.19.2 Impact Recorders

The supplier shall attach to each transformer an impact recorder, which shall be capable of recording shocks in three axes. One impact recorder shall be mounted inside the tank on the active part and the other one on the tank wall. This shall remain the property of the *Contractor* and will be returned by the purchaser with transportation charges collect. The chart, or three copies of it, shall be delivered to Eskom.

The *Contractor* shall inspect the impact recorder charts before unloading, and provide a report to the *Employer.*

3.19.3 Testing During Transport

Procedure 240-56030661 Requirements for transportation and movement of large electrical equipment shall be used.

The Contractor shall perform SFRA test and Core Insulation Resistance Test (500 V DC for one minute) during the following transport stages:

a) At the factory before loading into the transport

b) Alongside ship prior to loading

c) Before offloading from ship

d) After offloading from ship when on ground (in case of not loading direct to the road transport)

e) After loading on road transport, before start moving (Insulation resistance only for d) and e))

f) On arrival at destination port before loading for road transport

g) On arrival at site after final positioning

All test results shall match the original factory test results for acceptance. The results of the above tests shall be documented, signed off as part of the quality process and included in the transformer manuals, both hard copies and soft copies where applicable.

3.19.4 Sea Transport

The *Contractor* shall make the necessary arrangements for suitable slings or lifting tackle to be available for off-loading at the quay-side and may make use of the equipment provided under the contract, on the condition that it is handed over to Eskom in good order.

3.19.5 Road Transport

The transport arrangements shall include any necessary extensions and/or improvements to road routes, bridges, and civil works, and also the assurance that any abnormal loads comprising the transformers, their transporters, ancillary apparatus and plant and equipment required for erection shall pass without obstruction throughout the selected route.

3.19.6 Transport support brackets

Attention is drawn to the necessity of receiving approval from the transport contractor of the design and spacing of transport support brackets to avoid overstressing of the relevant trailer carrying beams.

3.20 Erection

3.20.1 General

Erection shall include off-loading, installation, full assembly, oil treatment and testing of the transformer.

All equipment provided for erection shall be removed from site when erection is completed and the site cleaned of any debris and oil spillage.

3.20.2 Foundation Tolerances and Transformer Layout Details

Foundation tolerances and layout details shall be submitted for prior approval by Eskom. When the foundation has been constructed, before installation begins, the *Contractor* or his appointed representative shall inspect and confirm the suitability of it to handle the intended transformer.

3.20.3 Site Installation

Site installation shall be performed by the OEM.

All installation projects shall comply with the OSH Act No. 83 of 1993 and ORHVS.

Before commencement of site / store installation a Scope of Work shall be compiled and agreed upon between the OEM and the *Purchaser*. Compiling of the SOW shall be the responsibility of the *Contractor*. The requirements of the Eskom document 240-56062726 *Standard for Intrusive work and Oil filling, under vacuum of transformers and reactors on site* shall be the minimum requirements for handling the transformer during works on site. OEM requirements that are betterment of these requirements will be welcomed. An internal inspection, where possible, will be done by an Eskom employee at the completion of all the intrusive work to ensure that there is no risk when the unit returns into service. This activity does not relieve the supplier/ *Contractor* from his obligation to provide a risk free unit to Eskom.

3.20.4 Functional Tests

Functional tests shall be done on site after complete erection to verify that all the systems are working in harmony. These tests shall include but are not limited to

- Fan and oil pump direction and setting of overload protection relays.
- Correct operation and indication of tap changers.
- All valves in service position.
- Functional test for all alarm and tripping contacts.
- Pump start not tripping buchholz
- Cooling system philosophy

3.20.5 Electrical Tests According to IEC

The onsite testing shall include, but not limited to, the:

- Voltage ratios on all winding sets, tap positions and on all phases
- Impedance test at all tap positions
- Vector group
- Three-phase 380 V magnetising currents
- Winding insulation test – minimum 5kV
- Core insulation test (500 V DC for 1 minute)
- CT polarities, function and insulation
- Fan- and oil pump motor insulation test
- Control/power cabling insulation (minimum 1 kV)
- Tap changer continuity test
- Winding & bushings insulation integrity test (Doble M4000 instrument)
- SFRA after final assembly and oil filling (Doble M5000 instrument)
- Zero sequence impedance

All the required tests shall be indicated in the relevant ITP or PQP document which shall be finalized between the *Employer* and the *Contractor* before installation commences.

3.21 Condition Monitoring

Condition monitoring is a very valuable tool for transformer life management. For a smart grid network it is important that transformer visualization is achieved at its best. It is preferred that all the condition monitoring signals from the transformer and from the components are available from one central point right at the transformer. These signals will then be sent to appropriate points where the operator can see them as well as to the APM tool for automated life assessment. The communication channels must comply with the requirements of IEC61850.

3.21.1 Gas Analysers

An option for a gas analyser to be provided & installed together with the transformer should be given on the tender return for all transformers of 80MVA or higher and highest voltage above132kV, and it should meet all the requirements of 240-64917195. Two valves shall be provided, one as an intake from the transformer tank to the gas analyser and the other as the outlet back to the transformer from the gas analyser. The oil intake shall be from the top oil expanse level, with the pipe routed inside the main tank against the tank wall to the intake valve. These valves shall be 25mm double flanged gate valves and be at ground level (1.5m or below).

For transformers with power rating below 80MVA and with highest voltage of 132kV and below, only the valves will be required but not the gas analyser itself.

3.21.2 On line drying system

An option for an on line drying system to be provided & installed with the transformer must be given on the tender return, it should meet all the requirements of 240-59083215. Provision for online dryer system shall be made with two gate valves installed for supply and return oil with appropriate locations for effective drying. The valves shall be 25mm double flanged gate valves full flow design. A method of anti-vibration shall be provided for mountings of online dryers (moisture removers). This requirement is fully applicable only to transformers with power rating of 80MVA and above plus with a highest voltage of above 132kV.

For transformers with power rating below 80MVA and with highest voltage of 132kV and below, only the valves will be required but not the online dryer itself.

3.21.3 Fibre optic temperature sensors

Transformers shall be provided with fibre optic temperature sensors as indicated in the AB schedules. The vendor must provide with the transformer the fibre optic extensions and the signal conditioning device to present the temperatures as 4-20mA signals to be connected to the data concentrator mentioned above or directly to the Eskom protection panels. These should be terminated in the transformer marshalling kiosk.

3.21.4 General

The condition monitoring station should have a life span matching that of the transformer and must not introduce more frequent maintenance requirements.

All bidders shall provide a proposal for a condition monitoring system for active part, bushings, and on-load tap changers.

3.22 Documentation

Drawings, Photographs, Instruction Books, and Test Reports-As listed below shall be sent to Eskom. All drawings shall include the following information: Eskom, Serial Number, Design Fault Levels, gravitational force design limits, Power Ratings, Voltage Ratio, and Eskom Purchase Order Number.

Five (5) copies of outline, nameplate, base, bushings, schematics and complete wiring diagrams, terminal block arrangement drawings showing physical locations with dimensions are to be submitted for approval. The nameplate, schematic and wiring diagrams shall be submitted one month after the receipt of Purchase Order. The remaining drawings shall be submitted together a minimum of 8 months prior to delivery. The base drawings shall indicate the dimensions, jacking points, load bearing surfaces, and approximate total weight to facilitate the customer's foundation design. *Purchaser* shall return one copy of each drawing with comments or approval. All approved drawings are to be submitted in paper and in a CD. A late drawing penalty shall be assessed according to the schedule A of the specification.

Four (4) Photographs of the core and coil assembly shall be taken at such angles as to provide the maximum of design and construction information for records.

Quality Control Information-after an order has been, a copy of the manufacture quality control manual will be provided upon request to Eskom for their review.

One (1) complete transformer manual shall be delivered with the transformer. The manual shall be easily accessible and protected from moisture / water damage during transport and storage. This manual shall be used for erection and commissioning purposes and shall include the factory test results and diagrams.

A further (4) manuals and one (1) electronic copy on CD shall be delivered not later than 14 days after completion of all commissioning tests. This manual shall include the electrical results from the commissioning testing carried out on site as well as testing done during transport. All oil sample results from tankers and main tank shall also be included. In the CD an original file in the original format for the SFRA test shall be included for the future reference purposes.

All drawings are to comply with the Eskom drawing standard TPC 41-246 .

3.23 Adjudication of Tenders

3.23.1 Failure Rates, Reliability and Manufacturing Experience of *Contractor*s

The failure rate, reliability and manufacturing experience of the transformers, reactors and phase-shifters supplied from the transformer factory from which the Employer's transformer(s) will be sourced during the contract duration are to be provided in Schedules A&B. The statistical data of failure rates and manufacturing experience reflects the experience of the factory from which the Employer's transformers will be sourced and not the company group.

The factory failure rate, in service failure rate, manufacturing and testing experience statistical data is used during the tender evaluation.

3.23.2 Population

The population of transformers to be considered in the calculations of the in failure rates is all the transformers and reactors with a rating above 10 MVA(r) that was manufactured at the factory over the past 10 years, irrespective of who was the customer.

3.23.3 Factory Failure

A failure in the factory is defined as a situation arising where major opening/dismantling of the transformer is required to correct a failure caused during factory testing. Thus having to drop the oil, un-tank or remove the top yoke in order to repair a failure or defect caused during testing is defined as a factory failure.

3.23.4 Factory Failure Rate

The factory failure rate (one-year) is defined as the ratio of the number of factory failures to the population of transformers, reactors and phase-shifters manufactured over a one-year period. A minimum of 10 years data must be provided in the tender documentation. The factory failure rate (five-year) is the rolling average of the factory failure rates (one year) taken over a five year period. Failures during testing of special transformers or new developments may be excluded from this statistics. Eskom allows for a maximum of 3% factory failure rate per annum. Eskom reserves the right to audit these figures at any given point. If an approved supplier's performance during the contract period deteriorate and is above this 3% figure, Eskom may terminate placing further orders at any given time.

3.23.5 In-service Failure

An in-service failure is defined as a forced outage failure plus a scheduled outage failure as defined in IEEE 57.117.1986. Further to the definition in IEEE 57.117.1986 the failure is only regarded as an in-service failure if the transformer had to be removed from its bay for the defect to be repaired.

3.23.6 In-service Failure Rate

The in-service failure rate (one-year) is defined as the ratio of the number of in-service failures to the population of transformers, reactors and phase-shifters accumulated service time over a one-year period. A minimum of 10 year's data must be provided in the tender documentation. The in-service failure rate (five-year) is the rolling average of the in-service failure rate (one year) taken over a five year period.

3.23.7 On Time Delivery

The On-Time Delivery Rate is defined as the number of the units that were delivered on or earlier than the agreed contractual date. This shall be calculated on ex-works.

3.23.8 On Time Delivery Rate

The On-Time Delivery Rate is defined as the number of the units that were delivered on or earlier than the agreed contractual date over the number of units delivered over the period of 12 months. Eskom requires an on time deliver rate of ≥95%. If an approved supplier's performance during the contract period deteriorate and is below this 95% figure, Eskom may terminate placing further orders.

3.24 Quality Assurance

The official Eskom Standard for "Quality Assurance Requirements for the Procurement of Assets, Goods and Services" is TST41-168.

Eskom or the representative reserves the right to inspect the materials, equipment manufacture and witness the tests. The manufacture shall allow access to the Eskom representative without any hindrance or additional charges to the Eskom. The Manufacture shall notify Eskom at least 10 weeks prior to commencement of the tests.

The Manufacturer shall submit a schedule within four weeks of the award of the contract.

This shall show dates for:

- Engineering
- Submit transformer Outline drawing to allow foundation design
- Submit Drawings for approval
- Supply of Instruction Manuals
- Purchasing and Delivery of Components
- Manufacturing and Assembly
- Testing of Transformer
- Shipment to Site

If a unit fails under test, the supplier will officially notify the employer in writing within 24 hrs of the failure, the *Contractor* will set up a meeting with the employer to discuss and agree on a way forward. The *Contractor* will supply a written report on the failure within 30 days of the failure.

3.25 Loss Evaluation

All losses will be capitalised using the formula below when adjudicating the tenders.

3.25.1 Guaranteed losses

The manufacture shall guarantee the following losses for each transformer:

- No-Load loss in kilowatts at rated voltage and rated frequency.
- Total losses in kilowatts at rated output, rated voltage and rated frequency
- Auxiliary losses – 50% of the total of the auxiliary supply load to be added to the load losses to give total load losses.
- Load losses shall be evaluated for MVA rating as specified in schedule A of the rating for each transformer.
- Transformer losses determined under tests shall be corrected to 75°C. No-Load loss shall not be corrected.

The transformer cost shall be evaluated as follows:

Evaluated Cost = P + [A * E] + [B * L]

Where:	P	=	Transformer tender price
	A	=	Evaluated Cost of No-load loss per kW
	B	=	Evaluated Coast of Load loss per kW
	E	=	No-load loss in kW
	L	=	Load loss in kW

Table 18: Coefficients of losses

Calendar Year	No load losses A (R/kW)	Load losses B (R/kW)
2023	R87 900	R19 200
2024	R93 200	R20 300
2025	R98 800	R21 600
2026	R104 800	R22 800
2027	R111 400	R24 200
2028	R118 100	R25 700

3.25.2 Non Conformance on losses

If the measured no-load losses and/or load losses exceed the IEC tolerances Eskom reserves the right to reject the transformer.

If the no-load losses and/or load losses measured exceed the guaranteed value then the incremental cost of loss evaluation shall apply as a penalty multiplied by the factor 4.

If the measured temperature rises exceed the guaranteed values, the highest deviation in degrees (top oil rise, average winding rise, hot spot rise) will be penalised. For each 1°C exceeding the guaranteed value, 1.5% of the transformer purchase price will be penalised. If the deviation is more than 5°C the transformer will be rejected or countermeasures have to be implemented to mitigate against the deviation.

There will be no credit or payment of premium if actual values are better than guaranteed values.

3.26 Training of Purchaser's staff

The *Contractor* shall propose an appropriate and cost effective training program for the operating, maintenance and engineering staff of the *Purchaser*. This shall include the nomination of an appropriate venue and duration of the training period.

If the proposed training involves travelling and accommodation and subsistence away from the *Purchaser*'s home country, the *Purchaser* shall be responsible for all the direct travelling and subsistence expenses involved for a maximum number of four (4) of the *Purchaser*'s staff.

The *Purchaser* shall have the option at his own expense, to add a further two (2) staff members.

The *Contractor* shall provide a complete and detailed broken down schedule of the training events but is not expected that formal training should last less than 5 consecutive working days nor more than 10 consecutive working days.

The *Contractor* shall advise the *Purchaser* of the minimum pre-requisite level of education required for the employees to successfully participate in the training programme.

Over and above any formal training, the program shall include as a minimum, an on-site component covering:

- on site preparation for transportation
- loading and off-loading procedure and precautions
- Installation procedures and precautions
- functional testing of tap changers, sensors and protective devices
- vacuum treatment, drying filtering and impregnation
- general maintenance and in-service inspections and checks
- all electrical testing of the completed system to ensure that it is ready for service

Special emphasis shall be placed on quality control processes and the maintenance of the oil and insulation system to keep it in the best possible condition to ensure maximum life for the transformer, as well as the underlying theoretical aspects.

These training requirements shall form part of the hand over for each installation.

The *Contractor* shall make available in electronic form training material that is adequate for the *Purchaser* to execute all handling and maintenance necessary in the future. The copy of such material will form part of the manual.

3.27 Local Support

Potential transformer suppliers shall have an established local technical support base. A Supervisor from the *Contractor* shall be available on site within 24 hours of notification of an emergency by the *Purchaser*.

The supplier shall be fully equipped to attend to emergencies and equipment failures within the guarantee period of the transformer.

3.27.1 Local Support's Requirements

It is required that the local technical support cater for:

- Emergency breakdowns
- Failure investigations
- Maintenance & breakdown spares
- Operational enquiries
- Training

3.28 Safety on Transformers

Safety is very important in Eskom, and this includes when working with transformers. It is important therefore that all transformers designed and manufactured for use in the Eskom network take into consideration the safety needs. This includes but not limited to

- Safety of people working on a transformer, especially on top of the tank. The employees and the contractors should be able to do so with no risk of falling.
- Safety of the people working inside the transformer (e.g. making connections or doing inspections). A worker must be able to safely execute this with no risk of falling as reasonably as possible.
- Safety of people around the transformer when in operation. There must be no possibility of inadvertent contact with live apparatus while on ground level and where this is not achieved, it must be highlighted to the *Purchaser* at the tendering stage.
- Tank designs and components arrangement should be such that as practically reasonable as far as possible, tank rupturing is avoided.

The technology and the materials used in the construction of transformers must support the safety drive of Eskom.

4 Authorisation

This document, in this revision, was distributed to the following managers.

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5 Revisions

Date	Rev.	Compiler	Remarks
Feb 2024	3	NS Mtetwa	Table 2 updated Paragraph 3.4.8 updated to include special requirements for heavy duty/Arc Furnace transformers Paragraph 3.5.2 for core materials revised to include quality and appearance of materials. Paragraph 3.6.4 revised to include specific requirements for EHV and UHV units. Paragraph 3.11.1 revised to include convertor requirements for non-standard voltages. Table 10 revised Paragraphs 3.14.11, 3.17.4, 317.10 removed. CTs changed to PX type on various tables. CT ratios revised in various CT tables Updated Table 18 by extending it.
April 2017	2	NS Mtetwa	On paragraph 3.4.8, the requirments for short circuit withstand capability were revised to include thin conductors, and merged with 3.6.6. of the previous revision. 3.6.6 was then deleted. Table 4 was added on paragraph 3.6. Paragraph 3.8.9.2 revised to include protection at the loss of oil in the tap changer conservator. On paragraph 3.9, the tap changer requirements updated to align with IEC revised standard by eliminating the flag cycle requirement. Furthermore, oil type tap changer was kept as an alternative technology. Paragraph 3.9.8.4 revised. Marshalling kiosk requirements revised on 3.11.2 Requirements for cooler control expanded on 3.14.7 paragraph 3.14.10 added to include self dehydrating breathers. Valves requirements for sections 3.21 revised for the online gas analyser and the online moisture remover. Data concentrator requirements removed on 3.21
June 2014	1	NS Mtetwa	This document was compiled to consolidate the requirements from the previous 3 different divisional specifications and to bring in the new requirements identified through learning since the previous documents.

6 Development team (Working Group)

The following people were involved in the revision of this document:

Lionel Jordaan	Senior Consultant - Power Generation Engineering
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Bongani Qwane	Chief Technologist – Transmission Secondary Plant
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Lester Guldenhuis	Chief Engineer – Transmission Grids

7 Acknowledgements

The Work Group (Development Team) acknowledges all the people who reviewed this document and contributed with comments and advises. Further acknowledgements go to all Eskom employees who made sure that the learnings from their various activities form part of this work, the people who compiled the divisional documents, and all the transformer experts who shared their knowledge and experience.

TECHNICAL SPECIFICATION

ITEM 7: 132kV and 275kV Bushing for power transformers

7.1 Scope

132/275kV outdoor transformer bushings of type GOB, GOA, GOE and GOM or equivalent to replace old outdated and damage bushings in CoT network transformers and are required for replacement on transformers from the following manufacturers and rating, ABB, GEC, English Electric and ASEA in the range from 20, 35, 250 and 300mVA transformers. As approved by Engineer

7.2 Normative references

SANS 60137: 2010 Insulated bushings for alternating voltages above 1 000 V
Terms, definitions and abbreviations. The requirements of the standards listed apply.

7.3 Bushing Ratings with the requirements of SANS 60137, schedule A and the following apply:
7.3.1 Standard values for highest voltage, $U_{m(kV)}$: 145kV and $U_{m(kV)}$: 300kV
7.3.2 Standard values for of rated current $I_{r(A)}$; 1250A. (132kV), and 1600A (275kV)
7.3.3 Standard values of rated thermal short-time current I_{th}; Clause 4.3.
7.3.4 Standard values for of rated dynamic current Id: clause 4.4.
7.3.5 Minimum withstand values for cantilever load: Table 1 refers.
7.3.7 Minimum nominal creep-age distance: 25mm/kV.
7.3.8 Temperature limits and temperature rise: Table 2 refers.
7.3.9 Standard insulation levels: Table 4 refers.
7.3.10 Test tap on transformer bushings: required.
7.3.11 Type Oil to Air
7.3.12 Construction oil impregnated paper

7.4 Tests
The requirements of SANS 60137 apply.

7.5 Marking, labelling and packaging
The requirements of SANS 60137 apply.

Documentation
The requirements of SANS60137 apply.

SECTION 4: TECHNICAL SPECIFICATION DGA

Technical and operational specification for transformer fault gas analysis and bushing partial discharge measurement

SPECIFICATION No: GR.01/0-12 – Rev 0

CONTENTS

1. SCOPE

This document describes the requirements for a system that will automatically monitor fault gases dissolved in transformer oil, while the transformer remains in service. The system must also provide an indication of dissolved water in the system, and have the option to provide all indications locally or remotely.

The document covers the description of units which can be used to measure the dissolved gas in a single oil tank, or multiple oil tanks. Where the transformer being tested has a main tank as well as tanks for on line tap changers and the oil quality is typically substantially different between the various oil tanks, the measurement in the multi tank solution must ensure that no contamination takes place.

Where DGA analysis in tap changers is being performed, it might be possible to measure fewer gases which are expected to be present with the sever arcing generally taking place in the

Portable units which can be used to test oil samples on site are also described in this document.

2. SCOPE OF SUPPLY

The provision of services described in this document shall include at least the supply, installation and commissioning of the complete system dissolved gas measurement equipment on site, but could also include the installation of the necessary communication infrastructure to allow remote on line monitoring.

Final calibration and verification of the installed equipment will be provided once commissioning is complete.

All necessary training required for the operation of the system will be provided to the maintenance and relevant staff.

The necessary repairs and services required to keep the system operational will also be included in the proposal.

The necessary post installation technical support required to keep the system operational will be included in the proposal.

3. REQUIREMENTS

3.1 General requirements

3.1.1 Physical requirements

All devices must be self-contained and suitably robust for installation in the field as required. As such, the system shall be contained in a weather proof enclosure with a minimum IP rating of IP55. This enclosure must be mounted on an independent stand which is bolted onto a concrete plinth.

3.1.2 Wiring and labelling

All terminals, cables and pipes shall be clearly labelled.

3.1.3 Data measurement and storage and transfer

All devices must be capable of having a preselected sampling rate between 24 hours and 1 hour. On board data storage should be at least 1 year at the maximum sampling rate.

Additional inputs shall be provided to allow be provided in the system to record such measurements as transformer load current, transformer oil temperature, ambient temperature and partial discharge measurements.

Communication with the system will be locally via a serial / USB port and remotely via either PSTN, GSM, or wireless radio.

3.1.4 Oil interface

Fixed units shall be provided with oil from the transformers via either the standard valves, or via valves fitted by the vendor and allow for continuous oil flow between the measuring units and the oil tanks. Sampling points shall be provided even after the fault gas measuring units are installed.

Oil retuned to the main tank may not be contaminated in any way during the fault gas measurements process.

It shall be possible to isolate the fault gas measurement system from the transformer.

3.1.5 Self-diagnostics

The system must allow for self-diagnostics which will flag any analyser malfunction.

3.1.6 Safety Compliance

The installed system shall comply with the relevant safety requirements and a safety file shall be provided to the site responsible person before work commences.

3.2 Tap changer oil measurement

Where DGA units used on the Tap changers, the units must be capable of measuring at least Hydrogen and Acetylene. These measurements must be based on discreet measurements without averaging.

3.3 Main Transformer tank oil measurement

Where the fault gas measurement units are to be used on the main tanks of the transformer, the units should preferably be capable of measuring the 8 relevant fault gases as well as moisture.

3.4 Partial discharge measurement

The DGA units used in the measurement of the transformer oil must allow for inputs for the measurement of partial discharge with the use of the necessary hardware and software.

3.5 Partial discharge measurement unit

The Partial discharge measurement unit must be capable of measuring partial discharge activity for at least three HV/MV bushings. It should be possible to upgrade the unit to measure the partial discharge activity in the three MV/LV bushings as well.

3.5.1 Partial discharge data, alarms and indication

The PD measurement unit will provide at least the power frequency current amplitude with the phase angle deviation.

The PD measurement unit will provide user configurable alarm contacts which can be connected to existing SCADA equipment.

The PD measurement unit will allow for the input of at least two temperature sensors to measure the top and the bottom temperature of the transformer.

Sunlight visible light indicators shall give an indication of the alarm status as well as the health of the unit.

4. DISSOLVED GAS ANALYSER FOR A SINGLE MAIN - 8 GASES AND MOISTURE

Each tank must be measured through a different manifold to prevent contamination

Temperature measurement – all DGA units must have inputs capable of accepting temperature sensor probes

PARAMETER (compound)	VALUE/MEETS (measurement range)
Hydrogen (H_2)	5 - 5,000 ppm
Carbon Monoxide (CO)	2 - 50,000 ppm
Carbon Dioxide (CO_2)	20 - 50,000 ppm
Methane (CH_4)	2 - 50,000 ppm
Acetylene (C_2H_2)	0.5 - 50,000 ppm
Ethane (C_2H_6)	2 - 50,000 ppm
Ethylene (C_2H_4)	2 - 50,000 ppm
Oxygen (O_2)	150 - 50,000 ppm, accuracy ±10%
Nitrogen (N_2)	10 – 130,000 ppm, accuracy ±15%
Water	0-100% RS (given in ppm)
Accuracy	± 5% or ± LDL (whichever is greater)

5. ALTERNATIVE 4 FAULT GAS ANALYSER

4 x gases

Each tank must be measured through a different manifold to prevent contamination

PARAMETER (compound)	VALUE/MEETS (measurement range)
Hydrogen (H_2)	5 - 5,000 ppm
Carbon Monoxide (CO)	10 - 50,000 ppm
Acetylene (C_2H_2)	3 - 50,000 ppm
Water	0-100% RS (given in ppm)
Accuracy	± 10% or ± LDL (whichever is greater)

6. BASIC FAULT GAS ALARM UNIT

This unit will be a 1 or 2 gas measurement unit which will assist the maintenance team with the maintenance of distribution level transformers. Two units are required.

The first type must be capable of being included into the communications network to allow analysis to be done at a central point

The second unit will be a lower end unit which will provide visual indication on site to the maintenance team.

For both these units, where alarms are detected, the maintenance team will be required to go out to site with the portable unit and do a complete 8 gas analysis to verify the fault.

7. PORTABLE UNIT

Where the basic fault gas alarm units are installed and an alarm is triggered, the maintenance team will be dispatch to site for further investigation. This team will be equipped with a portable unit capable of identifying each of the 8 fault gases, and performing basic analysis on site.

The unit will be robust and not require on site verification before carrying out any tests.

The unit will have an integrated graphical user interface which will allow the user to interact with the unit, provide detailed instructions on the operation of the unit, as well as present the test data from current tests as well as previous tests.

It must be possible to export the saved test data as well as make print copies of the test results.

PARAMETER (compound)	**VALUE/MEETS** (measurement range)
Hydrogen (H_2)	5 - 5,000 ppm
Carbon Monoxide (CO)	1 - 50,000 ppm
Carbon Dioxide (CO_2)	2 - 50,000 ppm
Methane (CH_4)	1 - 50,000 ppm
Acetylene (C_2H_2)	0.5 - 50,000 ppm
Ethane (C_2H_6)	1 - 50,000 ppm
Ethylene (C_2H_4)	1 - 50,000 ppm
Water	0-100% RS (given in ppm)
Accuracy	± 5% or ± 2ppm (whichever is greater)

8. SERVICE LIFE AND LIFE CYCLE COSTING

The service life of the system shall be at least 20 years. The vendor must indicate the maintenance, upgrade and required consumables with the associated costs of the system for the full 20 years.

9. LOCAL MAINTENANCE AND SUPPORT

All necessary maintenance and support shall be provided by a South African based company and sufficient spares shall be held locally to provide a support turn-around time of between 5 and 15 days. Technical telephonic assistance must be available during office hours.

10. COMMUNICATIONS

Options

DNP3

IEC61850

Ethernet

GPRS

Radio – MDS

MDS in substation to AP and GPRS back to backoffice (perception)

11. COMPLETE TRANSFORMER MONITORING

Where required, a complete transformer monitoring system shall be installed which will be capable of providing diagnostic, prognostic and recommendation data based on measured information and on line transformer modelling

11.1 On-Line Diagnostic Models

- MVA model which computes the apparent power on primary, secondary or tertiary winding
- Winding hot-spot temperature model which computes the hot-spot temperature of each winding where load current is measured
- Moisture model which computes the moisture content in the thin conductor insulation and in the barrier insulation
- Insulation aging model which computes the aging acceleration factor from IEEE or IEC guidelines
- Cooling control model for management and operation of the transformer cooling system
- Cooling efficiency model which monitors the actual efficiency of the cooling system
- Tap changer thermal model which computes the temperature difference between the LTC tank and main transformer oil tank
- Tap changer position tracking model as the tap position transitions are recorded and tracked

11.2 Basic Package Components

- The total transformer monitoring device shall include at least:
  - 8 analog inputs (4 - 20mA or RTD PT100)
  - 5 AC inputs (load and fan currents)
  - 2 digital inputs (system alarms, cooling control & cooling alarms)
  - Embedded functions complete with transformer models
  - Historical data acquisition
- The unit shall allow connection to fault gas analysis units
- The unit shall be capable of accepting two magnetic-mounted temperature sensors (top and bottom oil temperature measurements)

12. INSTALLATION AND COMMISSIONING

Supply, installation and commissioning of the fixed units shall be conducted on a turnkey basis as described in section 2.

13. DGA SOFTWARE

Two types of software are defined. This first will be basic software which could be used by the maintenance team leader

13.1 Basic software

Where applicable, software shall be provided to the customer to allow the viewing of test data on a PC, in a suitable format which will allow additional analysis to be performed. This software should allow:

- The manual input of DGA data
- Providing tending graphics over time
- Allow csv import and export of data

13.2 On line monitoring software

Software available for the on line monitoring of the fault gases as well as the partial discharge activity should be able to perform the following

- All features of the basic software
- Automated email alert notification
- Key gas analysis
- Duval triangle analysis
- Customized transformer reports
- Scheduled automatic data download

14. DGA MONITORING SERVICE

This service will make used of automatic download software which will produce reports and will have alarm features which will facilitate the generation of sms or email alerts which will provide an indication to the maintenance team on the status of transformers. This service will provide at least:

- Routine feedback on a weekly / fortnightly / monthly basis
    - Monthly costs
    - Automated alarms settings with emails

15. TRANSFORMER ANALYTICAL SERVICE

Transformer specialists monitoring transformer oil on real time basis

Immediate notification and alarms

16. SERVICING

Annual

Measurement verification

17. TRAINING

A formal approved training program shall be provided by the vendor.

This training program shall include at least:

- Operating principals of the system
- System installation and commissioning
- System setup and communication
- System software functions

SECTION 4 : SPECIFICATION

PART 12.1 : PROTECTION AND CONTROL EQUIPMENT

SPECIFICATION NO: RP.62/1-97 – Infranet PS05-001SZ – Rev 1

CONTENTS

1. SCOPE

1.1 Overview

This specification part calls for the detailed design, supply, installation, testing and commissioning of an integrated system of hardware and software for control, protection, interlocking, measuring, data recording, event recording, disturbance recording, communication, and engineering and operator interfacing for the 132, 33 and 11 kV equipment, transformers and substation secondary equipment, and includes interfacing to enable the remote master control centre at Capital Park Control Centre to control and interrogate the substation by means of bi-directional communication.

1.2 Integrated Control and Protection (Substation Automation)

The protection equipment shall consist, except where expressly stated to the converse, of numerical devices capable of communicating with and being interrogated by the substation control system on a local area network. The control equipment shall be suitable for continuous, reliable operation in a substation, and shall be required to carry out such tasks as interlocking, monitoring and control at bay-wide and station-wide levels. The systems offered shall be of the state of the art, follow the latest engineering practice, and shall ensure long term compatibility, continuity of equipment supply and the safety of the operating staff. Tenderers are requested to present only their latest **proven** products. The Tenderer may be required to demonstrate the operation of these proven products in actual, similar applications in South Africa or abroad.

1.3 Cubicles

The control and protection equipment shall be housed in sheet steel panel suites in the different control rooms, normally with one cubicle for each of the 132 kV bays and separate cubicles for busbar protection, local control computers and other common functions. For construction of these cubicles, refer to the relevant part of this enquiry document. Actual quantities of panels and content thereof are indicated in the relevant price schedules.

1.4 Overall Design and Commissioning

The Contractor will be responsible for the overall detailed electrical design to integrate all the equipment and switchgear supplied under this contract to form a complete working system which meets the requirements of this specification as a whole. The Contractor will also be responsible for site testing, functional integration and overall commissioning of the complete substation.

1.5 Complete Installation and Service

The Contract will include the provision, installation and commissioning of all equipment required, including all matters and details to provide a complete installation, negotiations with other Municipal Departments or other Authorities where necessary, and the carrying out of all aspects of the Work necessary to complete the Contract commitments. The specified requirements shall be considered basic in that the necessary refinements and additions to provide equipment which will function reliably shall be included in the Tender. Minor items not specifically mentioned in the Addendums and Schedules will be taken as having been included in the Contract Price.

1.6 Compliance

Compliance or otherwise with each item of this specification shall be expressly stated. Any items which may require clarification shall be taken up with the Engineer during the Tender stage, and the presentation of a Tender document by a Tenderer shall imply that the requirements of the specification presented herein have been thoroughly understood and shall be complied with unless the Tenderer clearly indicates the contrary. The Tenderer shall state compliance or otherwise for each paragraph of the written specification.

The Municipality reserves the right to accept or reject Tenders based on the overall compliance to the specification and each part thereof.

1.7 Assistance

Assistance will be given by the Energy and Electricity Division of the Municipality as specifically provided for in the Contract and at the discretion of the Engineer.

2. DEFINITIONS, ABBREVIATIONS AND SYMBOLS

For the purposes of this specification part and the related Particulars and Guarantees, Input lists, Outputs lists, Logic definitions, Event lists, block diagrams and scheme philosophy diagrams, refer to drawings and the definitions listed below. The substation control system philosophy diagram may also be of assistance in understanding the concepts described in the following definitions.

2.1 11 kV Switchgear Controller (SGC)

This refers to one of two devices. In the case of switchgear panels which have a multi-function combined over-current and earth fault relay, this relay shall, in addition to the protection functions, serve as the 11 kV switchgear bay controller. In the case of the 11 kV bus coupler and bus section panels, which do not require protection functions, a dedicated I/O module shall be used as the SGC. The functions of this device are to obtain status inputs from the switchgear, provide control outputs to the switchgear and associated equipment and perform the necessary interlocking as is shown in the relevant diagrams and input/output lists.

2.2 33 kV Switchgear Controller (SGC)

The multi-function over-current relay shall, in addition to its protection functions, serve as the 33 kV switchgear bay controller. The functions of this device are to obtain status inputs from the switchgear, provide control outputs to the switchgear and associated equipment and perform the necessary interlocking as is shown in the relevant diagrams and input/output lists.

2.3 11 & 33 kV SGC Supervisor

Should the 11 or 33 kV SGC not be capable of performing the required communication, interlocking and control logic, an SGC Supervisor shall be provided to carry out these functions.

2.4 132 kV Bay Controller (BYC)

An Intelligent Electronic Device (IED) used on every 132 kV bay panel, which assimilates general primary plant status information, contains the interlocking logic and provides the control mimic by taking cognizance not only of the bay-specific equipment status but also the status of other relevant equipment in the substation.

2.5 Engineering Local Area Network (E-LAN)

The separate LAN terminal via which a laptop may access the SMMI, all BYCs and SGCs, all protection relays and any other IEDs which may be present on the S-LAN, in order to carry out programming, setting and data retrieval. This LAN terminal makes use of the S-LAN, and does not require a separate engineering-oriented S-LAN.

2.6 Integrated Control And Protection (ICAP)

A concept whereby protection and control device functionality is merged into single modules. Protection devices therefore offer data gathering functions and control of the protected plant, while control devices may offer supplementary or backup protection functions. The primary purpose of ICAP is to maximise the utilisation of equipment in terms of functionality and information resolution while minimising the duplication of functions and wiring by making use of data processing and communication facilities inherent in modern numerical devices.

2.7 Isolator

A generic term used to describe all primary disconnectors and switch disconnectors.

2.8 Numerical device

A device termed as numerical in this document shall be microprocessor-based, programmable in terms of settings and configuration and, where required communications facilities to allow remote setting and re-configuration of the device.

2.9 Remote Engineering Workstation (REW)

The computer which may reside at a remote location relative to the substation and, via a communications channel installed for this purpose (the extended E-LAN), provide functions such as retrieval of engineering information from the SMMI and the setting and configuration of protection relays. The REW shall access the SMMI and IEDs via an extension to the E-LAN.

2.10 SCADA Access Port (SAP)

The physical point of connection between the protocol translator and the SMMI.

2.11 Substation IED (SIED)

The device which facilitates the gathering of substation common information and provides control facilities for substation common devices.

2.12 Substation Local Area Network (S-LAN)

The network which allows the BYCs, SIED, other IEDs and the SMMI to communicate and exchange information regarding the substation primary plant status, analogue values and secondary device generated information. The S-LAN shall also serve as the substation local communication medium to the IEDs for the E-LAN.

2.13 Substation Man-Machine Interface (SMMI)

The computer, monitor, keyboard, mouse and basic interfaces as well as all necessary configured software which comprise the local control computer for the substation.

3. STANDARDS

Refer to Section III, Part 1 of this specification for requirements regarding standards of workmanship and materials.

4. INTEGRATED CONTROL AND PROTECTION EQUIPMENT SPECIFICATION COMPONENTS

The specification part concerning the control and protection equipment is composed of a number of documents, which are interrelated and require careful studying as a whole in order to understand the full implication of the Municipality's requirements for the ICAP system. In addition, all other parts of the overall specification should be read in conjunction with Section III, Part 12 in order to understand the interface requirements. Section III, Part 1 in particular contains general information and requirements which are directly applicable to Section III, Part 12, such as drawing and documentation, ferruling, steelwork, painting, permits, etc.

4.1 Written specification: Part 12

This document contains the general requirements for the ICAP equipment.

4.2 Particulars and Guarantees: Part 12

Specific requirements regarding the equipment described in the written specification are listed in this document.

4.3 Price Schedule: Part 12

The price schedule lists the major items required for the ICAP system as well as the grouping of functions in cubicles or relay chambers. Any items not specifically listed are taken as having been included in the overall price. Detailed price breakdowns have been allowed for in order to allow the Municipality to make informed decisions regarding the inclusion or otherwise of specific functions. Tenderers shall complete the price schedule in the detail allowed for. The price schedule also allows for a number of options described in the written portion of the specification be priced in order to allow for the implementation of the most viable system. Tenderers are required to comment on alternative offers with regard to the compliance of alternative offers to the specification.

4.4 Input, output and event lists

The Hardwired Inputs sheet contains a list of status contacts from primary and secondary devices, which are to be made available to the control system via hard wiring to the communicating protection and control devices. The inputs listed are also indicated on the included logic diagrams. For the purposes of these lists, primary devices shall mean primary switchgear and disconnectors, and secondary devices shall mean protection, control and auxiliary devices.

The Secondary Inputs sheet lists the status information which is to be made available to the SMMI from the communicating protection and control devices via the S-LAN, and should preferably not be hardwired. Should the system not be capable of communicating a specific item of status information to the SMMI, this item should then be communicated to the SMMI via hardwiring to the relevant BYC, and a specific note made thereof in the Tender.

The Derived Inputs sheet lists variables that are to be used for SMMI indication and interlocking, and are the result of the interlocking and general logic equations listed which reside in the relevant bay modules. Abbreviations used in this sheet are sourced from the Hardwired Inputs and Secondary Inputs sheets.

The Analogue Inputs sheet lists the requirements for analogue values and at the levels which these values should be displayed on the SMMI.

The Digital Outputs sheet lists the digital outputs that are to be wired to various equipment from the BYC, SIED or SGC.

The Event lists indicate the Municipality's requirements regarding the Input Zone code, the Event Description which is made up of a Source field and a Status field, the Logic required to trigger the event, and the destination of the Event, be it the SMMI Mimic (denoted "Mimic" in the event lists, the event page, the alarm page or the SCADA system. Note that, in order to facilitate ease of fault post-mortems, only the events which are ticked are to be provided. Any events not ticked or listed but which are to be provided or cannot be disabled must clearly be indicated by the Tenderer.

4.5 Substation single line diagram

A single line diagram of the primary substation configuration is provided for tender purposes. The Contractor shall be responsible for the provision of a single line diagram, similar in resolution to the one provided, which reflects the actual installation.

4.6 Protection and Control logic diagrams

The substation control system's required architecture, as well as specific requirements regarding the implementation of the protection schemes is indicated on these diagrams. For interpretation of the symbols and abbreviations, refer to the above-mentioned Input and Output lists as well as the legend sheet. Note that the contacts shown in these diagrams are only representative of the type of contacts required for the control system. Actual quantities and types of contacts should NOT be based solely on the quantities shown in these diagrams.

5. GENERAL SERVICE CONDITIONS

5.1 Climatic Conditions

Refer to Section III, Part 1 for details regarding the climatic conditions applicable.

5.2 Distribution Network

The relay equipment will be utilised on an electricity distribution network comprising high-voltage overhead transmission lines, underground cables, switchgear and transformers, all of which are energised from interconnected power stations and infeed stations.

5.3 Operation and Maintenance

The equipment is intended for installation in remote, unattended switching stations and substations. The protection equipment shall be designed for minimum attention and maintenance and Tenderers shall state the extent of maintenance required for each major item in the scheme offered

6. POWER SYSTEM PARTICULARS

6.1 General Parameters

Refer to Section III, Part 1 for details regarding the applicable system parameters.

6.2 System Configuration

A Single line schematic diagram of the substation is issued with the Enquiry for tender purposes.

Control room panel arrangement: a proposed layout is shown on the general building layout drawing. This will be finalised after award of Tender.

Sufficient space shall be left for relay panels for future feeders and equipment indicated on the drawings. Where these future feeder bays are spatially interspersed with present feeders, correctly sized spaces shall be left in the suite of panels for future panels to image the orientation of the switchgear bays.

7. GENERAL DESCRIPTION OF INTEGRATED CONTROL AND PROTECTION SYSTEM

7.1 Overview of System Elements

An overview of the basic architecture of the integrated control and protection system required is given below and is also shown on drawing. It does not represent a complete list of functions required. Detailed descriptions of the functions are given in the rest of the specification and in the schedules and drawings, or are to be added by the Tenderer.

The basic requirements for the ICAP system are as follows:

a) Local substation operator station (SMMI), with control computer, software and printer, for supervision, local control and engineering functions.
b) SIED module for common interlocking, alarms and event recording.
c) An interface between the SMMI and the SCADA RTU (specified in Section III, Part 12) to allow complete substation interrogation and control from the Master Control Centre at Capital Park.
d) SGC Supervisors for communicating with, controlling and providing automatic sequences via the 33 & 11 kV multifunction over-current relays, should these relays not be capable of providing the required automatic sequences and communication facilities. These relays shall also provide the necessary measurands to the control system.
e) Bay controller (BYC) modules for network, relay and equipment interfacing, provision of local bay control mimics on 132 kV bays, local bay interlocking, supervision and local engineering.
f) SGCs for monitoring & controlling 33 and 11 kV switchgear.
g) Displays on relays may be used provided it is not too small and cumbersome to read. The relay shall also be setable to have current values as the default display.
h) No local alarm annunciator for local bay control is required, provided that the bay module status indications are labelled to provide annunciation should the SMMI fail.
i) Should the relays not be able to display clear English descriptions of events and alarms, a legend label shall be provided and installed on the panel to assist in the interpretation of the relay indications.
j) Data exchange between the different units via an optical fibre serial station bus.
k) Parallel, hard wired inputs from and outputs to 132 kV switchgear and yard equipment.
l) Local engineering network with a single point connection for a laptop computer and extended communication to a remote engineering workstation (E-LAN).
m) Global Positioning System (GPS) satellite receiver for accurate time synchronisation of all control devices and relays.
n) Remote engineering workstation software for a standard Intel 486/Pentium-based PC with Windows 95 or NT as the operating system.

7.2 Numerical Technology

The equipment offered shall be based on the latest generation of numerical technology, to allow a wide range of integrated protection and control functions, with comprehensive communication facilities. All internal relay events shall be logged separately in the SMMI. The system shall have forward compatibility with future equipment for a period of at least ten years.

Tenderers shall provide detailed descriptions as to how their equipment would improve the “Power System Management” aspects such as protection, control, monitoring, automation and analysis.

The degree of standardisation and compatibility with the equipment and communication with products from other leading suppliers must be stated clearly, giving a clear description of possible restrictions.

If non-numerical, solid state measuring relays are offered by the Tenderer, or requested as options in the Tender, Tenderers shall clearly state the limitations of these relays compared to the numerical equivalent. Tenderers shall give clear descriptions, aided by diagrams, if necessary, to illustrate how these relays will be incorporated in the integrated control and protection scheme.

7.3 Security

Every part of the system shall have continuous self-supervision and user-friendly diagnostic functions with clear alarm outputs to indicate malfunctions in the protection and control system.

Protection and control systems shall be based on distributed, intelligent multi-processor technology and fibre optic communications for increased reliability and security. This requires that event data be buffered and stored at distributed network points including the protection relays, the bay controllers and the SMMI.

Event data stored at any level in the network must immediately be retrieved on restoration of a failed network connection to any device.

The devices must be designed to operate in an electrically hostile environment, with stringent requirements on electromagnetic interference immunity. Restrictions on radiated emissivity shall be adhered to.

Although the protective relays are integrated into the control system, all protection functions shall work independently of the control system communications network.

Control system redundancy should be limited and reliance should instead be made on equipment with high reliability and proper monitoring of each system component.

7.4 General Control System Design

The system shall be designed so that personnel without any background in microcomputer based technology can operate the system easily after some basic training.

The substation automation system offered shall support control, monitoring and interrogating functions from SCADA centres (Master Control Centre) via the communications gateway to the SMMI.

Local control of bays shall be via the following mechanisms:

a) 132 kV bay : bay local mimic diagram incorporated in the BYC.

b) 33 kV bay : switchgear bay control pushbuttons or cord control pendant.

c) 11 kV bay : cord control pendant or plug control box. (see Section III, Part 11.1).

Maintenance, modification or extension of components or programs may not cause a shutdown of the whole substation automation system. Self-monitoring of single components, modules and communication equipment shall be incorporated to increase the availability and the reliability of the equipment and minimise maintenance.

Preference will be given to multi-user systems whereby maintenance, modification and extension of programs and databases can be performed via the E-LAN, either locally or remotely.

All the protection functions shall be enabled by downloaded settings from the SMMI or REW within their defined ranges, but inadmissible settings shall be prevented by the system.

The entire substation is controlled and supervised from the station level while individual bays are protected, supervised and controlled from the bay level equipment. It shall not be possible to control the substation from more than one operating level (SCADA, station or bay level) simultaneously. Clear indication of the "active" control level shall be given at every control level.

At each control level, the selection of a local control mode shall over-ride any higher level operating level's control. For example, the selection of a 132 kV ICAP bay panel to local shall over-ride any authority which the SMMI may have had, and disallow any commands to come from the SMMI, although full transparency must be maintained to higher control levels at all times.

The bay controllers (BYC) and other IEDs shall be independent of each other and of the network administrator and their operation shall not be affected by any fault occurring in the other BYC or other IED of this substation. The only exception to this shall be where a BYC receives interlocking information from another BYC, in which case the healthy BYC shall fail to safe. One BYC shall control and monitor only one bay at 132 kV level and, where applicable, not more than 6 bays at 11 kV level.

The main process information of the substation shall be stored in distributed databases. The system shall be based on a concept of bay oriented distributed intelligence for safety and availability reasons. Functions shall be decentralised and bay oriented as close as possible to the process whenever possible. In the event of a network administrator fault, the bay module should still be able to power up correctly and function independently.

It shall be possible to explicitly prescribe, by means of software configuration, which events will be recorded and reported, and duplicity and redundant information should be minimised. Many events (as indicated in the Events listings provided) are only required to be logged on the rising edge transition, and must be maskable for the falling edge transition.

In the event of the SMMI or the communications channel between the BYC and the SMMI being inoperative, the BYC shall store at least 50 discrete bay events in a FIFO buffer for later retrieval by the SMMI.

7.5 Substation Control and Monitoring Functions

All substation functions have to be designed for a safe and reliable operation. The following are the minimum functions required:

a) Acquisition of binary and analogue signals.
b) Control, interlocking and supervision of the bays and the substation.
c) Alarm handling in the BYC and in the SMMI.
d) Display of the bay and substation status.
e) Display of measured and processed analogue values.
f) Display of system status (BYCs, network connections, printer, etc.).
g) Station control via a mouse controlled SMMI.
h) Support of automatic control sequences for standard switching routines, e.g. busbar transfer, simultaneous closing of two or more circuit-breakers, 11 kV chop-over scheme.
i) Provisions for remote master control centre access via a gateway.
j) Provision for a Substation Remote Engineering Workstation.
k) Facilities to independently and remotely reset each bay's protection relays after a fault.
l) Transformer tap change and protection control and supervision.
m) Synchronising-check functions (where required).
n) Display of trend values.
o) Fault recording.
p) Event recording.
q) Evaluation of historical data.
r) Archiving facilities for trending data to enable complete storage and retrieval of trending data for later analysis. The data must also be made available in a format which can be transferred to standard spreadsheet software packages.

7.6 SMMI Displays

The SMMI shall provide at least the following unique screens:

a) A logon screen which provides access to:
   i. the substation primary equipment main view for each of the 132, 33 and 11 kV equipment;
   ii. a main control system view;

iii. the alarm list;
iv. the event list;
v. the protection and control system programming tools; and
vi. the trending view.

b) A substation primary equipment main view for the 132, 33 and 11 kV primary equipment which shows a single line diagram of all primary equipment at that level as well as key analogue values. 33 & 11 kV equipment may be controlled from this view, while at the 132 kV level the bay views must be accessed for control of the 132 kV primary equipment.
c) Bay views for each of the 132 kV bays, from which the 132 kV equipment may be controlled. Detailed analogue values are to be displayed in these views.
d) A main control system view which displays the basic connectivity of the SLAN, together with the status of each device connected to the network, and allows access to detailed views of specific groups of devices connected to the network, such as a 132 kV bay's control and protection devices.
e) An alarm list with the filtering and management functions required.
f) An event list with the filtering and management functions required.
g) A menu from which the protection and control system programming tools may be accessed.
h) A trending view which provides a graphical view of user-definable trends.

A block with the text “INT” shall be displayed next to each item of primary plant in the operating display, and shall indicate whether or not the item may be operated due to interlocking by colouring the block green when operation is allowed, and red when operation is not allowed.

7.7 Automatic sequences

The following automatic sequences should be selectable from the SMMI:
a) automatic live load transfer at 132 kV level;
b) automatic transformer chop-over at 11 kV level in event of a main transformer failure; and
c) simultaneous closure of 11 kV circuit-breakers.

The processing and control of these sequences may not, however, take place within the SMMI and should instead be performed by the SIED.

7.8 Bay standardisation

It can be seen from the block schematic diagrams PS5-011 to PS5-014 that phase and earth fault over-current protection is used on all 132 kV panels, whether it be as back-up protection or as the only bay protection. It is proposed that the same "intelligent" base relay or terminal, that would include the basic common functions such as breaker fail, measurements display, basic disturbance recordings and load level alarm and trip, be used on all panels for these functions, to promote uniformity and operator confidence.

The disturbance recording abilities of the "base" relay must be indicated in the Schedule of Particulars and Guarantees. The requirements for a "Medium resolution" disturbance recorder are also given in the Schedule of Particulars and Guarantees. If the base relay does not meet these, separate "Medium resolution" disturbance recorders shall be incorporated in the relevant feeders, as indicated in the Price Schedules.

Both the main and the back-up relay on a bay could have measurement, event recording and disturbance recording. Tenderers may rationalise the allocation of the features between the relays, but always ensuring that the requirements for detailed, high-resolution event recording and disturbance recording are retained. Precise details as to the allocation of these functions shall be given in the tender.

7.9 Control Supplies

Duplicated 110 V station batteries/charger units are to be supplied, for reliability and redundancy in control, protection and tripping circuits. An automatic change-over switch of adequate rating shall be provided and the selected output bus-wired through the control cubicles, to provide redundancy in the supply to all bay controllers and station control units. Capacitive dip-proofing equipment shall be provided on the output to allow the control units and other equipment to "ride" through the changeover operation. Alternatively, suitably rated diodes may be used to obtain a “selected” supply.

The battery charger has a facility to transfer the supplies to its separate DC distribution boards from the one battery bank to the other, by means of a hand-operated selector switch. The automatic changeover switch described above shall not operate for manual selector switch operation on the battery charger. The hand-operated selector switch may be operated during maintenance. It is therefore of utmost importance that the control system not be affected by the normal operation of this switch.

If BYCs with provision for dual supply inputs are available and offered, the requirement for the automatic change-over switch will fall away.

Tenderers shall describe their proposed auxiliary supply arrangement for control units and in particular the operator station. It is of the utmost importance to have all control units and the operator station operative for at least 8 hours without AC main supply. Tenderers shall state the minimum standby time offered. Measurements shall be made on total.

8. SPECIFIC CONTROL SYSTEM DEVICES

8.1 132 kV Bay Controller (BYC)

The BYC shall be based on microprocessor technology and a real time operating system. The BYC performs all bay related functions, such as local control, command sequences, bay and station interlocking, data acquisition, data storage, event and alarm storage, outputs of commands and signal processing required for the different switchgear units of the bay.

The BYC shall preferably have an integral mimic capable of controlling and displaying the status of up to seven primary plant devices per bay, and have a user-definable layout to suit the substation physical layout. The mimic shall only allow operation if the bay has been selected to local control.

The following functions shall be provided:
a) Event handling with event buffering.
b) Acquisition of measured and counted values.
c) Execution and monitoring of commands.
d) Data pre-processing.
e) Data communication to the SMMI and connected subsystems.
f) Calculation of derived operational measured values.
g) Generation of group signals.
h) Interlocking.
i) Self-monitoring.
j) Mimic panel with local control facilities for each bay.

Auxiliary power shall be supplied from a separately monitored, automatic changeover circuit taken from a selected output of the duplicated station batteries.

The BYCs, with all related input and output equipment, are to be installed in the bay ICAP panels in the control room.

The electronic system has to be provided with functions for self-supervision and testing.

Each circuit board shall contain circuits for automatic testing of its own function.

Faults in a unit have to be indicated on the front panel of the unit. The time for fault tracing and replacement of a faulty unit shall be reduced to a minimum. The supervision shall also cover the power supply system, the internal system bus and the ability of the central processing unit (CPU) to communicate with the different printed circuit boards.

The function and design of the switchgear interlocking systems shall be reliable and safe. Perfect determination and processing of all switchgear positions of the whole substation must be ensured at all times. Unclear information, such as intermediate switchgear positions, switchgear faults, faulty data transfer, etc. must prevent non-permissible switching operations and state clearly, intelligently and exactly the reason for the prevention. Control, regulation and synchronising functions shall require perfect collection and processing of all information of the substation. The information must be up to date and valid. Mal-operation of control and regulation facilities such as on-load switching of an isolator, out of step operation of on-load tap change control, switching on in an asynchronous state, etc. shall be avoided. When the station level control (SMMI and gateway) and regulation facilities have failed, back-up control shall be possible via the bay local mimic, with retention of bay related interlocking.

The BYC must have spare capacity for future equipment. The input and output modules must have 10% spare capacity with a minimum of 2 inputs and 2 outputs spare. The BYC must have at least 2 spare positions for extra I/O modules. The RAM or on-board memory must have at least 20% spare capacity for programs once the application's requirements are met.

The interlocking software RAM or on-board memory must be backed-up via a battery back-up or non-volatile memory and in the case of a supply failure, on return of supply automatically resume their function. The software must be reprogrammable via the SMMI in a straightforward manner.

8.2 Substation Intelligent Electronic Device (SIED)

Numerous substation-common items are to be monitored and controlled. For this purpose a communicating IED shall be provided. Tasks for this device shall include:
a) Substation-common interlocking;
b) automatic sequence control;
c) substation common alarm monitoring; and
d) substation access control system monitoring.

Refer to the relevant I/O lists for details regarding items to be monitored and controlled by this device.

The device shall be capable of communicating directly with all necessary devices on the S-LAN in order to perform the required automation functions.

8.3 SGC and SGC Supervisor

The SGC shall be based on microprocessor technology and a real time operating system. The SGC performs all 11 and 33 kV bay related functions, such as command sequences, bay interlocking, data acquisition, data storage, event and alarm storage, outputs of commands and signal processing required for the different elements of the switchgear bay.

The following functions shall be provided:

a) Event handling with event buffering.

b) Acquisition of measured and counted values.

c) Execution and monitoring of commands.

d) Data pre-processing.

e) Data communication to the SMMI and connected subsystems.

f) Calculation of derived operational measured values.

g) Generation of group signals.

h) Interlocking.

i) Self-monitoring.

The SGC is to be installed in the 11 or 33 kV switchgear panels.

The electronic system has to be provided with functions for self-supervision and testing.

Faults in a unit have to be indicated on the front panel of the unit. The time for fault tracing and replacement of a faulty unit shall be reduced to a minimum. The supervision shall also monitor the power supply system, the internal system bus and the ability of the central processing unit (CPU) to communicate with the different printed circuit boards.

The function and design of the switchgear interlocking systems shall be reliable and safe. Perfect determination and processing of all switchgear positions of the whole substation must be ensured at all times. Unclear information, such as intermediate switchgear positions, switchgear faults, faulty data transfer, etc. must prevent non-permissible switching operations and state clearly, intelligently and exactly the reason for the prevention. Control, regulation and synchronising functions shall require perfect collection and processing of all information of the substation. The information must be up to date and valid. Mal-operation of control and regulation facilities such as on-load switching of an isolator, out of step operation of on-load tap change control, switching on in an asynchronous state, etc. shall be avoided.

The interlocking software RAM or on-board memory must be backed-up via a battery back-up or non-volatile memory and in the case of a supply failure, on return of supply automatically resume their function. The software must be reprogrammable via the SMMI in a straightforward manner.

Should the SGC be unable to provide these functions, an SGC Supervisor shall be provided to supplement the SGC in performing these functions.

8.4 Disturbance recording: particular requirements

Each 132 kV line shall have a medium resolution disturbance recorder, as defined in the schedule of particulars and guarantees, installed and set up to operate for any 132 kV or transformer protection operation in the substation, including the transformer bays.

Each 33 & 11 kV transformer incomer shall, as an option, have a medium resolution disturbance recorder, as defined in the schedule of particulars and guarantees, installed and set up to operate for any transformer bay protection operation and any protection operation in the suite of 33 & 11 kV panels.

Each 33 & 11 kV feeder shall have a low resolution disturbance recorder, as defined in the schedule of particulars and guarantees, installed and set up to operate for any feeder-specific protection operation.

Analysis software for the disturbance recorder data shall be integrated into the SMMI software, and shall operate without having to suspend execution of the SMMI software.

8.5 11 kV I/O module

A communicating I/O device shall be provided to allow control and status determination for the 11 kV bus couplers and bus sections (refer to drawing).

The device shall be a modern numerical, self-monitoring instrument. It shall offer full interrogation by the substation control system, time tagged event recording and plant control capability.

The nominal ratings of the I/O module shall be as follows :

a) Auxiliary voltage 110 V DC ± 20 %

b) Output relay make and carry for 0,2 s 30 A

c) Output relay carry continuously 5 A

d) Output relay break (DC) 50 W resistive or 25 W inductive ($^{L}/_{R}$ = 0,045)

e) Output relay break (AC) 1 250 VA

The I/O module shall perform continuous self-monitoring. A separate output relay, that has one make and one break contact, shall be provided to indicate both healthy and relay defective conditions.

Time tagged event recording with a 1 ms resolution incremented every millisecond shall be provided, with access via the communication port.

8.6 Router

The modular router shall be robust, compact, portable, user friendly, micro-processor controlled and offer the following:

a) An Ethernet card slot;
b) A WAN interface card slot; and
c) A serial card slot.

The serial WAN port on the router shall support asynchronous serial connections up to 115.2 Kbytes/s and synchronous connections such as Frame Relay, leased lines, Switched 56, Switched Multi-megabit Data Service (SMDS) and X25 up to 2.048 Mbytes/s.

The WAN interface on the router shall allow easy change of - or add of WAN interface cards.

The router shall be designed to be ‘plug and play”.

The modular router shall accommodate the following software capabilities:

a) PCMCIA cards from where pre-configured software can be loaded at a central site and be sent to remote sites.
b) At the remote sites the software should be accessible via PCMCIA cards by means of plugging it into the WAN, LAN or power cables.
c) A Web-browser and monitoring utility shall be available to the user.

9. CONTROL SYSTEM CAPABILITIES

9.1 General Software

The software shall consist of basic type tested software modules and standardised supplementary function modules, which are configured depending on the layout and operation concept of the substation.

Security of control selections is of paramount importance and every precaution shall be taken in the software and hardware design to ensure that false selection or execution of a control is rejected. Failure of a communication, partial or total, intermittent or permanent, shall not lead to a false control action.

The system software shall be standard software as offered to other customers, and the structure shall be specially designed for the important requirements of switchgear operation. The system shall be able to restart faultlessly and as quickly as possible after loss of supply voltage. All necessary information must be kept in memory in case of supply voltage outage.

It shall be possible to test the system with help of simulations and without any hazard or unwanted influence to the substation.

The following software functions relate to the substation control system and shall be included in the tender as a minimum:
a) Design of the data base including all substation data
b) Design of an overall display for each voltage level
c) Design of single line diagrams
d) Design of system status displays

9.2 Programming Language

The application programming shall be made in a programming language dedicated for substation automation applications. Programming and documentation shall be based on pre-programmed functional blocks available in a library. These blocks perform typical functions that should be familiar to a substation engineer who is used to design hard-wired logic. Programming of the SMMI and reconfiguration thereof shall be possible by the highest authority level user, and the programming language in all cases shall be an English-language-based programming language.

The programming language has to be graphical as far as possible. Functions shall be programmed in a modular way, where each module shall handle a well-defined task. It shall be possible to test, change, add or remove an application function.

Full information and software manuals shall be supplied by the Contractor to enable the Municipality to reprogram the control system if so desired.

9.3 Station Interlocking and Control Sequence

The control program shall include the possibility for future modification and extension of the station control. It shall be possible to do on-line engineering and reprogramming of the actual application, while the main task is still running in the background, i.e. events are still logged, measurement still stored, etc.

9.4 Bay Interlocking

The control units referred to in the following paragraphs imply the following devices:

a)	132 kV bay ICAP panels :	BYC
b)	33 kV panels :	SGC
c)	11 kV incomer and feeder relay panels :	SGC
d)	11 kV bus coupler and bus section relay panels :	SGC

The bay as well as the station-wide interlocking shall be performed in the individual control units. The station-wide interlocking evaluation shall require switch position indications from other bays (e.g. busbar disconnector, bus-coupler busbar earth), which are transferred to the corresponding control unit via the inter-bay bus.

No protection function may be interlocked through the control unit.

A normally open and a normally closed "change of state" contact from each item of primary equipment must be wired into the control unit.

The "change of state" contacts of each item of primary equipment must be used as a failsafe check of equipment operation or equipment malfunction. In the case of equipment malfunction an alarm identifying the specific item of equipment must be initiated and all further control of that bay disabled until this malfunction has been corrected. This must not only include “change of state” discrepancies but also other alarms like circuit-breaker lockout or spring not charged.

The interlocking at bay and substation level shall prohibit the incorrect operation and or sequence of operation of all items of primary equipment (e.g. isolator opening or closing on load).

Due regard must be given to the operating of the primary equipment during a "dead" or maintenance condition.

The BYC must control the supply to the motorised isolators and mag bolt interlocks where applicable. The contacts within the control unit must be sufficiently rated to perform these operations.

9.5 Interlocking Concepts and Specific Interlocking

Due to the different types of software interlocking methods offered by the manufacturers, specific interlocking requirements will be decided with the successful Tenderer. However, details regarding the general interlocking requirements are listed in the Addendum.

10. SUBSTATION CONTROL SYSTEM: MAN-MACHINE INTERFACE

10.1 General

The SMMI-system shall be a high performance operator station with one operator workplace. It shall be designed for advanced operator's communication. The following functions are required :

a) Presentation of user defined displays (single line diagrams, switching status and analogue values e.g. V, I, P, f, power factor), standard displays, trend curve displays and reports.
b) Effective and safe dialogues for manual control of the substation and for release of control sequences. "Select before operation" procedures are required.
c) Presentation of alarms and events on the operator's video display units and printouts on the printer.
d) Presentation of system status displays (status of BYCs, etc.).

The system software shall be loaded from a transportable medium (e.g. diskettes) and shall be stored in a memory with error correction and battery back-up power or non-volatile memory.

The SMMI shall include a bi-directional logic-seeking 9 or 24-pin dot-matrix printer with a standard parallel interface, and it shall be used for continuous listing of all events occurring in the substation. An ink-jet type printer will not be accepted. It shall be possible to select between at least the following functions for the printer on the SMMI in a easy and straightforward manner:

a) Continuously print all events required as or shortly after they occur, in chronological order;
b) disable continuous printing, in which case the printer buffer is not written to by the SMMI;
c) printing of any sorted or unsorted events from the SMMI event list; and
d) printing of any sorted or unsorted alarms from the SMMI alarm list.

On completion of the substation commissioning, a new ribbon shall be supplied and fitted to the printer.

The operator shall have access to the distributed databases via the SMMI. For control of the substation the operator will use a mouse and soft keys on the screen. The operation procedures shall be user friendly and easy to understand. Data entry is performed with the keyboard.

It shall be possible to design new pictures in an interactive dialogue without taking the total substation control system off-line. Access to the engineering tools shall be provided.

The system shall distinguish between alarm lists and event lists selected on the monitor by the operator. Besides screen displays of these lists, there shall be a print out of any alarm or event in an event log which shall be arranged in chronological order.

An audible alarm shall indicate abnormalities and all unacknowledged alarms shall be accessible from any screen selected by the operator.

The following items shall be presented by the SMMI :
a) Single line diagram showing the switching status;
b) substation overall alarm list;
c) section alarm list;
d) system status list;
e) substation overall event list;
f) section event list;
g) event and alarm log;
h) measured values; and
i) parameter setting (on request).

Tenderers shall allow sufficient time for detailed set-up of the operational procedures and displays in close co-operation with the City Municipality. This will ensure that the SMMI system "appearance" will be compatible with that of the master control system.

Examples of symbols preferred by the Municipality have been included in the Addendum for this part.

10.2 Process Displays

The operational status of the substation, measured values of currents, voltages, frequency, active and reactive powers shall be presented in the single line diagrams. These displays shall also present the status of process objects such as circuit-breakers, disconnectors and transformers.

To ensure a high degree of security against unwanted operation, a special operation procedure "select - confirm - execute" shall be provided. After "selection" the operator shall be able to recognise the selected device on the screen and all other switching devices shall be blocked.

The interlocking conditions shall be checked by the BYCs. The operator can only execute the command successfully if the device is not blocked and if no interlocking condition is violated. After command execution the operator shall receive a message, either about the new switching position or about the unsuccessful switching.

Primary equipment control level selection (local, remote or off) shall be indicated on the SMMI in all displays which show the affected device by means of a single letter or symbol, to be defined during detailed design of the system, and which shall appear next to the relevant device.

Items relating to primary equipment shall be monitored, and functions assigned (e.g. event logging, control command refusal, etc.) as indicated in the input, output and event sheets in the Addendum.

Transformer tap changing shall be operated from a dedicated dialogue in a single line diagram. Manual control shall be selected, and after selection the operator may issue a command for increase or decrease of tap changer position. The status of the tap changer control mode shall be displayed clearly in this dedicated dialogue as well as in the transformer bay view.

The synchro-check function shall allow circuit-breaker closing only if the voltages on both sides of the breaker fulfil the pre-set conditions as to magnitude, phase and frequency difference.

The operator shall be able to remotely control the status of the auto-reclose function, where implemented, at the SMMI or master control centre. The status of the auto-reclose function shall be displayed on all dialogues which display the relevant circuit-breaker, and shall be clearly displayed on the auto-reclose control dialog and the relevant bay view.

Clear indication of each portion of the single line diagram's voltage shall be displayed by means of line colouring on all of the single line diagram views as follows:

a)	Earthed	Green
b)	132 kV	Orange
c)	33 kV	Dark Blue
d)	11 kV	Light Blue
e)	Uncertain	Flashing yellow

The indication of the voltage for each item of primary plant as described above shall be checked for correctness by considering all available information in order to minimise the chance of an incorrect display.

10.3 Alarm List

Faults and errors in the substation shall be listed in the alarm list and shall be simultaneously transmitted to all control centres. It shall contain unacknowledged alarms and persisting faults, e.g. "Circuit-breaker low SF6 pressure". Date and time of occurrence shall be indicated, with an overall resolution of 10 ms or better.

The operator shall be able to acknowledge alarms on display. Acknowledged alarms shall be marked on the list.

Faults that appear and disappear without being acknowledged (fleeting alarms) shall be marked as such in the alarm list.

A chronological alarm list shall be presented on the display screen, and shall be able to be transferred to the event printer.

The user-definable alarm description shall have at least 28 characters, and grouping of alarms based on their source shall be possible.

10.4 Control System Status Display

The system status display shall show the substation control system configuration and the status of all devices of the system.

10.5 Event List

The event list shall contain events that are important for the control and monitoring of the substation. The type of event and its time of occurrence have to be displayed for each event, with a resolution of 10 ms or less.

The operator shall be able to call up the chronological event list on the monitor at any time for the whole substation or sections of it, as required.

The event list shall be capable of storing at least 500 events in a first-in-first-out (FIFO) buffer.

The chronological event list shall contain :

a) Position changes of circuit-breakers, disconnectors and earthing devices;
b) indication of all protective relay operations, with clear distinction of the different functions of multi-function relays;
c) fault signals from the switchgear;
d) exceeding setable upper and lower limits of analogue measured value;
e) loss of communication; and
f) user-defined inputs.

The user-definable event description shall have at least 30 characters, and grouping of alarms based on their source shall be possible.

It shall be possible to select separately for each event whether or not it will be logged and whether it will be logged on a rising edge, a falling edge or for both transitions.

10.6 Event and Alarm Log

The event and alarm log shall be the continuous listing of events and alarms on the event printer.

Events that occur when the printer is off-line due to lack of paper or other similar occurrence shall be queued in the SMMI until the printer is again available. Queuing shall not, however, occur if the event printing function has been disabled.

It shall be possible to conduct searches in the alarm and event lists based on any of the following:

a) Characters with “wildcards” (so that a search for “??IBM*” will display all events or alarms which have the third, fourth and fifth letters of their description matching “IBM”);
b) time-period searches to obtain all events or alarms which occurred within a certain period of time on a specified date; and
c) functional group specific searches to obtain events or alarms which relate to a specific bay or the substation common items.

Typical event and alarm lists have been provided in the Addendum.

10.7 Power Supply

The supply shall be taken off the station batteries, via the automatic supply changeover unit described. Tenderers shall calculate the total standing and intermittent auxiliary supply load. The capacity of the battery banks shall be increased from the presently specified value, if needed, to allow a standby time, with control system operation and printing taking place, of at least 8 hours without AC mains supply for all protection and control functions.

10.8 Operator Station Hardware

The computer system shall be a high quality, high-speed industrial type with high reliability and immunity to electromagnetic interference. The Tenderer shall supply specific details regarding the computer’s extraordinary ruggedness and suitability to extended terms of unattended operation in the substation environment. The main requirements are given in the Schedule.

The computer hardware shall, at a hardware level, be Energy Star compliant, and shall enter the following modes during periods of inactivity in the following sequence:

a) Computer monitor shutdown after an inactivity period of 10 minutes
b) Computer hard drive shutdown after an inactivity period of 10 to 30 minutes

Inactivity for the monitor shall be defined as no input activity from the local keyboard or mouse.

The operator station equipment shall be mounted in a lockable cubicle(s), with provision for a chair and a comfortable operating position for the operator. Space shall be provided for manuals, a writing area or desk and for locking away the operator's chair.

Manufacturers’ MTBF figures shall be quoted for all hardware components of the operator station.

The printer described shall be positioned in a separately lockable compartment, in such a way that they are easy to reach and operate. It shall also be possible to utilise the printer from the engineering network connection.

Only a single station computer is required, but the hard drive system shall consist of two mirrored hard disk drives, which must be mirrored at a hardware level to minimise software dependency.

10.9 User Authority Levels

Access rights to the operator station shall be controlled by means of passwords. The allocation of user rights to each of the six levels required is shown in Table 1.

Individual users signing on to each level shall also be identified and logged.

11. REMOTE ENGINEERING WORKSTATION

11.1 General

Software for the existing REWs shall be provided and installed to allow protection engineers and service technicians to set up, do application programming, change and test the control system and analyse the behaviour of the control system and the primary network. Disturbance recorders and protection units shall be incorporated in the hardware configuration to allow access to event and disturbance recordings.

The system shall provide on-request information from protection terminals and disturbance recorders, comprising :

a) Reading of all indications;

b) resetting of all indications;
c) settings and configuration of all parameters;
d) measuring values at fault;
e) service values from analogue and digital inputs;
f) self supervision results; and
g) disturbance record analysis.

The E-LAN shall also have a communication port (LAN-extension) for data exchange with a remote centralised engineering workstation, via a multiplexed serial link.

The software of the REW shall consist of a flexible software package, handing both disturbance recorders and protection units. All programs shall be PC based.

Reading and setting of all parameters in the protection relays and changing between complete groups of parameters shall be possible. The editing of the parameters shall be done off-line. Fault recording for protection relays, each giving disturbance reports for 3 disturbances, shall also be included. It shall be possible to reset all values remotely.

Password access control shall be implemented.

Item No.	Function	Authorisation					
		Level 1 (MV operator)	Level 2 (HV operator)	Level 3 (Maint.)	Level 4 (Engineer)	Level 5 (Operator Supervisor)	Level 6 (System Administrator)
1.	Operator authorisation					√	√
2.	System Exit						√
3.	132 kV control		√			√	√
4.	11 kV control	√	√			√	√
5.	Alarm Acknowledge: 132 kV		√			√	√
6.	Alarm Acknowledge: 11 and 33 kV	√	√			√	√
7.	Print events and alarms	√	√	√	√	√	√
8.	Save log file to removable media				√	√	√
9.	Erase log file			√	√		√
10.	Program Trending curves				√		√
11.	View primary plant (132 kV)	√	√	√	√	√	√
12.	View secondary plant (11 and 33 kV)	√	√	√	√	√	√
13.	View control network	√	√	√	√	√	√
14.	Set protection Relays			√	√		√
15.	Substation local/ remote control	√	√			√	√
16.	System configuration						√

TABLE 1: USER OPERATING LEVELS

11.2 Disturbance Analysis

When disturbances occur on the network, various kinds of information are needed to analyse the fault and find the original cause, in as short a time as possible.

A communication program for manual or automatic collection of disturbance files to a PC shall be available. The automatic function shall poll the station at user-definable intervals. When new pre-selected disturbance recordings are available they shall automatically be transferred to the PC. The data collection program shall be integrated in the monitoring program.

The disturbance evaluation software shall include functions such as time, amplitude and angle measurement. Zooming in the time scale and independent magnitude scaling of each signal shall be possible and the software shall be able to handle 8 analogue and 8 digital signals in one window. The evaluation software shall accept the standard disturbance file format COMTRADE (IEE standard) and perform conversion between different formats which may be found in the substation.

A further option would be an expert system for automatic evaluation of disturbances. It shall include functions for handling of statistics and shall do accurate fault locator calculation using an algorithm that includes load compensation.

Tenderers shall give a detailed description of the evaluation software to be provided and the analysing and presentation features it offers.

12. SERVICE AIDS

12.1 General

All necessary software shall be provided for a laptop computer which is to be used as a service unit for on-site engineering, analysis and modifications. The software shall also enable the laptop to double as an REW.

Access to the SMMI shall be possible by means of a 10 Base-2 network BNC T-connection to the E-LAN from a laptop in order to access engineering data, program protection relays and make use of the local event printer.

12.2 Functions

The laptop-based service unit shall be used for the following purposes:

a) System entry
b) Application programming
c) Program testing
d) Fault tracing
e) Graphical program documentation
f) Loading and dumping of programs
g) Commissioning
h) Reading of values in the data base
i) Changing peripheral parameters and relay settings
j) Disturbance record analysis

12.3 Monitoring

The laptop-based service unit shall permit the user to investigate changes of status and analogues in the substation. The service aid shall be able to monitor data in the running substation control system and to present changing variables on the display screen, selected in tabular form or in graphic representation.

12.4 Display and Printouts

The program entry procedure shall be based on display screen techniques that provide the operator with visual control of the work performed.

The service aid shall be able to obtain data assimilated by the SMMI in order to allow for archiving and analysis.

12.5 Event Printer Compatibility

The event printer of the operator station shall be compatible with the service system computer's standard parallel printer port to allow it to be used for service printouts at the substation.

12.6 System Information

Tenderers must provide detailed information of the system hardware and software offered, and where the hardware has previously successfully been installed in a similar environment.

13. COMMUNICATION

13.1 Communication between BYCs and Protection Relays

If the protection relays do not communicate directly with the SMMI, a secondary communications bus may be installed to transfer the information required to the BYC. It shall allow transfer of information like events, alarms, operations, settings, status, measured values, time synchronisation etc. Tenderers shall give full particulars of this secondary or object bus and communication protocols.

Should this secondary bus be used for communication to the protection and other bay IEDs, data such as disturbance records shall take lower priority than digital and analogue information in order to avoid loss of general information during disturbance record uploading to the SMMI.

13.2 Substation Local Area Network (S-LAN) Communication

Data exchange shall be provided between bay and station control modules on a optical station data bus. Tenderers shall clearly state the physical properties and arrangement of the bus, the data protocols utilised and the speed of data update for analogue and digital values on the SMMI.

Analogue and digital values shall be updated at least every 2 seconds in the SMMI database and display, and shall take a higher priority than such information as disturbance records.

13.3 Communication to the Master Control Centre

Communication to a Master Control Centre (MCC) shall be provided via a gateway port. Details regarding the gateway are discussed elsewhere in this specification.

13.4 Protocol

Different protocols among manufacturers pose a major problem for a utility in terms of forward compatibility and compatibility among different elements of their system.

Tenderers shall report on the latest developments in this regard.

Tenderers shall clearly indicate the protocols proposed for the different communication levels and the disadvantages or advantages of the particular choices.

13.4.1 IEDs which have the ability to interface to relays with the IEC 870.5 VDEW, in addition to the Proprietary protocol, will be preferred.

14. TIME SYNCHRONISATION

14.1 Master Clock

A substation master clock shall be provided. The master clock shall synchronise the substation automation system internal clocks of the SMMI, the BYCs as well as the fault recorders.

14.2 Global Positioning System

The master clock shall be synchronised by a GPS (Global Positioning System) satellite receiver. A regular time telegram shall be sent to all control and protection units to allow a final time resolution of 10 ms or better for all event and alarm records.

15. PROTECTION DEVICES, FUNCTIONS AND ASSOCIATED ITEMS

15.1 General Information and Requirements

The protection equipment provided shall be suitable to protect the electrical system in the event of the occurrence of faults such as phase faults, earth faults, busbar faults, feeder faults, breaker failure, etc. The Contractor shall ensure that the equipment offered is suitable for the application and that the relay characteristics satisfy the tripping time and load current requirements. Should relays with different characteristics or operating principles to those specified hereafter be offered, the Tenderer shall state the reason for offering such a relay as well as the advantages of the said scheme over the one specified. The price for non-numerical relays shall be entered in the price schedule total if no offer is made on the numerical relay.

The protection measuring relays shall be based on the latest generation proven numerical technology, to allow a wide range of protection, control and measurement functions, with comprehensive communication facilities for integration with the overall substation control system. The system shall have forward compatibility with future equipment for a period of at least ten years.

Each relay element shall be provided with a sufficient number of correctly rated, electrically separate normally open contacts to cater for tripping of the two trip coils in each circuit-breaker directly, making use of two separate isolated DC supplies. Relay elements shall also be fitted with sufficient, suitable contacts for interconnecting to the bay processor and for blocking functions where necessary.

The circuit-breaker tripping supplies shall be provided from duplicated 110 V battery/charger units and shall be dedicated to tripping and related relay auxiliary supplies. The tripping supply circuits shall under no circumstances be used for closing, indication, monitoring, etc.

Redundancy shall be built into the tripping circuits by means of the following features:

a) Dual tripping supplies provided from duplicated 110 V battery/charger units.
b) Dual circuit-breaker tripping coils.
c) Main and back-up protection working in different modes and powered off different instrument transformers and power supplies.
d) Trip circuit supervision with circuit-breaker opened and closed on both tripping circuits.
e) Cross-tripping from relays to both tripping circuits.

Where trip contacts on relays are not adequately rated, high-speed shunt reinforcing contacts shall be provided. However, preference shall be given to direct operating relays. The Contractor shall present calculated values of the relevant parameters of tripping and closing circuits for approval of contact ratings.

All relays where possible shall be withdrawable, with suitable protection against open circuiting of current transformer circuits, where applicable. The tripping contacts of all relays shall also be so arranged that tripping does not occur while or when a relay is being withdrawn.

Operating of a relay element shall be clearly and positively indicated on the relay by an indicating light or alphanumeric display. The indication shall always positively identify the type of fault and where applicable the affected phase, busbar or bus-zone.

The adjustable settings on all relays shall be easily accessible, from the relay front panel, from the service aid (laptop), from the local SMMI and from the engineering network. At no time shall the downloading of new settings to the relay compromise the relay protection functions. Protection settings shall be completely alterable from the relay front panel, service aid (via the E-LAN), the REW and the SMMI.

Users shall be able to completely re-configure relays and protection functions via a service aid, the E-LAN and the SMMI.

Each protection relay and function shall have at least two complete setting groups, which may be selected from the relay front panel, a laptop computer, the E-LAN and the SMMI. The alternative setting group shall be selected by either energising an opto-isolated input assigned to this function, or by a suitable command via the serial communication port of the relay. These inputs shall be energised from an internally generated DC source and must not be affected by induced power frequency AC signals in the wiring.

Test blocks for each separate current transformer circuit shall be provided. The test block shall have 14 sockets and 28 terminals to allow, through the insertion of a test plug, short circuiting of the CT circuits and secondary injection testing by external testing equipment, or current measurement to be made while the circuit is in service. Insertion of the multi-finger test plug shall isolate the trip contacts of the relays whilst allowing external monitoring of the trip contacts. Three multi-finger and three single-finger test plugs, complete with shorting and bridging links, shall be provided with the test blocks.

Relays and auxiliary coils specified for operation from a nominal 110 V DC substation battery supply shall operate reliably and satisfactorily at any voltage between minimum limits 80 % to 120 % of 110 V DC, and shall be capable of withstanding the voltage level associated with boost charging of the station battery. Where relays require auxiliary power at a voltage other than 110 V DC, provision shall be made for the necessary DC to DC convertor equipment. Preference shall, however, be given to equipment operating directly from 110 V DC.

The relays shall all be of robust construction and shall have a positive action without chatter.

All relays shall be flush mounted.

The manufacturer's name, type and designation number and ordering code of each type of relay offered, together with the corresponding pamphlet or brochure reference shall be entered by the Tenderer in the Schedule of Particulars and Guarantees. The necessary brochures with sufficient information on each device, including the explanation of the order code shall be provided.

Where applicable, the ordering code of the relay shall also be specified as an indication of the choice of options which are intended to be supplied.

Full details, including any technical literature, descriptive and illustrative publications and catalogue pamphlets of the protection scheme and equipment offered shall be included in the Tender Document.

15.2 Particular Requirements

Various protection relays are covered in the remainder of this clause and in the Particulars and Guarantees. Information about the specific protection schemes covered by this enquiry is included in the following clause and in the form of block schematic diagrams of the schemes required.

The final arrangement of the protection circuits shall be agreed with and shall be to the approval of the Engineer.

The stated requirements are the City Municipality's minimum requirements for the protection of the various circuits and Tenderers are at liberty to expand on the requirements detailed hereunder.

15.3 Two terminal digital current differential protection

Digital current differential protection relays shall be supplied as the main unit protection on the 132 kV overhead transmission line or cable feeders where indicated.

The relay shall consist of a modern numerical, self monitoring IED utilising programmable scheme logic to provide multiple and independent tripping. It shall offer a user friendly interface, a display of measured steady state and fault quantities, isolated serial communication, remote setting and interrogation by the substation control system and time tagged event/disturbance recording to a 1 ms resolution.

The differential protection relay shall obtain it’s power supply from a dedicated DC Main Trip Supply circuit, and shall function independently of any control IEDs in the bay.

The relays shall communicate via dedicated optical fibre channels for current comparison and inter-tripping.

The current differential relay shall evaluate each phase current separately at both ends utilising the current amplitude and phase angle.

CT saturation detection or dual slope bias restraint characteristics must be utilised to stabilise the relay during through faults.

The relay shall allow direct inter-tripping via opto inputs. A prerequisite of this feature would be clear alarm indication descriptions and the origin of the inter-trip clearly defined at all ends of the protected zone.

The relay must perform continuous self-monitoring and shall not trip when a relay or communication error occurs. A separate output relay that has one make and one break contact, shall be provided to indicate both healthy and relay defective conditions.

Comprehensive computer based test facilities and the software for it shall be provided, to allow the relay to be thoroughly tested during commissioning, routine maintenance and fault finding operations.

The optical fibres for the relay communication will be available in the station communications cubicle, and are normally terminated with ST type optical connectors. The Contractor will be responsible for the installation and connection of the optical fibres from the relay panel to the communications cubicle. The particulars of the optical fibres are as follows :

a)	Type of fibre	Single mode glass fibre
b)	Max attenuation level at 1 300 nm	0,5 dB/km
c)	Cut-off wavelength	1 100 nm to 1 310 nm

The contractor shall install only single mode glass fibre for connection to the communications cubicle, and shall select the correct communications interface unit for the relay to suit the wavelength and attenuation of the installed system.

The feeders that are to be protected are short. The exact lengths of the optical fibre-links and an optical loss budget will be provided to the Contractor on request.

Current transformer details are given in the relevant part of this specification.

15.4 Combined transformer differential, HV and LV restricted earth fault protection relay

The relay shall consist of a modern numerical, self-monitoring IED utilising programmable scheme logic to provide independent transformer biased differential protection, overfluxing protection and restricted earth fault protection separately on the HV and LV sides of the transformer. It shall offer a user friendly interface, a display of measured steady state and fault quantities, alternative setting groups, isolated serial communication, remote setting and full interrogation by the substation control system, time tagged event/disturbance recording, plant control capability and start contacts.

The combined differential/REF relay shall obtain it’s power supply from a dedicated DC Main Trip Supply circuit, and shall function independently of any control IEDs in the bay.

The relay shall be stable for all through-faults without compromising the sensitivity to in-zone faults.

The biased differential protection shall utilising six biased current inputs (two per phase) and be able to compensate internally for CT ratio and vector group mismatch.

The differential protection operation shall be blocked for normal magnetising in-rush currents (inrush restraint), by means of either a high-speed waveform recognition technique or a second harmonic restraint technique.

The restricted earth fault (REF) protection for the HV and LV side of the transformer shall utilise two additional inputs, one from each of the transformer neutral circuits. Separate trip elements shall be provided for each of the REF functions.

The differential protection shall detect over-fluxing (over-excitation) of the transformer and allow for a definite time delayed alarm output as well as an inverse time delayed trip output. A 3-phase VT will be installed (under part 11 of this Contract) on the LV side of the transformer for this purpose.

The relay shall have programmable output relays which can be allocated to the different relay functions.

The relay shall perform continuing self monitoring. A separate output relay, that has one make and one break contact, shall be provided to indicate both healthy and relay defective conditions.

An alternative group of settings shall be provided for both the phase fault and earth fault protection functions. The alternative setting group shall be selected by either energising an opto-isolated input assigned to this function, or by a suitable command via the serial communication port of the relay. These inputs shall be energised from an internally generated DC source and must not be affected by induced power frequency AC signals in the wiring.

The relays shall provide and display the following control and measurement features :

a) Measured or derived quantities such as phase currents and zero sequence currents. When CT ratios are entered into the relay, measured quantities and settings shall be displayed in primary quantities.

b) Circuit breaker maintenance data ie. sum of the square of the fault current interrupted by the circuit breaker for each individual phase and also the number of times the relay has issued a trip command.

c) Fault records such as setting the trip LED and displaying the responsible protection function(s) and fault currents.

Time tagged event recording with a 1 ms resolution incremented every millisecond shall be provided. This data must be automatically uploaded to the SMMI as soon as the recording has been completed, and the storage facilities within the relay shall allow for first-in-first-out buffering of the event records.

15.5 132 kV Busbar Protection

A busbar protection scheme comprising one zone per connected busbar of the station and an overall check-zone (utilising separate CTs) shall be supplied to detect busbar faults quickly and selectively and thereby isolate the faulty zone only, with the minimum damage occurring.

Busbar protection schemes offered may be either of the static or numerical type.

Should a numerical scheme be offered, the scheme should be integrated into the substation ICAP system.

The design of the protection scheme shall be based on the biased low or medium impedance current differential principle offering protection against phase-to-phase and phase-to-earth faults. The protection scheme shall be based on the latest generation of numerical technology, to allow a wide range of protection, control and measurement functions, with comprehensive communication facilities for integration with the overall substation control system. The system shall have forward compatibility with future equipment for a period of at least ten years.

The lay-out of the busbars and the number of circuits to be incorporated are depicted on the accompanying single line drawing. The busbar scheme and central unit shall be configured for all the future feeders, bus-sections and bus-couplers. Measuring units shall only be provided for present bays, as far as possible, without compromising the future upgrading to a complete scheme.

The busbar protection scheme shall preferably operate from dual redundant power supplies for the purpose of continuity of operation. Alternatively, the busbar protection scheme shall obtain it's power supply from a dedicated DC Supply circuit connected to the main battery bank, and shall function independently of any control IEDs in the bay.

Each zone measuring unit shall have integral CT circuit supervision which must detect CT circuit faults, flag these faults and prevent mal-operation of the protection scheme during normal system operation. It must not be necessary for the CT circuit supervision to await an over-current situation to detect a problem.

Each zone measuring unit shall have two separate measuring elements, one of which operates for the differential current exceeding the current setting threshold (differential detection) while the other element must operate for the differential current exceeding the through current bias (over-current start detection). Both elements must operate in order to allow a busbar fault output to occur.

In order for a busbar fault to be acknowledged and acted on, the main and check measuring unit outputs must both operate.

The busbar protection scheme shall perform self-supervision and provide local indication and alarm outputs should any element of the scheme become faulty.

Current transformer circuits are to be wired directly to the busbar protection scheme and must not be routed through the isolator auxiliary contacts. The busbar protection scheme must perform its function via "busbar imaging" and obtain plant status via isolator and circuit-breaker auxiliary contacts.

Comprehensive test facilities shall be provided.

The protection shall retain full stability in the event of a through fault.

The busbar protection shall accept inputs from external breaker fail protection relays which shall activate bus-zone trip auxiliary relays to disconnect all the circuits connected to the affected busbar zones(s).

The busbar protection scheme shall automatically detect the closing of two busbar selector isolators in the same bay and immediately combine the two bus zones and disable the main and backup trip circuits of the bus coupler circuit-breaker (Bus coupler “solid”). Any busbar fault detected after combination of the two busbar zones must strip both busbars.

The detection of the movement of the busbar selector isolators shall be based on the changing of state of the outermost limit contacts N or G.

Local indication on the busbar protection panel and alarm outputs to the SMMI shall be provided to indicate the combination of bus zones.

In order to ensure the stability of the busbar protection, the resistance of the secondary CT circuit wiring shall be taken into account, and the resistance of this wiring reduced to a minimum.

The busbar protection schemes shall be housed in free-standing protection panels in the control room. In the case of a distributed busbar protection scheme the main unit must be housed in a free standing protection panel. Data transfer between bay units and central units shall be via optical fibre links to ensure immunity to electromagnetic interference.

15.6 Combined over-current and earth fault protection relay/function

The multi-function relay must perform the bay standardisation function described. Where bay VT's are not available, an accurately derived or imaged busbar voltage shall be supplied to the relay for voltage and power measurement information.

The relay shall be a modern numerical, self-monitoring instrument utilising programmable scheme logic to provide multiple, independent three-phase and earth fault protection curves. It shall offer a user friendly interface, a display of measured steady state and fault quantities, alternative setting groups, isolated serial communication, remote setting and full interrogation by the substation control system, time tagged event and disturbance recording, plant control capability and start contacts.

The functions required of the combined over-current/earth fault protection may, alternatively, be incorporated into the BYC, should the BYC be suited to this purpose.

The relay shall obtain it’s power supply from a dedicated DC Backup Trip Supply circuit, and shall function independently of any control IEDs in the bay. Alternatively, should the relay functionality be implemented within the BYC, it shall make use of the selected supply provided to the BYC.

Over-current elements shall conform to the following :

a) The relays shall contain three independent over-current stages for both phase elements ($I_{>}$, $I_{>>}$, $I_{>>>}$) and for earth fault elements $I_{o>}$, $I_{o>>}$, $I_{o>>>}$). Measurement shall be based on the Fourier derived value of the power frequency component, with harmonics up to and including the sixth suppressed.
b) The $I_{>}$/$I_{o>}$ elements shall operate when the power frequency component of the current exceeds the set threshold. The time/current characteristic associated with these elements must provide a selection of inverse definite minimum time (IDMT) curves, or be setable to a fixed (definite) time delay.
c) The $I_{>>}$/$I_{o>>}$ and $I_{>>>}$/$I_{o>>>}$ elements shall provide instantaneous functions that are not affected by offset waveforms, such as those occurring with power transformer inrush currents. This shall allow the instantaneous elements to be set down to 35% of the anticipated peak transformer inrush current. To a first approximation, the peak inrush is given by the reciprocal of the per unit series reactance of the transformer. These over-current stages shall also have selectable definite time settings.

The relay shall be provided with a start function (and programmable relay output) that responds to the current exceeding either the $I_{>}$ or $I_{o>}$ thresholds.

The relay shall have programmable output relays (quantified in the Particulars and Guarantees) that can be individually and collectively allocated to the different relay over-current functions.

The relay shall perform continuing self monitoring. A separate output relay, that has one make and one break contact, shall be provided to indicate both healthy and relay defective conditions.

An alternative group of settings shall be provided for both the phase fault and earth fault protection functions. The alternative setting group shall be selected by either energising an opto-isolated input assigned to this function, or by a suitable command via the serial communication port of the relay. These inputs shall be energised from an internally generated DC source and must not be affected by induced power frequency AC signals in the wiring.

The relays shall provide and display the following control and measurement features :

a) Measured or derived quantities such as phase currents and zero sequence currents. When CT ratios are entered into the relay, measured quantities and settings shall be displayed in primary quantities.
b) Circuit breaker maintenance data ie. sum of the square of the fault current interrupted by the circuit breaker for each individual phase and also the number of times the relay has issued a trip command.
c) Fault records such as setting the trip LED and displaying the responsible protection function(s) and fault currents.

Breaker failure protection with internal and external initiation and a programmable relay output shall be available as an integral relay feature.

Time tagged event recording with a 1 ms resolution incremented every millisecond shall be provided, with access via the communication port.

15.7 Transformer standby earth fault protection relay

The relay shall be a modern numerical, self-monitoring instrument utilising programmable scheme logic to provide multiple, independent three-phase and earth fault protection curves. It shall offer a user friendly interface, a display of measured steady state and fault quantities, alternative setting groups, isolated serial communication, remote setting and full interrogation by the substation control system, time tagged event/disturbance recording, plant control capability and start contacts.

The relay shall obtain it's power supply from a dedicated DC Main Trip Supply circuit, and shall function independently of any control IEDs in the bay.

The earth fault elements shall conform to the following :

a) The relays shall contain three independent, single-phase earth fault over-current stages ($I_{o>}$, $I_{o>>}$, $I_{o>>>}$). Measurement shall be based on the Fourier derived value of the power frequency component, with harmonics up to and including the sixth suppressed.
b) The $I_{o>}$ element shall operate when the power frequency component of the current exceeds the set threshold. The time/current characteristic associated with this element must provide a selection of inverse definite minimum time (IDMT) curves or be setable to a fixed (definite) time delay.
c) The $I_{o>>}$ and $I_{o>>>}$ elements shall operate when the power frequency component of the current exceeds the set threshold. The time/current characteristic associated with this element must be setable to a fixed (definite) time delay.

The relay shall be provided with a start function (and programmable relay output) that responds to the current exceeding the $I_{o>}$ thresholds.

The relay shall have programmable output relays that could be allocated to the different relay functions.

The relay shall perform continuous self-monitoring. A separate output relay, that has one make and one break contact, shall be provided to indicate both healthy and relay defective conditions.

An alternative group of settings shall be provided for the earth fault protection functions. The alternative setting group shall be selected by either energising an opto-isolated input assigned to this function, or by a suitable command via the serial communication port of the relay. These inputs shall be energised from an internally generated DC source and must not be affected by induced power frequency AC signals in the wiring.

The relays shall provide and display the following control and measurement features :

a) Measured or derived quantities. When CT ratios are entered into the relay, measured quantities and settings shall be displayed in primary quantities.
b) Circuit breaker maintenance data ie. sum of the square of the fault current interrupted by the circuit breaker for each individual phase and also the number of times the relay has issued a trip command.
c) Fault records such as setting the trip LED and displaying the responsible protection function(s) and fault currents.

Time tagged event recording with a 1 ms resolution incremented every millisecond shall be provided, with access via the communication port.

15.8 Transformer voltage regulating relay

The relay shall be a modern numerical, self-monitoring instrument utilising programmable scheme logic to provide multiple, independently programmable settings for each measuring element and timer. It shall offer a user friendly interface, a display of measured quantities, isolated serial communication, remote setting and full interrogation by the substation control system, time tagged event/disturbance recording, plant control capability and start contacts.

The relay shall obtain it's power supply from a DC Control Supply circuit, and shall function independently of any other control IEDs in the bay.

The relay shall provide the following voltage regulating features:

a) The tap change controller's regulating voltage, deadband, initial activation time delay and inter-tap time delay shall be user setable.
b) Line drop compensation shall be provided which simulates resistive and reactive components of the voltage drop across a feeder.
c) An over-current situation on any or all of the three phases shall be provided to inhibit tap changing (i.e. the device shall provide three phase over-current blocking).
d) Voltage blocking (setable in the range of 70% to 100% of the nominal voltage) shall be provided to inhibit tap change operations.
e) Should a VT failure be detected, the voltage blocking function shall not inhibit tap changing.

The relay shall provide the following supervisory functions:

a) Tap changer position display and control from the front of the unit.
b) User-selectable automatic and manual control of the tap changer, with manual tap changing being possible from the front of the relay and remotely via the communications port.
c) Tap changing in progress shall be clearly indicated on the relay.
d) Tap changer runaway detection to detect incorrect tap changer operation, inhibit further operation and present an alarm.

The relay shall be able to provide the tap position and the transformer voltage as default displays, with preference given to the display of actual primary system voltage values. The type of tap position indication transducer or method must be determined in co-operation with the ICAP equipment and transformer suppliers

The relay shall perform continuous self-monitoring. A separate output relay, that has one make and one break contact, shall be provided to indicate both healthy and relay defective conditions.

Control of the voltage regulating relay shall take place as follows:

a) If the relay is on remote and the transformer bay is switched to remote control mode, the tap position must be selectable from the SMMI or the SCADA, whichever is in control of the substation;

b) If the relay is on remote and the transformer bay is switched to local control mode, the relay must be manually controllable from the bay local position; and

c) If the relay is on auto, the tap position shall be automatically selected by the voltage regulating relay regardless of the substation and bay control mode selected.

15.9 132 kV Inter-trip Send and receive facilities

Inter-tripping shall be facilitated via the digital protection channels, which form a part of the communication equipment specified elsewhere in this Enquiry document.

Provision shall be made on the terminal blocks of each panel for terminating the inter-trip circuit loops to the yard marshalling kiosk and isolator and back to the fibre optic communication equipment panel via the relay panel.

Inter-trip circuits shall be taken through isolating MCBs with auxiliary contacts for control system monitoring.

Where possible the digital current differential relay will be used for the inter-trip send medium via an optic isolated input on the relay. This will serve as a back-up inter-trip, as indicated on the block diagrams.

Two spare normally open contacts shall be provided on the inter-trip send relay, over and above the full relay contact requirement.

A self-resetting auxiliary inter-trip receive relay is used to cross-trip to the two trip circuits. It also provides a contact to the BYC for inter-trip receive indication.

15.10 132 kV synchronising-check relay and busbar voltage imaging

Busbar VT's are not normally provided.

A reflected busbar 3-phase voltage, sourced from incomer line VTs and derived from each bay primary equipment configuration, must be bus-wired through each panel to provide the "running" busbar voltage reference for synchronising.

The reflected busbar voltages must also be used for the measurement and indication on the bus- coupler, bus-section and transformer panels, or other bays where there are no VT's available.

Where required, a synchronising-check relay is to be incorporated, so that connecting-up of two systems through the circuit-breaker may only take place whilst the voltages of the two systems are synchronised or close to synchronism. Provision shall also be made for dead-line and dead busbar charging. The relay shall measure phase angle difference and slip frequency, and shall block for differential voltage above setting.

The synchronising-check scheme shall be designed so as to prevent the circuit-breaker from closing if the operator holds the control switch in the closed position and waits for the synchronising-check relay to operate.

Overriding the relay synchronisation check function shall be performed via a clearly marked push-button mounted on the protection and control panel.

15.11 132 kV Line automatic reclosure

The relay shall be a modern numerical, self-monitoring instrument utilising programmable scheme logic to provide multiple, independent reclose actions. It shall offer a user friendly interface, a display of measured quantities, alternative setting groups, isolated serial communication, remote setting and full interrogation by the substation control system, time tagged event/disturbance recording, plant control capability and start contacts.

The relay shall obtain it’s power supply from a dedicated DC Main Trip Supply circuit, and shall function independently of any control IEDs in the bay. Alternatively, should the relay function be implemented within the BYC, it shall make use of the selected supply provided to the BYC.

The relay shall perform continuing self monitoring. A separate output relay, that has one make and one break contact, shall be provided to indicate both healthy and relay defective conditions.

The relay shall provide the following functions:

a) Four-shot, three phase auto-reclosing with independent control of the time characteristics for each of the different stages of the reclosing cycle.
b) Manual closing of the circuit-breaker shall start the relay reclaim timer, whilst manual tripping shall lock out reclosure. When the line is energised onto a fault the instantaneous protection shall operate and no reclosing shall be initiated.
c) A clearly marked centre-return switch shall be provided on the panel to override the auto-reclosing function.
d) The relay shall take cognisance of the circuit-breaker spring status.
e) The relay shall clearly indicate and communicate the auto-reclose in progress state.

The relay shall have the following time settings:

a)	Close pulse	0,1 to 2 s
b)	Dead time 1	0,25 to 180 s
c)	Dead time 2	1 to 180 s
d)	Dead time 3 and 4	10 to 200 s
e)	Reclaim time	1 to 180 s

An alternative group of settings shall be provided. The alternative setting group shall be selected by either energising an opto-isolated input assigned to this function, or by a suitable command via the serial communication port of the relay. These inputs shall be energised from an internally generated DC source and must not be affected by induced power frequency AC signals in the wiring.

The relay shall clearly indicate whether or not auto-reclosing is enabled, and also indicate when an auto-reclosing cycle is in progress.

Time tagged event recording with a 1 ms resolution incremented every millisecond shall be provided, with access via the communication port.

Auto-reclosing must be inhibited if the bay main protection relay is faulty.

15.12 Current differential

Due to the municipality standardization on the P521 current differential relay. Current differential relay shall be installed on the local substation (primary substation) and its remote end (secondary substation) with fiber optic cables between fox panels included

15.13 132 kV Trip Circuit Supervision

Both trip coils and the main and back-up DC trip supplies must be monitored by a relay with the circuit-breaker in the open and the closed position.

Separate supervision relays shall be used for each of the trip circuits, and one of the relays may reside in the bay controller.

The relay must be suitably slugged to prevent false alarming due to voltage dips caused by faults on other circuits, or due to the “change-over” action from one element to the other when a circuit-breaker is tripped.

The relay must operate at ± 40% of rated voltage and reactivate at ± 80% of rated voltage.

Relay internal resistors must be suitably rated for the circuit-breaker trip coils.

15.14 Auxiliary latching and flagging trip relays

These relays shall be of the latching, hand reset type with flag indication.

15.15 Auxiliary relays for inter-tripping

These inter-trip receive relays shall be of the self-resetting type without any flag indication.

16. PROTECTION SCHEMES

This section summarises the composition of each bay’s protection scheme. The protection devices referred to below are specified in the previous clause.

16.1 132 kV overhead line bay protection

Refer to the drawing for details regarding this bay’s protection scheme.

The main overhead line protection shall be the digital current differential protection relay specified. Circuit-breaker closing shall be inhibited (by the BYC) should the main protection relay fail.

The backup protection shall consist of a combined backup over-current and earth-fault relay, as specified, which shall also fulfil the role of bay standardisation as described.

Supplementary functions to be included are as follows:

a) Trip circuit supervision for both the main and backup circuit-breaker trip circuits, with a software circuit-breaker close control lockout should both circuits be faulty.
b) Busbar voltage imaging.
c) Synchronism checking (only as an option in the price schedule).
d) Automatic reclosing of the circuit-breaker (only as a price option in the price schedule).
e) Breaker fail logic implemented in the backup relay.

16.2 132 kV Bus coupler bay protection

Refer to the drawing for details regarding this bay’s protection scheme.

The main and only protection for this bay shall be the combined over-current and earth-fault relay specified, which shall also fulfil the role of bay standardisation as described.

Supplementary functions to be included are as follows:

a) Trip circuit supervision for both the main and backup circuit-breaker trip circuits, with a software circuit-breaker close control lockout should both circuits be faulty.
b) Busbar voltage imaging.
c) Synchronism checking (only as an option in the price schedule).
d) Breaker fail logic implemented in the main relay.

16.3 132/33 & 132/11 kV Transformer bay protection

Refer to the drawings for details regarding this bay's protection scheme.

The first main protection for this bay shall be the combined biased differential and HV and LV restricted earth fault relay specified.

The second main protection consists of the Buchholz trip repeat relay and the transformer tank over-pressure trip repeat relay. This circuit is to obtain its power supply via the DC Backup Supply, and shall also perform cross-tripping as prescribed for the protection relays.

The third main protection consists of the transformer standby earth fault protection relay.

Failure of any main protection relay shall inhibit closure of the transformer HV circuit-breaker.

The backup protection shall consist of a combined backup over-current and earth-fault relay on the transformer HV side, as specified, which shall also fulfil the role of bay standardisation as described.

Supplementary functions to be included are as follows:
a) Trip circuit supervision for both the main and backup circuit-breaker trip circuits, with a software circuit-breaker control lockout should both circuits be faulty.
b) Busbar voltage imaging.
c) Breaker fail logic implemented in the backup relay.

16.4 132 kV busbar protection

The 132 kV busbar protection scheme shall be implemented as described.

16.5 33 kV Transformer incomer protection

Refer to the drawing for details regarding this bay's protection scheme.

The only protection installed in the switchgear instrument cubicle shall be the combined over-current and earth-fault protection relay specified, as well as the auxiliary tripping relays. Circuit-breaker closing shall be inhibited should the protection relay fail. This relay shall also fulfil the role of bay monitoring and control as indicated in the block diagram.

Supplementary functions to be included are as follows:
a) Busbar voltage imaging.
b) Blocking and breaker fail logic (refer to drawing).

16.6 33 kV Overhead line feeder protection

Refer to the drawing for details regarding this bay's protection scheme.

The main feeder protection shall be the Differential/Line Distance relay. Circuit-breaker closing shall not be inhibited (by the BYC) should the main protection relay fail.

The backup protection shall consist of a combined backup over-current and earth-fault relay, as specified, which shall also fulfil the role of bay monitoring and control as indicated in the block diagram.

Supplementary functions to be included are as follows:
a) Busbar voltage imaging.
b) Blocking and breaker fail logic (refer to drawing).

16.7 33 kV Bus section protection

Refer to the drawing for details regarding this bay's protection scheme.

The bus section protection shall consist of a combined backup over-current and earth-fault relay, as specified, which shall also fulfil the role of bay monitoring and control as indicated in the block diagram.

The only supplementary function required is busbar voltage imaging.

16.8 33 kV busbar protection

Refer to the drawing for details regarding this protection scheme.

The functions required in this scheme are as follows:

a) Feeder blocking of transformer 1 and 2 (TX1 & TX2) incomer and the bus section definite time trip outputs via the feeder over-current starter element for feeder faults. Since the intention is to operate the transformers in parallel, the single relay blocking outputs from feeders 1 and 2 should be commoned.
b) The feeder relay shall not block the transformer incomer or bus section for a busbar zone fault, and the bus section definite time will be set lower than the transformer definite time, to allow them to trip in sequence and thus obtain discriminative tripping of the two busbar zones.
c) Immediately upon detection of a feeder breaker fail condition, the feeder relay must remove the blocking signal to enable the bus section and the relevant TX definite time element to trip the bus section circuit-breaker and the correct incoming circuit-breaker.
d) The transformer incomer relay shall, for a definite time over-current trip, trip the circuit-breaker and operate a latching, flagging, hand-reset relay which shall inhibit re-closing of the 11 kV transformer circuit-breaker.
e) The bus section relay shall, for a definite time trip, inhibit re-closing of the bus section circuit-breaker.
f) Should the transformer incomer or bus section relay detect its own breaker fail condition, the 132 kV transformer circuit-breaker should be tripped and operate a latching, flagging, hand-reset relay which shall inhibit closing of the 132 kV transformer circuit-breaker.

16.9 11 kV Transformer incomer protection

Refer to the drawing for details regarding this bay’s protection scheme.

The only protection installed in the switchgear instrument cubicle shall be the combined over-current and earth-fault protection relay specified, as well as the auxiliary tripping relays. Circuit-breaker closing via the control system shall be inhibited should the protection relay fail. This relay shall also fulfil the role of bay monitoring and control as indicated in the block diagram.

Supplementary functions to be included are as follows:

a) Busbar voltage imaging.
b) Blocking and breaker fail logic (refer to drawing).

16.10 11 kV Main feeder protection

Refer to the drawing for details regarding this bay’s protection scheme.

The main feeder protection shall be the Translay HO4 relay specified. Circuit-breaker closing via the control system shall not be inhibited should the main protection relay fail.

The backup protection shall consist of a combined backup over-current and earth-fault relay, as specified, which shall also fulfil the role of bay monitoring and control as indicated in the block diagram.

Supplementary functions to be included are as follows:

a) Busbar voltage imaging.
b) Blocking and breaker fail logic (refer to drawing).

16.11 11 kV bus coupler protection

No protection functionality is required for the bus coupler. Control of these panels should therefore be implemented with a communicating I/O module as described in the control paragraphs.

16.12 11 kV bus section protection

No protection functionality is required for the bus coupler. Control of these panels should therefore be implemented with a communicating I/O module as described in the control paragraphs.

16.13 11 kV busbar protection

Two 11kV busbar protection schemes shall be installed which are blocking scheme and arc protection scheme

Refer to the drawing for details regarding this protection schemes.

16.13.1 Blocking scheme

The functions required in this scheme are as follows:

a) Feeder blocking of both transformer A and R incomer (TXA & TXR) definite time trip outputs via the feeder over-current starter element for feeder faults. The outputs shall be separate relay outputs, and each transformer will have a single set of buswires to each relevant panel (i.e. transformer R is connected to all feeders, but transformer A is only connected to section A's feeders).

b) Immediately upon detection of a feeder breaker fail condition, the feeder backup relay must remove the blocking signal to enable the relevant TX definite time element to trip the incoming circuit-breaker.

c) The feeder backup relay shall not block the transformer incomer for a busbar zone fault.

d) The transformer incomer backup relay shall, for a definite time over-current trip, trip the 11 kV circuit-breaker and operate a latching, flagging, hand-reset relay which shall inhibit closing of the transformer 11 kV circuit-breaker.

e) Should the transformer incomer backup relay detect a breaker fail condition, it shall trip the 132 kV transformer circuit-breaker via a latching, flagging, hand-reset relay which shall inhibit closing of the 132 kV transformer circuit-breaker.

16.13.2 Arc Protection Scheme

a) An arc protection scheme must be installed providing high speed detection of the arc inside the switchgear and tripping the circuit breaker in a few milliseconds to extinguish the arc.
b) Adopting a philosophy that combines the detection of light inside the switchgear (which indicates the formation of the arc flash) with the detection of significant increases in load current nominal values (which confirms the presence of a short circuit between live parts inside the switchgear)

16.14 11kV Live load transfer

a) Auto/manual live transfer of all feeders/incomers must be programmed according to City of Tshwane philosophy using available circuit breakers and isolators. It must be programmed in the switchgear panel relays not in the Remote Control Panel/HMI.
b) The live load transfer shall be activated (transfer ready) on all feeders of the stages provided the 11kV buscoupler is closed.
c) Philosophy to be discussed with City of Tshwane Protection Engineer.

16.15 11kV Chop-Over Scheme

a) 11kV automatic chop over incomers must be programmed according to City of Tshwane philosophy using available circuit breakers and isolators. It must be programmed in the switchgear panel relays not in the Remote Control Panel/HMI.

b) A chop-over scheme shall be activate automatically if any of stage transformers (A, B and C) trips with unit protection thus closing the buscoupler of the relevant stage to transfer load to transformer R provided that transformer R is not loaded but it is energized on the reserve busbar.

c) Philosophy to be discussed with City of Tshwane Protection Engineer.

16.16 11kV/132kV Power Quality Meters

a) Power quality meters shall be installed on 132kV line incomers, all 11kV transformer incomers and feeders that are dedicated to companies.
b) Power quality meters shall use voltage transformers (cable or busbar VTs) for measuring voltage and current transformers (protection CT) to measure current.
c) Philosophy to be discussed with City of Tshwane Protection Engineer and Power Quality Engineer.

16.17 11kV Remote Control Panel

a) Each stage of the switchgear panels must have its own remote control panel which uses new mode of communication (LAN/FIBRE) to the relays. No multicore cables shall be used for sending commands from the remote control panel to the switchgear panel.

17. DEMONSTRATION OF SYSTEM

Tenders must be prepared to arrange a fully working display of the main components of the control and protection equipment to demonstrate the system's functions and capabilities to the client or his representative. This demonstration will take place at the request of the client. Visits to completed, functional substations and meetings with other clients could form a part of the client's inspection.

Time for in-depth, detailed inspection and familiarisation shall be set aside, to allow the client to assess the advantages and limitations of the new concept of highly integrated control and protection systems.

18. SPARES

A comprehensive list of each different part, which could be considered as a possible spare, shall be submitted with the offer, stating descriptions, quantities and prices.

19. INSPECTION AND TESTING

Refer to Part C2.1, Specifications 4, Part 1 for requirements regarding the inspection and testing of equipment and systems.

20. DRAWINGS AND DESCRIPTIVE LITERATURE

Refer to Part C2.1, Specifications (Section 4), Part 1 for requirements regarding the drawings and descriptive literature.

21. INPUTS, OUTPUTS, LOGIC AND EVENT LISTS

Refer to Appendixes for this information.

SECTION 4 : SPECIFICATION

PART 12.1.1 : APPENDIXES PROTECTION & CONTROL

SPECIFICATION No: Rev 8

CONTENTS

SECTION 4: SPECIFICATION

PART 17.1: OPTICAL FIBRE BASED TELEPROTECTION & COMMUNICATION EQUIPMENT

SPECIFICATION No: /0-98 – Rev 1

CONTENTS

1. SCOPE

This chapter specifies the requirements for communications equipment with regard to the project, which includes dedicated communications equipment for protection signalling purposes and dedicated equipment for voice and data communications.

To render a sufficient communications service to the Metering-, Protection-, and Control Divisions of Pretoria Electricity, adequate communication links have to be established with equipment and infrastructure. The equipment will be the optical fibre terminal equipment and the infrastructure the optical fibre cables installed between Buffel and Soshanguve substation on the power lines. The services commonly rendered are the following :

1.1 Protection System Communications

Installed on request exclusively for the use of protection relays to communicate with each other for sending 1st, 2nd or 3rd stage tripping and ARC blocking signals. This is a specialised application supplied on request of the Protection Division.

1.2 Data Communications

Used to transport data from the Quality of Supply and Tariff Metering, Remote Control, SCADA and Fault Recorders to the Control Centre or centralised office sites. Channels are configured as point-to-point or point-to-multipoint, depending on the equipment capabilities and requirements.

1.3 Voice Frequency Communications

Telephone services are essential for verbal communications with the Control Centre during switching operations. Service personnel also need to phone the office for advice or information when locating faults. The use of voice frequency modems is very limited, but serves as a temporary means for data communications.

Clause 4 will cover the technical and general requirements for the establishing of a teleprotection service to the Protection Division of Pretoria Electricity. Clause 5 covers all general and technical specifications for a reliable voice and data communications service for several users within Pretoria Electricity.

2. DEFINITIONS

Protection System Communications : A dedicated set of communications infrastructure for protection relays to exchange their protection signals on.

Data Communications : Non-verbal digital data transmission for the purpose of monitoring conditions of indicators and remotely measure variables at the control centre and for transporting control signals from the control centre to the remote substations.

Voice Frequency Communications : Verbal or data communications using the voice frequency band. Verbal communications provided by means of extending the private automatic exchange's lines over the communications network.

Infrastructure : The presently installed and the to be installed base of optical fibre cable, patch panels, multiplexers and related communication equipment to realise the provision of communication services to operate the electricity network.

3. STANDARDS

The equipment offered against this specification shall comply fully with the requirements thereof. Any deviation from this specification shall be clearly stated.

Alternative offers will be considered, providing the equipment offered complies fully with the minimum requirements of this specification.

The tenderer shall submit a detailed statement of compliance or non-compliance and reasons (if any) for each and every requirement called for in this specification.

These are the standards to be adhered to:

South African National Standards (SANS) for fiber optics include the SANS 60794 series for generic optical cable specifications and testing, and the SANS 60794 series for connectors. Other relevant standards are the NRS 088 series for specific cable types like direct-buried ones and NRS 061-1 for overhead ground wire with optical fiber (OPGW).

SANS standards (International IEC adoption)

- SANS 60794**:** This is the primary series for optical fiber cables.
    - SANS 60794-1-21**:** Mechanical test methods for optical cable performance.
    - SANS 60794-1-23**:** Cable element test methods
    - SANS 60794-2-2003**:** Indoor cables (sectional specification).
    - SANS 60794-2-31**:** Detailed specification for ribbon cables in premises cabling.
- SANS 60794 Series**:** Covers the generic specifications for fiber optic connectors.
    - SANS 60874-1**:** Generic specification for connectors.
    - SANS 60874-14-1**:** Detail specification for the SC-PC connector for multimode fiber.
- **SANS 62614-1:** Multimode launch condition requirements for measuring attenuation.

NRS standards (National, Rural, or Municipal Standards)

- NRS 088 series**:** Specifications for fiber optic cables in specific applications, such as direct-buried cables.
- **NRS 061-1:** Product specification for overhead ground wire with optical fiber (OPGW).

3.1 Works Content

The tenderer shall be responsible for the manufacturing or sourcing and delivery to site of the equipment, accessories and/or options and the carrying out of installation works in installing the said equipment, accessories and/or options, asked for in this specification.

The tenderer shall be required to source, transport to his workshops and deliver to site after fitment of equipment any cabinet, rack or tray needed in order to install the equipment called for in this specification.

3.2 General Requirements

The tenderer/supplier shall comply to ISO9002. A copy of such a compliance certificate shall be included with this enquiry.

Delivery and installation costs shall be included in the Schedule Of Prices, where requested.

Preference shall be given to equipment with extended warranties.

The tenderer shall submit a separate price in the Schedule of Prices on each item (Equipment, Accessories and Options) asked for in this specification. Each item shall be listed separately.

A separate Schedule Of Prices shall be completed for alternative offers with the same detail as requested in 2.5.4.

Equipment offered with a higher or better specification asked for in this tender shall be considered.

The successful tenderer shall submit a complete itemised invoice, describing all the equipment, accessories and technical documentation of the equipment delivered.

Each unit shall be packed in a container with all the accessories. The packaging shall be robust to prevent damage to the equipment when transported by public transportation.

Pretoria Electricity reserves the right to visit the factory to inspect the manufacturing process at any time during normal office hours.

The tenderer shall submit a list of references with this document.

3.3 Training

The successful tenderer shall present a course in the installation, maintenance and configuration of the equipment to at least four (4) staff members.

The City Electrical Engineer shall be satisfied as to the standard, duration and contents of the course.

The cost of the course shall be quoted and included in the Schedule of Prices.

3.4 Maintenance

The City Electrical Engineer shall be satisfied that the successful tenderer carries adequate stock or has access to a complete range of spare parts for the equipment offered and has adequate service facilities to maintain the equipment for a period of 10 years.

3.5 Demonstration

Tenderers shall be prepared to demonstrate their equipment offered, as specified in this document before the tender is awarded, at no extra cost. The tenderer shall also demonstrate that the equipment is working correctly in his workshop before delivering equipment to site.

3.6 Guarantee

The tenderer shall guarantee all the equipment offered in this tender against defects arising from faulty materials, design or workmanship for a minimum period of twelve (12) calendar months from the date of delivery.

The tenderer shall repair and make good at his own expense and to the satisfaction of the City Electrical Engineer any omissions from the statement of work and defects arising or becoming noticed during the guarantee period.

If any faults or defects are not rectified within a reasonable period, the City Electrical Engineer may arrange for the equipment to be repaired at the suppliers expense.

The tenderer shall collect and deliver any faulty equipment during the guarantee period, the costs of such transportation shall be for the suppliers account.

3.7 Execution of Orders

Tenderers are reminded that orders placed against accepted quotation are to be executed in strict accordance with the accepted specification and within the quoted delivery period.

The Pretoria City Council shall not be held responsible for any losses incurred by tenderers should the tender not be awarded.

The City Council reserves the right to accept the whole or any portion of this tender.

4. COMPACT FIBRE OPTIC BASED TELEPROTECTION EQUIPMENT

The equipment supplied shall comply fully to CCITT Rec. G.703.10, G.732 and G.958.

The equipment offered shall be tested against surge voltages, insulation and impedance in accordance to IEC 255-4, Class III.

Equipment offered shall be interchangeable and / or adaptable with existing equipment in use and shall interact seamlessly with the equipment base already installed, which is equivalent or similar to the FOX6+/20 range of compact multiplexers.

The serial number of the equipment supplied shall be engraved or imbedded on a label on the outside of the modules or housing.

The equipment shall be used between primary infeed substations with drop and insert facility at various teed-off substations.

The equipment offered shall have a universal bus, an omnibus and time slot through-connection as a standard feature.

In some cases installation work will not be required, but the successful tenderer is not relieved from the responsibility to make sure that the equipment supplied operates reliable and according to specification.

Detail specifications are as follows :

4.1 Power Supply

the supply shall be protected against RF interference; and

the supply shall be fitted with an Over and Under voltage protection to prevent damage to the equipment in use.

The power supply shall be galvanically isolated with short circuit protection and shall be fitted with an externally accessible fuse.

Please refer to the Schedule of Particulars and Guarantees for additional information.

4.2 Multiplexer

Please refer to the Schedule of Particulars and Guarantees for detail.

4.3 Alarm and Oscillator unit.

Please refer to the Schedule of Particulars and Guarantees for detail.

4.4 Digital Protection Interface

The Digital Protection Interfaces will interface electrically to the inter tripping protection relay. An inter trip signal will be sent across the infrastructure to the distant relay to effect a line trip.

Please refer to the Schedule of Particulars and Guarantees for detail.

4.5 Asynchronous data interface

The asynchronous data interface has to be a standard feature in the backplane of the equipment. It should be capable of being configured as a point-to-point link or a multi-drop data bridge.

Please refer to the Schedule of Particulars and Guarantees for detail.

4.6 Binary interface

The binary interface shall be capable of transmitting 8 input/output signals via one 64 kbit/s time slot in full duplex.

All the input/output connectors shall be galvanically and optically isolated, except for the auxiliary voltage source.

In transmission interference or in transmission loss the unit shall store the last output states or reset all the jumpers.

4.7 Accessories and Options

Please refer to clause 4.75.11 for specifications on accessories and options for both Teleprotection and Communications items.

5. COMPACT FIBRE OPTIC BASED COMMUNICATIONS EQUIPMENT

Specifications in general must include and comply to the following :

The equipment supplied shall comply fully to CCITT Rec. G.703.10, G.732 and G.958.

The equipment offered shall be tested against surge voltages, insulation and impedance in accordance to IEC 255-4, Class III.

Equipment offered shall be interchangeable and / or adaptable with existing equipment in use and shall interact seamlessly with the equipment base already installed, which is equivalent or similar to the FOX-U range of compact multiplexers.

The serial number of the equipment supplied shall be engraved or imbedded on a label on the outside of the modules or housing.

The equipment shall be used between substations for protection, SCADA, telephones, etc., with drop and insert facility at various substations.

The equipment offered shall have a universal bus, an omnibus and capable of time slot through-connection.

In some cases installation work will not be required, but the successful tenderer is not relieved from the responsibility to make sure that the equipment supplied operates reliable and according to specification.

The following elements have to comply to the following specific specifications:

5.1 Power Supply.

The supply shall be protected against RF interference according to EN55022 of 4/87.

The supply shall be fitted with an Over and Under voltage protection to prevent damage to the equipment in use.

The power supply shall be galvanically isolated with short circuit protection and shall be fitted with an externally accessible fuse.

Chopper clock frequency shall be synchronised to the 64kHz system clock to minimise in-band interference

Test points on the front panel shall be available with a visual indication on the front panel when output voltage fails.

Please refer to the Schedule of Particulars and Guarantees for more technical detail.

5.2 Equipment Chassis

The construction of the equipment chassis shall be such that it is 19" rack mountable with the width of slots number 1 to 17 of 8M and the width of slots 18 and 19 of 14M. Chassis with units have to be designed to achieve EMC Directive 89/336/EEC, meet EN55022 (1993) Class B for emission and meet EN50082-1 (1992) for immunity to noise. All internal connections are to be made by the backplane.

Please refer to the Schedule of Particulars and Guarantees for more technical detail.

5.3 Control Card

The digital cross-connection of time slots on 64 kbit/s and on 2 Mbit/s levels resides within this module

Controls the functionality of a drop & insert multiplexer

Shall be equipped to permit conference circuits to be set up by means of time slot sharing.

The module shall act as the main clock supply to the whole multiplexer unit.

Monitoring of the entire system and alarm generation.

Availability of an Embedded Operations Channel for maintenance purposes is essential

5.4 64kbits/s Data interface

The 64 kb/s data interface shall enable the creation of Engineering Overhead Channels to enable the remote configuration and monitoring of the communications equipment, metering information or SCADA. Refer to the Schedule of Particulars and Guarantees for details.

5.5 Universal data interface

The Universal Data Interface shall enable the creation of Super-Rate (n x 64kb/s) primary rate connections to enable a Router Network to interlink several Local Area Computer Networks.

5.6 Telephone Subscriber Line interface

The Telephone Subscriber Line interface card shall emulate the telephone exchange line to the Subscriber Unit and shall comply to the specifications in the Schedule of Particulars and Guarantees.

5.7 Telephone Exchange Line interface

The Telephone Exchange Line interface card shall emulate the Subscriber Unit to the telephone exchange line and shall comply to specifications in the Schedule of Particulars and Guarantees.

5.8 Ringing generator

The Ringing Generator shall supply the Subscriber Unit with a ringing current via the Telephone Subscriber Line interface when the telephone exchange presents a ringing current to the Telephone Exchange Line interface. Shall comply to specifications in the Schedule of Particulars and Guarantees.

5.9 Optical Fibre transmission interface

The Optical Fibre transmission interface shall connect to the single mode optical fibre infrastructure of Pretoria Electricity. Specifications as per Schedule of Particulars and Guarantees.

5.10 G.703 2Mbits/s transmission interface

The 2Mbit/s transmission interface shall be an integral part of the Optical Fibre transmission interface and specifications shall be as per Schedule of Particulars and Guarantees.

5.11 Accessories and Options (Clause 4 and 5)

A complete installation kit with all the connecting cables and connectors including patch leads shall be supplied with each unit.

A complete set of configuration / setup / network monitor software and firmware shall be included and/or supplied with each unit, whichever is necessary. If only one item of the latter is needed for a complete network, it shall be supplied as such.

Blanking plates shall be supplied for the front cover to cover open slots.

The tenderer shall list all accessories and options not listed that are of importance to the user and that are essential to the successful installation, commissioning and operation thereof.

An extra power supply shall be available for redundancy, the power supply shall slot into a open slot in the main chassis.

Ethernet Cable specifications

Description	Technical requirements
Ethernet cable	• **Data Speed**: Supports speeds up to 10 Gbps • Bandwith up to 600MHz • Distance: up 100 meters • Shielding both twisted pair and the overall cable individually shielded • Connectors: ARJ45 and RJ45 compatible • Construction: solid copper;

n South Africa, the specifications for ethernet cables are typically based on international standards, primarily **ISO/IEC 11801** and **TIA/EIA 568-B.2-1**, which are adopted as South African National Standards (SANS). The SABS (South African Bureau of Standards) offers a voluntary certification scheme, allowing manufacturers who meet these SANS requirements to use the SABS mark.

Key Specifications and Standards

Ethernet cables do not have a unique, separate "SABS approved" standard but rather adhere to the following internationally recognized specifications and are often required to comply with SANS versions of them:

- **International Standards:** The primary standards governing the physical and electrical characteristics of balanced twisted-pair cabling for telecommunications are ISO/IEC 11801 and TIA/EIA 568.

- **SABS Certification:** The SABS provides a product certification scheme, and a manufacturer can apply for a permit to use the SABS mark on their cables if they pass regular audits and testing at SABS laboratories. This mark indicates compliance with the relevant SANS standard.

- **Compulsory Specifications:** While the SABS marking is voluntary, the National Regulator of Compulsory Specifications (NRCS) enforces mandatory safety specifications for certain electrical cables (like low voltage power cables under SANS 1507), but network/ethernet cables generally fall under performance and quality standards rather than compulsory safety specifications in the same way.

Technical Requirements

When dealing with installations in South Africa, especially for commercial or governmental projects, specific performance requirements are often stipulated in line with the following general technical specs:

- **Conductor Material:** Standards typically dictate pure copper conductors for optimal performance, especially for Power over Ethernet (PoE) applications. Copper Clad Aluminium (CCA) cables are cheaper but have higher resistance and are not ideal for PoE or long runs.
- **Conductor Thickness (AWG):** American Wire Gauge (AWG) determines the minimum core diameter. Common requirements are 24 AWG for Cat6 and 23 AWG for Cat7 cables.
- **Performance Categories:** Cables must meet the specifications for their category (Cat6e, Cat7, etc.) regarding bandwidth, speed, and distance capabilities.
- **Flame Resistance:** In certain installations, cables may need to conform to specific flame-resistant standards like IEC 60332-1.
- **Marking:** SABS-approved cables must have specific information imprinted on the sheath, including the manufacturer's name, cable type, size, manufacture year, and length markings.

SECTION 4: SPECIFICATION

PART 18.1: SCADA INTERFACE

SPECIFICATION No: SC.03/0-97 - Rev 3

CONTENTS

1. INTRODUCTION

This specification specifies the Supervisory Control and Data Acquisition (SCADA) interface for a substation.

The City of Tshwane Metropolitan Municipality control centre are situated at Capital Park, from where fifty substations are monitored and controlled via SCADA links

The Scada Protocol at the Control Centre of the City of Tshwane is DNP 3 level 3. The Tenderer shall submit the following documents

) A document stating that the tenderer complies to IEC 60870-5-103

ii) A document explaining the protocol that the tenderer will be using in the substation.

iii) A document stating that the protocol being used by the tenderer can be converted to

DNP3 level 3.

The conversion of the substation protocol to DNP 3 level 3 can de done by the tenderer, by doing the conversion in the substation MMI or by doing the conversion in a Harris D20++ Processor board. The tenderer must be able to prove both conditions. The implementation of the protocol conversion at the substation will be the responsibility of the tenderer. The tenderer will supply the City of Tshwane with an IO list indicating Digital Inputs, Digital Outputs, Analogs and DNP mapping.

The Tenderer will give training to personnel of the City of Tshwane on fault finding, populating of the database in the MMI and the substation protocol

2. STANDARDS

The following documents are referred to in this specification:

a) The DNP Basic 4 Document set which includes the complete description of all the facilities available in DNP together with their usage; and

b) the DNP V3.00 Subset Definitions which explains the minimum functionality that is expected in the three officially recognised subsets of DNP.

Both of these documents are available from the DNP users group and from Tshwane Electricity.

3. OVERVIEW

Harris Distributed Network Protocol (DNP) has been developed by Harris Canada Inc. for application in both SCADA and distributed automation systems. The DNP protocol are being used by CCP to interface the front end processor at Capital Park with different substations.

4. COMMUNICATION MEDIUM

The communication medium consists of optical fibre with multi-plexers, twisted copper pilot wire with modems and micro wave radio links. The baud rates vary between 300 baud and 19 200 kilo baud.

5. SUBSTATION SCADA INTERFACE

The preferred option will be for the Tenderer to make use of a standard D20 ++ processor card from Harris to convert the protocol inside the substation to interface to the Control Centre at Capital Park talking DNP protocol on the SCADA link.

Harris support protocols such as ABB SPA-BUS, GEC Courier K-bus, Modbus, etc.

The configuration for the substation will be programmed on NV Ram situated on the D20 ++ card.

The Council will provide a suitable cubicle to house the 19 inch rack.

An option for the Tenderer to make use of an intelligent device (Gateway) to convert the protocol inside the substation to interface to the Control Centre at Capital Park talking DNP protocol on the SCADA link would also be considered by the Council.

The Tenderer should quote on both the above options.

6. BUSBAR COLOURING

a) Powered : 275 kV Busbar : Blue
b) 132 kV Busbar : Orange
c) 33 kV Busbar : Magenta
d) 11 kV Busbar : Cyan
e) Without power : All busbars white
f) Earthed : All busbars green
g) Invalid : All busbars yellow
h) Background : Black

7. SYMBOLS LIST

For further details see Part 12.

7.1 Breaker

Use a square symbol with the following conditions:

a) Breaker closed : a square solid red;
b) breaker open : a square solid green; and
c) breaker disturbed : a square yellow with a line running from top left to bottom right.

7.2 Isolator

Use a circle with the following conditions:

a) Isolator closed : a circle solid red
b) isolator open : a circle solid green
c) isolator disturbed : a hollow circle in yellow with a 45 degree line running from top left to bottom right.

7.3 Earth

The conventional 3 horizontal lines arranged within the outline of a triangle.

When earthed the green symbol should show, when not earthed no symbol should show.

8. DATA POINT NUMBERING

For the purposes of maximum efficiency of the communications system and data entry into the SCADA system the following are recommended for any equipment to be connected to the control centre via DNP.

a) All point numbers for all types of data should start from zero (0);
b) all point numbers should be contiguous, with no gaps or spares within the point mapping. This is recommended because on start-up and at pre-set intervals the FEP will ask for all data (integrity poll) and gaps in data will make the response inefficient as the real data and the spare points are all transmitted together;

c) the two points associated with status of a device (e.g. open-closed status of a circuit breaker) shall be adjacent to each other in the point map and located at an even boundary. The Open and Close indications should be in the same order as for the RTU□s that have already been installed (Closed Indication first, Open indication second). If this procedure is followed the SCADA system data entry and FEP mapping will be easier; and

d) control output bits should follow the same procedure in that the associated output should be next to each other and at an even boundary. The sequence should be Trip first and then Close.

Digital Inputs (time tagged or not) should be allocated to Class 1, Analogue Inputs should be allocated to Class 2 and Counter values to Class 3

9. OFFICIAL DNP SUBSETS

Three official subsets of DNP have been defined by the DNP Users group. These are as follows:

a) Level 1 Implementation (DNP-L1)

b) level 2 Implementation (DNP-L2)

c) level 3 Implementation (DNP-L3)

Level 1 is the minimum subset that should be implemented and is typically used between a master station and an IED. The requests for the following data objects from the slave must be accepted

a) Reads of Class Data Objects;

b) Reads of Binary Outputs and Analogue Output Objects only if these objects exist in the slave;

c) Control Operations;

d) Writes to the RESTART Internal Indication;

e) Cold Restarts; and

f) Time Synchronisation.

The Level 2 implementation consists of all the Level 1 features plus additional data objects as defined in the subsets document.

The Level 3 implementation consists of all Level 2 plus additional data objects as defined in the subsets document. This is the level which is required and specified by the Council.

10. CLASS DATA

DNP has the facility to send □changed (event), data to the master station. The master station thus polls for changed data rather than for data of a specific type e.g. the poll is for all Class 1 data rather than all Analogue.

DNP has 4 different classes of data, each of which can contain different types of data, but which have different event queues and priorities :

a) Class 0 Data is the exception in the that data is static data rather than changed data. Class 0 consists of all data and is called an integrity poll because it returns the status of all the I/O points in the RTU; and

b) Class 1, 2 and 3 data there are different priorities of data and the master station can be set up to poll more frequently for Class 1 data than for Class 2 data and Class 3 data.

Class Data requests are the basis for the communications in the Tshwane Electricity SCADA network. This is due to the necessity to most efficiently use the bandwidth available for communications, as DNP is a relatively high overhead protocol.

11. MODES OF OPERATIONS

DNP provides several different means of operation:

a) **Quiescent Operation;**

where the master never polls the slave. All communications are unsolicited report by exception. This mechanism is generally used for systems using radio communications and pole top RTUs to keep communications to a minimum. The integrity of the data is never verified and is thus not recommended for Tshwane Electricity;

b) **Unsolicited Report by Exception;**

in which most communications is unsolicited, but the master occasionally send integrity polls for Class 0 Data (all data) to verify its database. This option is not acceptable to the Council.

c) **Polled Report by Exception Operation;** and

in which the master polls frequently for event data and occasionally for Class 0 Data. Polling is generally quick because only significantly changed data objects are reported to the master station. This is the mechanism that is used by the Tshwane Electricity system at this moment, due to the combination of high efficiency, good integrity, and control by the master. The slave never sends data unless polled by the master and the master is thus controlling the system. This is the recommended implementation needed by the Council.

d) **Polled Static Operation.**

where the master always polls for all data. This is very inefficient and not acceptable to the Council.

12. GPS CLOCK

The Tenderer shall supply and install a GPS clock for the time tagging of events at the substation and also for time synchronisation with the front end processor at Capital Park with an accuracy of 1 ms or better.

13. FUNCTIONALITY OF THE SCADA

The SCADA shall be able to control the substation in the same way and with the same detail as the MMI or substation control system. All controls, status indication, analogue indications, event recording and alarms shall be provided.

When any of the elements of the substation is in local mode it shall not be possible to control that element by the SCADA.

It is not necessary for the SCADA to be able to communicate with the relays

In addition intruder detection and alarms shall be supplied, as well as battery status alarms and charger control (e.g. battery boost charge).

14. TESTING

The Contractor shall be responsible to test all the Substation SCADA alarms, analogues, tap positions and indications to the front end processor at Capital Park

15. DOCUMENTATION

The following drawings shall be supplied by the Tenderer :

a) Single line diagrams showing the basic layout of the busbars, breakers, isolators, bus couplers, bus sections etc.

b) a document showing the numbering of addresses for all the different 1 bits, 2 bits, analogues, tap positions, controls and alarms

c) a drawing of the element types (circuit breakers, transformers, isolators etc.

d) transducer outputs (0-5 mA or 4-20 mA etc.) and voltage- and current transformers ratios.

The following documentation will be supplied by CCP to the Contractor:

a) DNP documents mentioned above

b) protocols supported by Harris

c) a hardware manual on the Harris D20 ++ processor card

d) a name and telephone list of contact persons at CCP.

SECTION 4: SPECIFICATION

PART 19.1: POWER LINES 132KV 150 & 300MVA

SPECIFICATION: PL.60/0-93 – Rev 0

1. SCOPE

TECHNICAL SPECIFICATION FOR THE CONSTRUCTION OF DOUBLE CIRCUIT OVERHEAD 132KV POWER LINES AND COMPOSITE EARTH WIRES:

1.1 This Specification covers the design, manufacture, supply, delivery, installation, erection, stringing, commissioning and handing over in a complete and proper working condition of three-phase double circuit overhead 132kV power lines having “BEAR” A.C.S.R. phase conductors and tow overhead earth wires erected on single lattice steel towers, complete with foundations, supplementary earthing, Tee-off, cross-over or terminal gantry structures and gantry spans as required, down droppers, insulators, all line fittings and accessories as required, and all other items, components and incidental work as detailed in the Specification, the Schedules of Particulars and Guarantees and the contract drawings. Alternatives designs of towers shall be discussed with the Engineer, and the compliance with or deviation from the provisions of this specification shall be submitted in writing. The following two types of power line are covered by this Specification:

1.1.1 150MVA three-phase double circuit overhead 132kV power line using a single “BEAR” A.C.S.R. conductor per phase with steel or fibre-optic earth wire and supported on towers as depicted on drawings Nos B-500, B-501 and B-502.

1.1.2 300MVA three-phase double circuit overhead 132kV power line using twin “BEAR” A.C.S.R. conductors per phase with steel or fibre-optic earthwire and supported on towers as depicted on drawings Nos B-500, B-501 and B-502.

1.2 This Specification also covers alterations to, or deviations of similar existing overhead power lines in accordance with the provisions of the Specification and the Schedules of Particulars and Guarantees and as depicted on contract drawings if so called for in the enquiry.

1.3 Except where specifically stated to the contrary, the contract work to be carried out under this Specification includes the provision and installation of all the equipment required, including all matters and details to provide a complete power transmission system and includes negotiations with and/or giving notice to other Municipal Departments, other Authorities where necessary, landowners where necessary, and the carrying out of all aspects of the Work necessary to complete the contract commitments. Assistance will be given by the Electricity Department of the City of Tshwane as specifically provided for in the contract and at the discretion of the General Manager, Electricity.

2. STANDARDS

2.1 Power lines to be constructed to this Specification and all equipment to be supplied and work to be carried out under this Specification, shall comply with the requirements of this Specification, shall comply with the requirements of this Specification, the particulars and guarantees stated by the tenderer in the Schedule(s) of Particulars and Guarantees and the relevant requirements in the latest revisions of the following standard specifications and codes of practice:

2.1.1 Power line in general

2.1.1.1 The design and construction of the complete power line shall be in accordance with South African Institute of Electrical Engineers' code of practice for overhead power lines for conditions prevailing in South Africa.

2.1.2	Concrete work and foundations	
2.1.2.1	SANS 471	Portland cement and rapid-hardening Portland cement
2.1.2.2	SANS 718	Aggregates for concrete
2.1.2.3	SANS 878:2004	Ready-mixed concrete
2.1.2.4	CKS 53	Sand for concrete
2.1.2.5	SANS 920	Steel bars for concrete reinforcemen
2.1.2.6	SANS 282:2004	Bending dimensions and scheduling of steel reinforcement for concrete
2.1.2.7	SANS 088	Pile foundations
2.1.3	Structural steel	
2.1.3.1	SANS 222	Dimensions and properties of rolled carbon steel structural sections
		or
	BS.4848	Hot-rolled structural steel sections together with BS.4360: Weldable structural steels
2.1.3.2	SANS 763	Hot-dipped (galvanized) zinc coatings (other than on sheet and wire)
		or
	BS.729	Hot dipped galvanized coatings on iron and steel article
2.1.3.3	SANS 10094:2005	The use of high-strength friction grip bolts
2.1.3.4	BS.5135	Metal-arc welding of carbon and carbon manganese steels
2.1.4	Conductor and earth wire	
2.1.4.1	SANS 182-3: 2003	Conductors for overhead electrical transmission lines: Part 3: Aluminium conductors, steel reinforced
2.1.4.2	BS.183	General purpose galvanized steel wire strand
2.1.4.3	SANS 935:2007	Hot-dip (galvanized) zinc coatings on steel wire
2.1.5	Insulators	
2.1.5.1	SANS 60120:1984	Dimensions of ball and socket couplings of string insulator units
2.1.5.2	SANS 60372:1984	Locking devices for ball and socket couplings of string insulator units - Dimensions and tests
2.1.5.3	SANS 60471:1977	Dimensions of clevis and tongue couplings of string insulator units
2.1.5.4	SANS 60815-3:2009	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions Part 3: Polymer insulators for a.c. systems

2.1.5.5	SANS 61109:2008	Insulators for overhead lines - Composite suspension and tension insulators for a.c. systems with a nominal voltage greater than 1 000 V - Definitions, test methods and acceptance criteria
2.1.5.6	SANS 60815-1:2009	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions Part 1: Definitions, information and general principles
2.1.5.7	SANS 60815-3:2009	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions Part 3: Polymer insulators for a.c. systems
2.1.5.8	SANS 61109:2008	Insulators for overhead lines - Composite suspension and tension insulators for a.c. systems with a nominal voltage greater than 1 000 V - Definitions, test methods and acceptance criteria
2.1.5.9	SANS 61466-1:1997	Composite string insulator units for overhead lines with a nominal voltage greater than 1 000 V Part 1: Standard strength classes and end fittings
2.1.6	Incidental work	
2.1.6.1	CKS.146:1972	Gates, steel with tubular frames (for farm and domestic use)
2.1.6.2	CKS.82:1973	Steel posts, stays, standards and droppers for strained wire fences
2.1.6.3	SANS 935:2007	Hot-dip (galvanized) zinc coatings on steel wire

2.2 Except where otherwise specified or implied, the Contract Works shall comply with the standards of the British Standards Institution current at the contract commencement date (such standards being herein referred to as “BS.”) or the standards of the South African Bureau of Standards (herein referred to as “SANS”), as applicable.

3. QUALITY OF MATERIAL AND WORKMANSHIP

3.1 The Plant shall be manufactured and constructed to the highest standards and all materials used under this Contract shall be new and of approved qualities and of the class most suitable for working under the conditions specified, and shall withstand the variations of temperature and atmospheric conditions arising under working conditions without distortion or deterioration or the setting up of undue stresses in any part, such as to affect the efficiency, suitability and reliability of the installation.

3.2 Workmanship shall be of the highest standard and shall in all respects be subject to approval by the Engineer.

3.3 The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the Work.

3.4 The general arrangement of all plant supplied under this Contract, the arrangement of all towers, gantry structures and earthing including any special arrangements which may be necessary, shall be to approval.

4. STATUTORY REQUIREMENTS

4.1 With regard to power line design and construction and with regard to his own operations when working on site, the Contractor shall comply in all respects with the requirements of the Machinery and Occupational Safety Act (Act No 6 of 1983) and the Regulations issued there under which shall take precedence over other statutory requirements.

4.2 Should a power line route cross the route of a national road the Contractor shall, in the execution of the contract, comply with the requirements of the Act on National Roads (Act No 54 of 1971) and such requirements as may be laid down by the Department of Transport.

4.3 In the execution of the contract, the Contractor shall comply with the Transvaal Road Ordinance and Regulations (No 22 of 1957) and such requirements as the Transvaal Roads Department may lay down for power lines crossing provincial roads.

4.4 Should the power line route cross any railway line, the Contractor shall, in the execution of the contract, comply with the requirements laid down by the South African Transport Services.

4.5 Should the power line route cross any telegraph or telephone line, the Contractor shall, in the execution of the contract, comply with the requirements of the Post Office Act (Act No 44 of 1958) and such requirements as laid down by the Department of Post and Telecommunications.

4.6 Copies of way leave conditions for certain specific power line crossings as laid down by other Authorities in correspondence with the Electricity Department, can be obtain by the Contractor from the Electricity Department.

4.7 The Engineer shall have the power to instruct the Contractor to alter, replace, rectify, or otherwise provide for any item which is necessary to comply with any statutory requirement applicable to the contract. No extra payment will be considered for any provision which the Contractor may have to make to comply with any act or statutory requirement as all such costs will be taken as having been provided for in the prices quoted in the tender.

5. SERVICE CONDITIONS

5.1 The power line shall be suitable for continuous outdoor operating under the varying atmospheric and climatic conditions occurring at all seasons in Pretoria and shall operate satisfactorily under the following conditions:

5.1.1	Altitude above sea-level	1 530 m
5.1.2	Maximum ambient temperature (summer)	40°C
5.1.3	Average daily maximum ambient temperature (summer	30°C
5.1.4	Minimum ambient temperature (winter)	minus 5 °C
5.1.5	Average daily minimum ambient temperature (winter)	2 °C
5.1.6	Minimum relative humidity	20%
5.1.7	Maximum relative humidity	At times up to 94%
5.1.8	Maximum wind speeds:	
5.1.8.1	Steady conditions	25 m/s
5.1.8.2	Gusty conditions	45 m/s
5.1.9	Lightning area	Yes
5.1.10	Average thunderstorms days per annum	± 75
5.1.11	Approximate ground flash density per square km per square annum	7
5.1.12	Median value of peak discharge current	41 kA
5.1.13	Mean duration of strokes	less than 200 microsecond
5.1.14	Number of multiple stroke flashes as a percentage of total number of strokes	40%
5.1.15	Pollution conditions	Normal to heavy (dust and smog)
5.1.16	Other climatic conditions	At times dry and dusty
5.1.17	Gravity constant for Pretoria	9,786 m/s

6. SYSTEM PARTICULARS

6.1 The transmission line will be connected to a power distribution system in which electrical energy is generated at interconnected power stations as three-phase current at a frequency of 50 Hz and transmitted by means of overhead lines and underground cables.

6.2 The load on the system will consist of all or any of the following: Static transformers, induction and synchronous motors, motor generators, rotary converters and rectifiers for the supply of motive power, traction, lighting, heating and electromechanical work.

6.3 Further particulars of the three-phase distribution system are as follows:

6.3.1 Nominal system voltage (r.m.s. line to line) ……… 132 kV

6.3.2 Highest system voltage (r.m.s. line to line) ……… 145 kV

6.3.3 System frequency …………………………………. 50Hz

6.3.4 Maximum symmetrical fault current capacity

(1.0 second rating) ………………………………… 31,5 kA (r.m.s.)

6.3.5 System BIL at sea-level …………………………... 650 kV

6.3.6 System insulation level at Pretoria altitude ……… 550kV

6.3.7 Phase colour identification ……………………….. A – Red

B – Yellow

C – Blue

6.3.8 Phase rotation …………………………………….. R – Y – B

Anti-clockwise

6.3.9 Details of system neutral earthing ……………… Neutral points of transformers solidly earthed

7. POWER LINE PARAMETERS

7.1 In addition to other requirements specified else where in the enquiry document, the power lines to be erected under this Specification shall be designed and constructed in compliance with the basic parameters specified in the Schedule of Basic Parameters for the design and construction of power lines at the end of this Specification.

8. WORKING LOADS

8.1 The complete power line including all towers, supporting structures, cross-arms, line fittings, conductor and foundations shall be designed, manufactured and constructed to operate safely under the specified in the Schedule of Basic Parameters for the design and construction of the power lines.

8.2 The assumed maximum simultaneous working loads on towers and supporting structures shall not be less than that specified in the clauses hereafter.

8.3 **Simultaneous working loads under normal balanced load conditions**

8.3.1 <u>Vertical load</u>
8.3.1.1 The weight of all insulator sets complete with all fittings attached to the structure; plus
8.3.1.2 The weight of all phase conductors and earth wires (including the weight of spacers and dampers) of twice the normal span length (to allow for towers at different levels); plus
8.3.1.3 The weight of all phase conductors and earth wire jumpers including the weight of jumper spacers and jumper terminals supported by the structure;

Together with

8.3.2 <u>Longitudinal load</u> (tension towers only)
8.3.2.1 The horizontal longitudinal components of the maximum tensions in the phase conductors and earth wires under minimum temperature and maximum wind loading conditions;

Together with

8.3.3 Transverse load

8.3.3.1 A wind pressure of 700 Pa on 1,5 times the projected area of all members on one face of the supporting structure; plus

8.3.3.2 A wind pressure of 700 Pa on 0,6 times the projected area of all phase conductors and earth wires in the maximum wind span length as stated in schedule B (Items 2.5. and 3.5); plus

8.3.3.3 The horizontal transverse components of the maximum working tensions in all phase conductors and earth wires operating at minus 5°C in still air and assuming the maximum power line deviation angle permissible for the structure under consideration.

8.3.4 Uplift consideration

8.3.4.1 On all types of angle tension towers the tower shall also be designed to safely withstand the loads specified in clauses 8.3.1, 8.3.2 and 8.3.3 but with the vertical load specified in clause 8.3.1.2 for the down hill span applied on the down hill side of the tower and a maximum nett total uplift equal to one-third of the respective maximum conductor working tensions applied at each attachment point on the other side of the tower.

8.3.5 Safety factor : balanced load condition

8.3.5.1 Based on the type-tested failing load or based on the calculated failing load (elastic limit for tension members and crippling load for compression members), the minimum factor of safety under the above assumed maximum simultaneous normal balanced loading conditions shall not be less than 2.5 for all support structures including any extensions up to maximum extension height.

8.3.5.2 Each tower together with any combination of base and tower leg extensions shall be designed such that no failure or permanent distortion shall occur in any part or component when tested with applied forces equal to 2.5 times the maxi simultaneous working loads specified in clause 8.3 above.

8.4 **Simultaneous working loads under unbalanced load conditions** (Broken conductors)

8.4.1 For suspension type towers the maximum unbalanced load condition shall be the worst case of tower loading with any one phase conductor and any one earth wire broken (remote side of span) with either one or both circuits strung assuming both earth wires strung in both cases before conductor breakage. The assumed simultaneous maximum working loads on attachments carrying unbroken conductors shall be the same as that specified in clauses 8.3.1, 8.3.2, 8.3.3 and 8.3.4 above. The simultaneous working loads on attachments carrying broken conductors shall be assumed to be altered as follows:

8.4.1.1 A vertical load (conductor weight) equal to 75% of the conductor weight as specified in clause 8.3.1.2.

8.4.1.2 On the cross-arm carrying the broken conductor a longitudinal load equal to 70% of the maximum working tension in the case of a phase conductor and 100% in the case of an earth wire

8.4.1.3 A horizontal transverse load (wind load) equal to 75% of the conductor wind load specified in clause 8.3.3.2

8.4.1.4 All other loads remain as specified in clause 8.3

8.4.2 For strain angle towers (tension towers) the maximum unbalance load condition shall be the worst case of tower loading with any two phase conductors and any one earth wire broken (remote side of span) with either one or both circuits strung but assuming both earth wires strung in both cases before conductor breakage. The assumed simultaneous maximum working loads on attachments carrying unbroken conductors shall be the same as that specified in clauses 8.3.1, 8.3.2, 8.3.3 and 8.3.4. The simultaneous working loads on the cross-arms carrying broken conductors shall be assumed to be altered as follows:

8.4.2.1 The vertical load due to conductor weight reduces to 75% of that specified in clause 8.3.1.2.

8.4.2.2 An unbalanced longitudinal load equal to the conductor maximum working tension is imposed on the other side of the cross-arm.

8.4.2.3 The conductor wind load on the cross-arm reduces to 75% of that specified in clause 8.3.3.2.

8.4.2.4 All other loads remaining as specified in clause 8.3.

8.4.3 Safety factor : Unbalanced load condition

8.4.3.1 Based on the type-tested failing load or based on the calculated failing load (elastic limit for tension members and crippling load for compression members), the minimum factor of safety under the above assumed maximum unbalanced loading conditions shall not be less that 1,5 for all types of towers including any extensions up to the maximum simultaneous working loadings specified in clause 8.4 above.

8.5 The gravitational acceleration constant to be used for calculating the above loads in newtons shall be 9,786 m/s (for Pretoria)

9. SUPPORTING STRUCTURES

9.1 Towers general

9.1.1 The power line shall be supported on galvanized steel towers of bolted lattice construction which shall be of the self-supporting brad-based type designed to accommodate double circuit transmission lines: one three-phase circuit on each side of the tower. The towers shall have concrete foundations. Where the right of way is exceptionally narrow, the Engineer may allow the use of a support of the tubular steel or concrete pole type for straight-line suspension supports only.

9.1.2 All towers shall be so designed that the two circuits are arranged symmetrically with the three-phase conductors of each circuit vertically disposed and with the two earth wires in the uppermost positions. Each conductor and earth wires shall be carried by its own cross-arm.

9.1.3 The towers shall be of standard design and all members of towers of the same type shall be fully interchangeable. The dimensions, dispositions and methods of connections fo all tower members and accessories shall be to approval

9.1.4 The Standard tower heights shall be designed for a ground clearance of 7.5 m to the bottom conductor at an operating temperature of 75°C for a normal span (or standard span) length of 300 m over level ground; the span length being measured horizontally between supports. All standard towers shall be designed so that where favourable grounds contours exists the sum of two adjacent spans may total the maximum length stated in the Schedule of Basic Parameters provided that no single span shall exceed the maximum permissible single span length stated in the Schedule of Basic parameters provided that the specified factors of safety are maintained.

9.1.5 To increase the height of support where necessary, it shall be possible to extend the height of towers by the addition of standard base extension of lattice construction in steps of nominally 3m without affecting the specified maximum working load or factor of safety of the tower.

9.1.6 To facilitate the erection of tower bases on very steep slopes, standard individual tower leg extensions in steps of nominally one metre within the range minus one metre op to plus 2 m shall be available. Tower leg extensions shall be designed such that the maximum working load rating and safety factors for the tower is not affected by the use of leg extensions.

9.1.7 Towers shall be designed with standard cross-arm lengths but alternative cross-arm lengths shall be available, if required, especially on terminal towers for special take-off purposes.

9.1.8 The cross-arm designs shall facilitate the separate attachment of earth wire clamps (on earth wire cross-arms) and disc insulator strings (on phase conductor cross-arms) by means of suitable shackles, as well as all other accessories and equipment for the erection of conductors and maintenance equipment.

9.1.9 All tower and tower components, including special cross-arms, base extensions, tower leg extensions etc, shall be designed to carry the phase conductors and earth wires together with all insulator strings and fittings under the working load conditions and with the minimum safety factors specified in clause 8. The towers shall also be designed to comply with the parameters specified in the Schedule of Basic Parameters for the design and construction of the power line at the end of this Specification.

9.1.10 Tower designs based upon strength calculations only will not be accepted. Towers shall be type-tested to determine their simultaneously acting failing loads as specified in clause 18 and Tenderers shall quote prices and delay times for type-testing of towers not previously type-tested. Where acceptable type-test reports and certificates on type testing of towers similar to those specified can be provided, and the designs of the towers offered are certified by an independent professional Structural engineer, the required type-testing may be waived by the Engineer. Type-testing may also be waived by the Engineer in the case of towers previously accepted and proved satisfactory for use on the Council's 132kV overhead line system.

9.1.11 The maximum unit stresses in the various members of towers, extensions and base steelwork shall not exceed the figures stated in the Schedule of Particulars and Guarantees and the Contractor shall submit such drawings, stress diagrams and calculations of tower and extension design to the Engineer as the Engineer may require.

9.2 Types of towers: application and designation

9.2.1 For the purpose of standardization, towers for double circuit transmission lines shall nominally have the dimensions shown on the drawings issued with the Specification and shall have the following type designation for the specified applications:

TOWER TYPE DESIGNATION		TOWER DESCRIPTION APPLIATION	LIMITS OF LINE DEVIATION ANGLE
150 MVA SINGLE CONDUCTOR LINES	300 MVA TWIN CONDUCTOR LINES		
1D	2D	Straight line suspension tower	0° to 2°
1D30	2D30	Strain angle tower for line deviations up to 30°	2° to 30°
1D60	2D60	Strain angle tower for line deviations above 30° up to 60°	30° to 60°
		Right angle strain tower for line deviations above 60° up to 90°	
1D90	2D90	Terminal strain tower with angle between normal of landing gantry and line approach between 0° and 45°	60° to 90°
1DT	2DT	Terminal strain tower with angle between line approach and normal of landing gantry above 45° up to 90°	
1DT90	2DT90		
NOTE: *The prefix “D” designates “Double circuit” transmission line towers			

9.2.2 Suspension insulator sets shall be used on type 1D or 2D towers whilst tension insulator sets shall be used on all other tower types.

9.2.3 Type 1DT and 2DT towers shall be designed to allow the conductors of the line to be terminated on the tower at any angle up to 45° from the normal to the cross-arms, assuming the tension on the other side of such a tower to be zero as the down-droppers from the tower will be installed with greatly reduced tensions and insulated by means of light duty tension insulator sets.

9.2.4 Type 1DT90 and 2DT90 towers are intended for use where the angle between the approaching line and the normal of the landing gantry exceeds 45° but not 90°. In these cases the terminal tower is normally placed such that the vertical plane through the tower cross-arms bisects the supplementary angle (larger angle) between the down droppers to the landing gantry and the centre line of the power line. Type 1DT90 and 2DT90 towers shall be designed to allow the line conductors to be terminated on the tower at any angle up to 45° from the normal to the cross-arms assuming zero tension on the take-off side.

9.2.5 Should it prove economical the duties of one or more towers may be combined in a single tower in which case tower designation shall be agreed with the Engineer.

9.2.6 A tower extended by means of the addition of a base extension shall be designated by the standard designation followed by the letter E and a figure indicating the height of the base extension as follows:=-

TOWER TYPE	POSSIBLE EXTENSION DESIGN	MAXIMUM EXTENSION HEIGHT
1D and 2D	E3, E6, E9, E12, E15 and E18	18 m
1D30 and 2D30	E3, E6, E9, E12, and E15	15 m
1D60 and 2D60	E3, E6, E9, and E12	12 m
1D90 and 2D90	E3, E6, E9, and E12	12 m
1DT and 2DT	E3, E6, and E9	9 m
1DT90 and 2DT90	E3, E6 and E9	9 m

9.2.7 Special parts for any standard tower as well as special towers, foundations or special extensions shall be of an approved design and shall be provided where required.

9.2.8 The type of tower and extension to be used in each position along the route shall be approved by the Engineer.

9.3 **Gantry structures**

9.3.1 Should gantry structures be required under the contract, all cross- over gantries, tee-off gantries and landing gantries shall be of bolted lattice steelwork construction of the self-supporting portal type mounted on block type concrete foundations:

9.3.2 Two types of gantries are defined as follows:

9.3.2.1 “Single gantry” or H-gantry consisting of two column supports and a horizontal strain beam suitable for carrying one three-phase circuits.

9.3.2.2 “Double gantry” or M-gantry consisting of three column supports and two horizontal strain beams suitable for accommodating two parallel running three-phase circuits

9.3.3 Gantry types shall be designated as follows:

9.3.3.1 A single gantry for a single conductor circuit shall be designated type 1HG.

9.3.3.2 A double gantry for a single conductor circuit shall be designated type 1 MG

9.3.3.3 A single gantry for a twin conductor circuit shall be designated type 2HG

9.3.3.4 A double gantry for a twin conductor circuit shall be designated type 2MG.

9.3.4 Gantries shall be designed to carry the three-phase conductors of each circuit in horizontal formation.

9.3.5 Gantry spans and phase-to-phase spacing shall be designed such that at maximum sag at a conductor temperature of 75° and assuming two adjacent conductors swinging through 90° towards each other for example under external fault conditions, the phase-to-phase clearance shall not be less than the value specified in the Schedule of Basic Parameters.

9.3.6 Subject to the requirements of clause 9.3.5 above, the minimum phase spacing (centre line to centre line) of gantry span conductors shall be as follows:

GANTRY TYPE	SPAN LENGTH	MIN. PHASE SPACING
1H and 1M	Up to 36 m	3,0
1H and 1M	Above 36 m up to 45 m	3,5
2H and 2M	Up to 30 m	3,0
2H and 2M	Above 30 m up to 38 M	3,5

9.3.7 Gantry designs shall be such that the phase-to-earth (steelwork) clearances laid down in the Schedule of Basic Parameters are complied with.

9.4 **Steelwork**

9.4.1 In the case of lattice type towers and structures all members shall be of standard metricated rolled steel sections (manufactured from structural steel to the requirements of BSS 4360 and /or SANS 222) bolted together. All such members shall be cut to jig and all bolt holes shall be drilled or punched to jig prior to galvanizing.

9.4.2 All members shall be clearly stamped with a distinguishing code corresponding to an approved code provided on approved drawings or material lists to be submitted by the Contractor. Such code shall be stamped prior to galvanizing and shall be clearly legible after galvanizing.

9.4.3 Bolted friction-grip joints shall comply with the requirements of SANS Code of Practice 064.

9.4.4 No Bolt holes shall be more than 1.5 mm larger than the corresponding bolt diameter and drifting and reaming of holes will not be allowed.

9.4.5 All bolts, nuts and other fittings shall be galvanized unless otherwise approved and all bolts shall as far as conveniently possible, be fitted with the bolt head on the outer face of the structure, rather than the nut. The minimum diameter of bolts used to fix members shall be:

9.4.5.1 Stressed members - 16 mm

9.4.5.2 Other steelwork - 12 mm

9.4.6 The length of bolts shall be such that when fitted the maximum projection through the nut shall be 15 mm and the minimum 6 mm. Under no circumstances shall the screwed portion of any bolt fall within the shearing plane between members.

9.4.7 The centres of all bolt holes in plate members shall not be less than one bolt diameter from the edge of such a member.

9.4.8 A hole to clear a 16 mm bolt drilled approximately 200 mm above the concrete encasement, necessary for bolting of the earthing counterpoise shall be provided in each leg of every tower or extension and gantry column.

9.4.9 All steelwork below ground level shall be completely encased in concrete of not less than 80 mm thickness from a position 200 mm above ground level down to the main foundation. Details shall be given of the method and type of concrete to be used as well as the preventative measures against ingress of water between the steelwork and foundation concrete.

9.4.10 All exposed steelwork shall be hot-dipped galvanized as specified elsewhere.

9.5 **Galvanizing**

9.5.1 Galvanizing shall be in accordance with SANS 763 or BS 729.

9.5.2 Tenderers shall include in their supply prices, for the complete test and approval of the galvanizing by the SANS at the factory of the galvanizing by the SANS at the factory of the galvanizing company. Steel members will be unacceptable without the stamp of the SANS or their written approval.

9.5.3 The hot-dip process shall apply galvanizing. Sheradising or other similar processes shall not be used.

9.5.4 All welding, drilling, punching, cutting and bending of parts shall be completed and all scale, flux, rust and burrs removed and fabrication completed before the galvanizing process is applied.

9.5.5 The minimum weight of zinc coating on structural steelwork and other fittings shall not be less than 763 grams per square metre.

9.5.6 The threads of bolts and screwed rods shall be cleared by spinning or brushing; a die shall not be used. In the case of nuts the threaded portion shall be cleared after galvanizing by the passing through of a tap. Immediately after tapping to clear the threads the un-galvanized portions shall be coated by dipping in hot grease. The grease used shall be to approval.

9.5.7 The zinc coating shall be adherent, smooth and continuous. The coating shall be free of such imperfections as lumps, thin patches, blisters, gritty areas, uncoated spots, acid and black spots and flux. The zinc coating shall not be so loosely adherent as to be removable by any reasonable process of handling during transport and erection. Light blows with a hammer shall not cause peeling of the coating adjacent to the area deformed by the hammer blows.

9.5.8 Globular and extra heavy deposits of zinc which will interfere with the intended use of material will not be permitted.

9.5.9 Faulty areas of galvanized steelwork may only be repaired by re-dipping in molten zinc before the sample cools or oxidizes.

9.6 **Tower accessories**

9.6.1 Anti-climbing devices

9.6.1.1 An anti-climbing device shall be provided on each tower and tee-off or cross-over gantry column at a height of not less than 3 m and not more than 6 m above ground level.

9.6.2 Climbing bolts (step bolts)

9.6.2.1 Climbing bolts to approval shall be provided on two diagonally opposite legs of the tower commencing immediately above the anti-climbing devices at a maximum spacing of 400 mm up to the earth wire cross-arm.

9.6.2.2 No climbing bolts or ladders are required on gantry columns.

9.6.3 Tower identification and danger plates

9.6.3.1 General:

1) Each tower erected under this specification shall be fitted with a danger and property plate, a tower number and route identification plate with two circuit identification discs.

2) The plates shall be fixed to the tower in such positions that they cannot be tampered with and are clearly legible to any observer, either from the ground or the air, underneath the lines with the front facing the source (as discussed with customer), at a height of 6 m from ground level.

3) All tower plates and discs shall be durable and robust. The plates shall be of approved design and sizes and the layout, wording and numbering shall be approved by the Engineer. The inscription on all plates shall be on a contrasting background and shall be clearly distinguishable.

9.6.3.2 Substrate:

1) The substrate shall be non fading and resistant to ultra violet rays.

2) All tower, route identification, danger and property plates shall have black inscriptions on a yellow background.

3) The colours to be used on the tower plates shall comply with the colour requirements of SANS 1091 – 1975 as follows:

COLOUR	**SANS 1091:2004**	
	COLOUR NUMBER	**COLOUR NAME**
Black	-	-
Yellow	G.61	Canary yellow

4) Unless specifically otherwise approved, the substrate shall be manufactured of cold rolled enamelling quality steel plates, (like chromadeck), with the background as well as the inscription in vitreous baked enamel.
The vitreous baked enamelling shall properly cover the whole surface of the plate including the edges and back to prevent corrosion.

9.6.3.3 Legend:

1) The material of the legend shall be non fading and resistant to ultra violet rays. The colour shall be black and the lettering shall be style ARIAL.

2) The letters on the line designation labels shall have a minimum height of 75 mm.

3) The letters on the tower designation labels shall have a minimum height of 150 mm.

4) The lettering used on danger and property plates shall be of minimum height of 50 mm.

5) The circuit identification discs shall be yellow lettering on black circular background. The background circle shall be of minimum diameter of 125 mm. The lettering inside the black circle shall be of minimum height of 100 mm, and of style ARIAL.

9.6.3.4 Identification

1) Each label shall be marked with the suppliers name. The identification marking shall be of the same quality and standard as the rest of the tower plates and the legend shall be legible with a maximum height of 15 mm.

9.6.3.5 Size of plates:

1) The size of the identification plate shall be of dimensions 500 (w) x 500 (h) mm. The layout of the lettering and symbols required will be as illustrated in figure …………………..

2) The size of the danger plate shall be of dimensions 500 (w) x 450 (h) mm. The layout of the lettering and symbols required will be as illustrated in figure ………………….

9.6.3.6 Affixing methods:

1) Both the danger and identification plates, shall be affixed as follows:
   - For steel lattice towers, at the crossing of the second horizontal cross beam and connecting lattices, see figure …………
   - For concrete and other poles, at a distance of 9 m from ground level.

2) The plates shall be mounted on a 50 x 50 x 3 mm angle-iron rectangular frame, in a robust way, provided with adjustable connection points for connection on the lattice frame of the tower, (or relevant part of pole, if poles are to be used).

3) Assurance must be given for the design’s ability to withstand atmospheric and temperature conditions, without failure.

9.6.3.7 Naming of towers :

1) Tower route numbers and identification will be provided by the customer.

9.6.4 Bird Guards

9.6.4.1 Guards of approved design to prevent birds perching above insulator sets shall be provided on all suspension type towers.

10. FOUNDATIONS

10.1 Standard foundations and design

10.1.1 Concrete block or frustum type foundations shall be regarded as standard foundations and shall be used in all cases where suitable ground conditions exist.

10.1.2 Rock anchor foundations of approved design will only be permitted in solid fresh rock or massively bedded fresh rock and then only with the specific approval of the Engineer for each instance. Rock anchors in shale, "ouklip", boulders or other loose or fragmented or decomposed rock strata will not be accepted. Should rock be encountered during excavations, and the Contractor propose to install rock anchors, he shall employ the services of a Geological Engineering Consultant (Geotechnical Consultant) approved by the Engineer to investigate and report on the suitability of the rock for the type of rock anchor proposed by the Contractor. The Contractor shall submit a copy of the geotechnical report with his request for approval for using a rock anchor foundation. The cost of the geotechnical investigation and report shall be included in the price to be quoted for rock anchor foundations.

10.1.3 No drilled or root pile type foundation will be allowed without the specific approval of the Engineer. If piled foundations for special purposes are approved by the Engineer they shall comply with SANS Code of Practice 088 and full details of piling and foundation design shall be submitted to the Engineer for approval beforehand.

10.1.4 Where poor subsoil conditions are encountered, i.e. excavations below water table level, or in soils of which the bearing pressures are to be determined by test as specified in the Schedule of Basic Parameters, or in soils of which the maximum safe bearing pressure could possibly become less than the minimum safe bearing pressure used for the design of standard foundations, the Contractor shall employ the services of a Geotechnical Consultant approved by the Engineer to carry out subsurface geotechnical investigations, and if necessary, soil tests, to determine soil parameters for the selection of foundation type and report on the suitability of employing standard foundations. Should standard foundations not be suitable, specially designed foundations, the type(s) and details of which are approved by the Engineer, shall be provided by the Contractor at prices to be agreed. Unit rate(s) for geotechnical investigations required in terms of this clause shall be quoted in the Form of Tender. The Engineer shall nevertheless be entitled to instruct the Contractor to appoint a Geotechnical Consultant to carry out geotechnical subsoil investigations, including soil tests if required, at sites to be selected by the Engineer at the unit rate(s) quoted for geotechnical investigations.

10.1.5 For each site so investigated, the Contractor shall submit a copy of the Geotechnical Consultant's detailed report on the investigation to the Engineer for approval of foundation type before installation of the foundation is commenced with.

10.1.6 In dolomite areas percussion drilling or other approved means shall be used for investigating sub-soil conditions and exploring subsurface cavities at proposed tower positions before starting foundation excavations.

10.1.7 In the design and application of standard and special foundations. The Contractor shall be responsible for ensuring that the subsoil at each foundation is suitable to withstand the maximum design load which will be imposed upon it by the foundation under maximum simultaneous tower working load conditions specified in clause 8 and according to the parameters specified in the Schedule of Basic Parameters.

10.1.8 The Contractor shall be responsible for any subsidence or failure of foundations due to insufficient care having been taken in the examination of the soil or the installation of the foundations. In such an event the foundation shall be replaced by the Contractor at his own expense.

10.1.9 Foundations design(s) shall comply with the parameters specified in the schedule of Basic Parameters for the Design and construction of the power line and the minimum safety factors specified therein.

10.1.10 The type of foundation to be used at each tower and gantry position shall be approved by the Engineer and the Contractor shall submit full particulars and design details of each type of foundation to be used before installation thereof.

10.2 **Concrete block foundations**

10.2.1 Concrete block foundations shall have stubs of galvanized steel sections embedded in the concrete. The stubs shall be firmly keyed into the concrete by means of suitable attachments or cleats. The adhesion between galvanized steel and concrete shall not be relied on to transmit the load to the foundations.

10.2.2 Each tower leg or base shall be bolted to a foundation stub with the top end of the joint approximately 300 mm below ground level. The concrete encasement shall however be continued to a level approximately 200 mm above finished ground level where it shall be finished off smoothly and neatly. The upper surface of this encasement or cap shall be sloped in an approved manner to prevent the accumulation of water.

10.2.3 All steelwork below ground and part of the tower shall be galvanized. Steel shall be completely covered by concrete not less than 80 mm thick. Care shall be taken to ensure that no crack can develop between the encasing and the main foundation block.

10.2.4 All members projecting above the concrete section at the lower leg bases as well as the concrete encasement cap shall be thoroughly coated with black bitumastic paint to a point approximately 1 m above ground.

10.3 **Rock anchor foundation**

10.3.1 The holes in rock for rock anchors shall be made in such a way that the possibility of cracking the rock is eliminated.

10.3.2 The dispositions and dimensions of holes for rock anchors shall be to approval. The actual depth of an anchor bolt grouted into the rock shall in no case be less than one metre.

10.3.3 Rock anchor bolts shall be completely galvanized. The adhesion between galvanized steel and grouting shall not be relied upon to transmit the load to the rock. The anchor bolt shall be firmly keyed to the rock by means of taper heads of split ends with taper wedges properly and completely grouted.

10.3.4 If solid rock is encountered below the surface, the tower leg or footing shall be supported on a concrete base or cap extending down to the rock surface in which the rock anchors shall project at least 200 mm above finished ground level and shall be grouted off around the base plate with the upper surfaces sloping in an approved manner to shed water.

10.3.5 The design of rock anchor foundations shall be to approval and shall comply with the parameters specified in the Schedule of Basic Parameters.

10.4 Concrete work for foundations

10.4.1 Unless otherwise approved, the concrete mix for all foundations shall consist of one part Portland Cement, two parts of sand and four parts of 18 mm crushed stone aggregate whilst the concrete required for encasing of tower steelwork above ground line shall consist of one part Portland Cement, two parts of sand and four parts of 6 mm stone chipping

10.4.2 In the case of excavations required beyond the normal foundation depth in order to establish suitable sub-soil, such sub-foundations shall be filled with a mixture of one part Portland cement and 10 parts of approved soil/sand well tamped down.

10.4.3 Broken stone and sand shall be clean and free from earthy or organic matter and salt. Seashore sand, unwashed pit sand or unwashed gravel shall not be used. All gravel or broken stone shall be of approved grading, and able to pass through a mesh of not more than 18 mm diameter. All sand shall be screened through a mesh not exceeding 5 mm square in the clear. All sand shall be coarse, sharp, clean and free from dust, salt, clay, vegetable matter or other impurities. Fine sand of a uniform grain size shall not be used, but all sand shall be a well graded mixture of coarse and fine grains.

10.4.4 Stone aggregate for concrete shall comply with SANS 718 and concrete sand with CKS 53. Fresh Portland cement complying with SANS 471 shall be used.

10.4.5 Water shall be clean and free from all earthy vegetation or organic matter, acids and alkali substances in solution or suspension.

10.4.6 The aggregates and cement shall first be mixed dry, then after addition of the minimum water consistent with practical workability, mixing shall be carried on until the concrete is of even colour and consistency throughout. No concrete shall be poured, or mixed, when the ambient temperature, or the temperature of the ingredients, is less than 2°C.

10.4.7 Ready-mixed concrete, if used shall comply with SANS 878:2004.

10.4.8 All concrete shall be mechanically vibrated during installation so as to form a well consolidated mass presenting a smooth surface upon removal of the shuttering.

10.4.9 Where required, the Contractor shall supply all re-inforcing steel required for foundations. All reinforcing steel shall comply with SANS 920 and bending dimensions shall conform to SANS 282:2004. The concrete cover over steel reinforcement shall not be less than 50 mm.

10.4.10 Joints in concrete are to be avoided. Where the construction requirements are such that joints are unavoidable, adequate bond between old and new concrete shall be ensured by chipping the old concrete to a rough and clean surface. Before casting the fresh concrete, the old concrete shall be sprinkle and dusted over with dry cement.

10.4.11 The Contractor shall provide all shuttering and foundation templates required for concrete work. Unless otherwise approved shuttering or templates used for foundations shall not be struck within 24 hours after casting and towers or other structures shall not be erected on any foundation within fourteen days of casting.

11. EARTHING OF STRUCTURES

11.1 All towers and steel structures shall be earthed to a resistance level not exceeding 10 ohms. Buried foundation earths as specified below shall be installed under each tower leg and gantry column foundation. Structure earth resistances shall be measured before stringing and supplementary buried earthing or driven earth rods shall be installed to lower the earth resistance in cases where the footing resistance exceeds 10 ohms.

11.2 Buried foundation earths shall consists of a galvanized steel tape of dimensions 38 mm by 3 mm and 7 m long coiled at the bottom of each foundation excavation and covered with a layer of at least 80 mm of good riddled soil, which shall be well tamped down prior to the casting of the foundation. If the steel tape is not one continuous length, the joint(s) shall be bolted and soldered to approval. One end of the coil shall be brought up outside the foundation and be bolted to the structure leg at a position clearly visible for inspection. The cost of supply and installation of the steel tapes shall be included in the price for the erection of the foundation. The Contractor shall arrange with the Engineer for the inspection of foundation earths before casting the foundation concrete.

11.3 As provided for in clause 9.4.8, in addition to provision for the above earthing coils, provision shall be made on each leg of all structures for the connection of a buried supplementary earthing system where required by the Engineer. The conductor to be used for the supplementary earthing system shall be as specified in the Schedule of Particulars and Guarantees.

11.4 One week prior to stringing of the earth conductors, the Contractor shall advise the Engineer of the proposed stringing date, in order that the Engineer may make timely arrangements for the measuring of tower earthing resistances by the Council, (if required) after which the Contractor will be advised of the extent of the counterpoise earthing system to be installed by the Contractor.

11.5 The supplementary earthing shall be buried in a 700 mm deep trench along a route to be directed by the Engineer. The cost of excavation shall be included in the installation rate for supplementary earthing. No extra price will be paid to the Contractor due to variations in the ground conditions.

11.6 Terminal towers shall be bonded to the overhead earth wires and to the station earthing system. The earthing of the earth peaks on gantry structures shall be to approval of the Engineer.

11.7 The overhead earth wires shall be continuous between terminal towers and all intermediate towers and structures shall be connected to the earth wires except for the following exclusions:

11.7.1 For the control of electrolysis, all towers within 800 m of electrified railway lines or within 800 m of major pipe lines with cathodic protection shall be insulated from the earth wires using standard earth wire insulators with spark gaps.

12. CONDUCTORS

12.1 Phase conductors

12.1.1 Phase conductors shall be of the stranded aluminium conductor steel reinforced type with the code reference specified in the Schedule of Basic Parameters. The conductor shall comply in all respects with the requirements of BS 215 Part 2 and/or SANS 182-3: 2003 and shall have the characteristics detailed in the Schedule of Particulars and Guarantees.

12.1.2 The steel core of the conductor shall comply with BS 4565 and shall be uniformly covered with an approved grease of applied mass not less than 16 kg per kilometre of conductor.

12.1.3 The number of conductors per phase conductor for the different line ratings shall be as specified in the Schedule of Basic Parameters.

12.1.4 The conductors of twin conductor lines shall be disposed horizontally throughout the entire span at the centre line spacing specified in the Schedule of Basic Parameters.

12.1.5 At tension points, phase conductors shall be terminated by means of approved clamps of the compression type (dead ends). On strain angle towers, terminal towers and gantries, phase conductors shall be connected through by means of removable (bolt-on) jumper loops made up of accurately cut lengths of the same conductor fitted with compression type jumper terminals at each end. Twin jumper loops shall be used for connecting through twin conductor lines. Removable jumpers shall also be used for connections between down-droppers and lines or jumper loops,

12.1.6 Phase conductors, including jumpers and droppers, shall comply with the conductor clearances specified in the Schedule of Basic Parameters. Jumper swing shall not be limited by the installation of additional insulator sets. Where approved by the Engineer, jumper weights of jumper stiffeners of aluminium tube may, if necessary, be installed to obtain the specified clearances. On twin conductor lines the centre line spacing on twin down-droppers and over the centre section of twin jumper loops may be reduced as stated in the Schedule of Basic Parameters.

12.2 **Earth conductors** (Ground Wire

12.2.1 The two aerial earth wires used as overhead earth conductors shall be of the stranded galvanized steel wire type. Where specified, optical Fibre Ground Wire (OPGW) as detailed in Clause 15 shall be used. The size and other parameters are specified in the Schedule of Basic Parameters

12.2.2 The earth conductor shall comply with the requirements of BS 183 and/or SANS 182-3: 2003 and shall have the characteristics stated in the Schedule of Particulars and Guarantees. Galvanizing of the earth wires shall comply with BS 443 and/or SANS 935:2007.

12.2.3 At tension points earth wires shall be clamped in suitable bolted earth wire strain clamps. The tails of the earth wires shall be taken through and bonded to the structures where required by means of compression type earth wire lugs bolted to the steel structures. Where called for, earth wires shall be insulated from the towers by using approved earth wire suspension and tension assemblies.

12.3 Conductor general

12.3.1 All conductors on the power line shall be applied with the factor of safety specified in the Schedule of Basic Parameters under maximum working load conditions and in compliance with the other relevant parameters laid down in the Schedule of Basic Parameters.

12.3.2 Factory drum lengths of conductor shall be supplied without joints in individual strands of conductor.

12.3.3 On site, joints for jointing successive conductor lengths shall be of approved types. Mid span joints (tension joints) shall be avoided as far as possible. Unless otherwise approved conductor joints shall be located at tower positions. No Joints will be permitted in spans crossing proclaimed roads, railway lines, other power lines, important communication lines or buildings. Joints will also net be permitted in gantry spans or down-droppers.

12.3.4 Vibration dampers shall be fitted to all conductors to damp vibration, oscillation and galloping of the conductors to damp vibration, oscillation and galloping of the conductors.

12.4 Drumming of conductor

12.4.1 All conductors to be installed on this contract shall be supplied on new wooden drums of substantial construction, suitable in every way for the safe handling and transport thereof. All drums shall be clearly marked to indicate the drum number; the length of conductor on the drum and the correct direction of rolling shall be indicated by an arrow.

12.4.2 Any spare conductor required on this contract shall be supplied to the Council's Stores on approved steel drums. These steel drums shall be suitable for rotation on a 120 mm diameter spindle with at least 20 mm wide bearing surface at each point of contact with the spindle. Both flanges and the barrel of the drum shall be of material of approved gauge which shall be braced to the approval of the Engineer and the entire drum shall be either galvanized or painted with approved anti-rust paint and clearly marked as specified above.

13. BASIC REQUIREMENTS STIPULATED FOR COMPOSITEINSULATORS FOR 132 KAV POWRLINES:

Phase conductors shall be insulated from towers and supporting structures by means of string insulators

13.1 Relevent standards

All insulatorstrings and fittings shall comply with the following relevant standards unless otherwise specified:

- NRS 041:1995
- IEC 815

13.2 Sesvice conditions

The insulators shall be suitable for continuous outdoor operation under the varying atmospheric and climatic conditions occurring at all seasons in Pretoria and shall operate satisfactory under the following conditions:

Altitude above sea level	1700 m
Maximum ambient temperature (summer)	45°C
Average daily maximum ambient temperature (winter)	30°C
Minimum ambient temperature (winter)	-5°C
Average dailly minimum ambient temperature (winter)	2°C
Minimum relative humidity	20%
Maximum relative humidity	94%
Maximum wind speeds • Steady conditions • Gusty conditions	 25 m/s 45 m/s
Lightning area	Yes (high)
Average thunderstorms days per annum	± 75
Approximate ground flash density per square km per annum	7
Median value of peak discharge current	41kA
Mean duration of strokes	<200µs
Number of multiple stroke flashes as a percentage of total number of strokes	40%
Pollution conditions	Normal to Heavy (industrial dust, smog & mist)
Gravity constant for Pretoria	9.786m/s²
Design wind pressure (DWP)	1170 Pa

13.3 System particulars

13.3.1 The insulators will be used on transmission lines and gantry structures, which are connected to a 132kV power distribution system in which electrical energy is generated at interconnected power stations as three-phase current at a frequency of 50 Hz, and transmitted by means of overhead power lines and underground cables.

13.3.2 The load on the system will consist of all or any of the following: Static transformers, induction and synchronous motors, motor generators, rotary converters, rectifiers for the supply of motive power, traction, lighting, heating and electromechanical work.

13.3.3 Further particulars of the three-phase distribution system are as follows:

Nominal system voltage (r.m.s. line to line)	132kV
Highest system voltage (r.m.s. line to line)	145kV
System frequency	50Hz
Maximum symmetrical fault current capacity (1 second rating)	31,5kA (r.m.s.)
System BIL at sea level	650kV
System insulation level at Pretoria altitude	550kV

13.4 **Electrical requirements**

13.4.1 All components used in insulator assembly sets shall be designed such that the voltage stress anywhere on the metal surface of such fittings shall not exceed a value equivalent to a voltage gradient of 0,65 MV/m at sea level with the fittings energised at the specified maximum system voltage (line to line)

13.4.2 There shall be no audible or visible corona on the fittings when in use on site and energised to the maximum system voltage.

13.4.3 Insulator assembly sets shall not cause unacceptable levels of radio or television interference when energised to maximum system voltage.

Required creepage:	
Light pollution	16 mm/kV
Medium pollution	20 mm/kV
Heavy pollution	25 mm/kV
Very heavy pollution	31 mm/kV

13.5 **Mechanical**

13.5.1 The insulator string as a whole shall be designed, manufactured and constructed to operate safely under the specified service conditions under the maximum simultaneous working loads to which it may be exposed with the minimum factors of safety as in NRS 041:1995 (table 1)

13.5.2 The assumed maximum simultaneous balanced and unbalanced working loads, as well as the maximum loads during broken conductor conditions, on the insulator string and fittings shall not be less than that specified in the NRS 041:1995.

13.5.3 A 16 mm ball and socket connection will be provided on all new suspension and tension insulator strings, to provide a 120kN mechanical load strength on suspension insulator strings.

13.5.4 On all tenders where replacement of existing glass or porcelain insulators are called for, the following will be provided:

- 16 mm ball and socket connection for tension insulator strings
- 16 mm ball and socket connection for suspension insulator strings

13.5.5 On suspension towers, a single suspension string shall be used for both single and twin conductor lines.

13.5.6 Strain insulator strings shall be used on all strain towers. On single conductor lines, a single tension string shall be used. On twin conductor lines, double tension strings shall be used.

13.6 Other requirements

13.6.1 The insulator sheds shall be self-cleaning

13.6.2 The insulator sheds shall be hydrophobic

13.6.3 The insulator sheds profile will be designed so that:

- The insulator surfaces are sufficiently aerodynamic to minimise the deposition of pollution;
- Rain washing will be effective; and
- Bridging of adjacent sheds will not take place under heavy rain conditions

13.6.4 The material rod shall be a well pultruded fibreglass reinforced resin rod. A test sample of the rod shall be supplied.

13.6.5 The sleeve shall cover the whole fibreglass rod, up to the end fittings, and shall be of uniform thickness. The sleeve shall be High Temperature Vulcanized to the rod to form a seamless protective covering.

13.6.6 The sleeve shall hermetically seal the rod and provide resistance to hydrolysis, ultraviolet radiation; corona and ozone degradation.

13.6.7 The sheds shall be installed over the sleeved rod and High Temperature Vulcanized to insure a track resistant, bonded composite insulator.

13.6.8 The sheds shall also be resistant to hydrolysis, ultraviolet radiation; corona and ozone degradation.

13.6.9 The preferred material used for the composite shall be silicone rubber, free of all EPDM and EPM alloy polymers.

13.6.10 The required lifespan of the insulator string and fittings is 30 years, during this time no degrading in the insulator string and fittings is 30 years, during this time no degrading in the insulator's ability of hydrophobic action, mechanical strength, or any other requirements will take place.

13.6.11 Insulator sheds must be able to withstand the amount of reasonable pressure generated during washing, without loss of bonding to the sleeve.

13.6.12 All insulator string and fittings must be accompanied by the following tests:

Flashover test

Type test

Sample test

Breaking strength test (*to be arranged with tenderer)*

13.6.13 The insulator shall be provided with a arcing control lip to provide a termination point for 50 Hz power follow current during an insulator flashover. The lip shall be designed to divert the heat generated from flashover currents away from the crimped portion of the end fitting.

13.6.14 The insulator shall be vandal proof.

13.6.15 The manufacturer shall have at least 10 years field experience in composite insulators.

13.6.16 Proof of adequate service and support must be supplied by the tenderer.

13.6.17 The manufacturer shall comply with ISO 9000 standards in Quality Control.

13.7 Profile parameters

To be specified in the Schedule of basic parameters as follows:

Definitions

C	-	Shed clearance – the length of perpendicular to the shced surface to the outer rib of the shed above.
S	-	Shed spacing – the vertical distance between two similar points on successive sheds
P	-	Shed protection – the maximum shed overhang
_	-	The straight air distance between any two points on the shed surface
I_	-	The creepage distance measured between the two points that define _
Is	-	The creepage distance measured between the two points that define S.
L	-	The total creepage distance of the insulator
A	-	The arcing distance of the insulator
CF	-	Creepage factor = L/A
Pf	-	Profile factor = (2P+S)/Is or (2P1 + 2P2 + S)/Is (P1 and P2 is the respective maximum shed overhangs for sheds on an alternating shed insulator)

Recommended profile parameter limits:

C	>	20mm (shed clearance the length of perpendicular to the shed surface to the outer rib of the shed above
S/p	>	0.8 for ribbed sheds
S/P	>	0.65 for plain sheds
I_/_	<	5
P1-P2	>	15mm
_	>	5°
ß	>	2°
CF	<	4
PF	>	0.7

14. POWER LINE FITTINGS AND HARDWARE

14.1 Fittings general

14.1.1 All power line fittings shall be of approved design and shall comply with the relevant requirements of SANS 178 and/or BS.3288.

14.1.2 All fittings made of ferrous materials shall be hot-dipped galvanized to SANS 763 and/or BS 729 after complete manufacturing.

14.1.3 All fittings shall be supplied complete with all nuts, bolts, washers, pins, clips and locking devices as required. Bolts and pins shall be fitted with approved locking devices such as split pins. Spring washers on galvanized surfaces will not be permitted. All split pins shall be backed by flat washers and shall be either of phosphor bronze or stainless steel.

14.1.4 All bolt threads shall be greased before erection.

14.1.5 Standard ball-ended links or fittings shall be used for attachment to the cap side of disc insulators, and links or fittings used for attachment to the pin side of the disc insulators shall have standard socket connections. These links or fittings shall have facilities to accommodate arcing horns if required.

14.1.6 All ball and socket joint shall be effectively locked by means of W-security clips or retaining pins or other approved locking device.

14.1.7 Retaining pins or locking devices shall be of phosphor bronze or stainless steel and shall be so formed that when set and under any conditions nothing but extreme deformation of the retaining pin or locking device shall allow separation of the insulator units or fittings, or shall permit accidental displacement of the retaining pins or locking devices. Their design shall be such as to allow for easy removal or replacement of insulator units or fittings without removal of the insulator sets from the structures. Retaining pins or locking devices shall be incapable of rotation when in position.

14.1.8 All ball and socket couplings shall be lightly coated with approved grease immediately before erection on site.

14.1.9 Standard pin type shackles and clevis couplings shall be used for attachment of insulator assembly to conductor clamps or yoke plates. Under no circumstances will hooks be allowed.

14.1.10 All fittings and components in tension and suspension assemblies shall be of sufficient mechanical rating of the set is met and applied with a minimum factor of safety under maximum working load conditions as specified in the Schedule of Basic Parameters.

14.1.11 All clamps to be used shall have the minimum mass consistent with good design and adequate mechanical strength. Clamps shall comply with the relevant requirements of SANS 178 and/or BS 3288. Clamps intended for stranded conductor shall be designed to avoid any possibility of deforming the stranded conductor or separating of the individual strands.

14.2 Tension insulator assemblies (sets) for phase conductor

14.2.1 The fittings of tension insulator set assemblies shall be arranged to provide a minimum clearance of 150mm between the rim of the live end insulator disc and the jumper conductor or arcing horn.

14.2.2 For single conductor lines a single tension insulator assembly shall be used and be referred to as a normal tension set. Each normal tension set shall be provided with approved sag adjusting plate or links for sag adjustment where necessary. No device employing screw threads shall be used for sag adjustment on Norman tension sets.

14.2.3 In the case of twin conductor lines, a separate insulator string assembly for each conductor shall be used which shall be separately attached to the cross-arm. These tension sets shall be referred to as double normal tension sets and shall be fitted with approved sag adjustment links to provide a total adjustment range of 300 mm in approved steps. Devices using screw threads for sag adjustment will not be acceptable on double normal tension sets.

14.2.4 For low duty applications, on down droppers and gantry spans, low duty tension sets employing disc insulators and fittings with a lower assigned safe load rating, may be used. These tension sets shall be referred to as low duty tension sets and reverse low duty tension sets where the insulators have to be reversed to shed water. A single insulator string shall be used for both single and twin conductor low duty tension sets, but the low duty tension set for twin conductor construction shall incorporate a yoke plate to equalise conductor tensions. Separate means shall be provided for sag, adjustment on each conductor on twin sets. On low duty tension sets, approved turn-buckles with suitable lock nuts will be allowed for sag adjustment.

14.3 Suspension insulator assemblies (sets) for phase conductor

14.3.1 For both single and twin conductor lines, phase conductor suspension sets shall consist of a single insulator string assembly with the necessary links and fittings. Suspension sets intended for supporting twin conductor lines shall incorporate a yoke plate to equalise conductor loads.

14.4 Arcing horns

14.4.1 Acing horns of approved types, capable of safely withstanding a force of 500 N applied to the tip of the horn and designed to minimise the damage to conductors or insulator assemblies under all flash-over conditions, shall be attached to the fittings of the assembly in an approved manner and not to the clamps or insulator caps.

14.4.2 All suspension and normal tension insulator sets throughout the line shall be fitted with arcing horns on the live end only. Arcing horns shall only be fitted on the outer strings of double tension insulator sets.

14.4.3 Low duty and reverse low duty tension sets shall be fitted with arcing horns on the live as well as on the earthed side.

14.5 Phase conductor strain clamps

14.5.1 All tension clamps for phase conductors shall be of the current carrying compression type.

14.5.2 Compression type strain clamps shall have a mechanical strength of not less than 100% of the ultimate strength of the conductor when tested in accordance with BS 3288 Part I.

14.5.3 Compression type strain clamps for steel reinforced aluminium conductor shall comprise two compression sleeves, an inner steel compression sleeve for transmitting the mechanical strain from the steel core of the conductor to the attachment fitting and an outer aluminium compression sleeve mainly for current transfer.

14.5.4 Compression type strain clamps shall be supplied complete with jumper flags (jumper lugs) for bolting on jumper terminals. Where required strain clamp sleeves shall have double flags opposite each other for making two connections. The bolt-on surface of the flag shall be machined to provide a flat and reasonable smooth contract surface which shall be protected against oxidation by approved means.

14.5.5 Compression type strain clamps shall comply with the relevant requirements for current carrying clamps.

14.6 Phase conductor suspension clamps

14.6.1 Suspension clamps for phase conductors shall be of the trunnion type fixed in position by means of two M12 U-bolts and a keeper piece. The clamp shall be designed to support the conductor even if both U-Bolts are removed.

14.6.2 The conductor supporting groove of suspension clamps shall be flared out in a vertical plane to allow the conductor to leave the groove tangentially at any angle of declination encountered in service. In addition the groove shall be bell-mouthed to a minimum radius of 25 mm.

14.6.3 The mechanical clamping of the conductor shall be designed so as not to cause mechanical damage to the conductor of deforming it or separating the individual strands. The clamp shall permit conductor slip before conductor failure.

14.6.4 On conductor suspension clamps pivoting shall be provided about a horizontal axis transverse to, and through the centre line of the conductor.

14.6.5 Suspension clamps shall be of galvanized malleable cast iron. Ferrous suspension clamps shall be provided with soft pure aluminium liners to protect the conductors.

14.6.6 Suspension clamps shall comply with SANS 178.

14.7 Earth wire strain clamps

14.7.1 Earth wire strain clamps shall be of the straight bolted type strain clamps and shall comply with the relevant requirements of SANS 178.

14.7.2 The clamp shall be forged from steel and shall comprise a clamp body with integral pulling eye and keeper plate(s). At least six M12 bolts shall be used for clamping the conductor in the groove. The clamp shall be reasonably smooth and all parts shall be hot-dipped galvanized.

14.7.3 The clamp shall be supplied compete with all necessary bolts, nuts and washers.

14.8 Earth wire suspension clamps

14.8.1 Suspension clamps for earth wires shall be of the trunnion type and shall be fixed in position by means of two M12 U-Bolts bolting down onto a preformed keeper plate to clamp the conductor.

14.8.2 Earth wire suspension clamps shall comply with similar requirements as laid down for the phase conductor suspension clamps.

14.9 Current carrying clamps, joints and accessories

14.9.1 All current carrying parts of compression type clamps, joints and accessories (e.g. conductor repair sleeves) for aluminium conductor shall be manufactured of aluminium of at least 99.5%purity.

14.9.2 The conductivity and current carrying capacity of compression type clamps and joints shall not be less than that of the conductor.

14.9.3 The clamps shall clamp the stranded conductor effectively under all conditions including repeated cyclic heating resulting in clamp temperatures varying between minus 5°C and plus 95°C.

14.10 Phase conductor jumper terminals

14.10.1 Jumper terminals shall be of the compression/bolt type arranged for compression jointing to the conductor and bolt-on to other clamps as for instance strain clamp flags.

14.10.2 The connection between jumper terminals and strain clamps shall be arranged such that the jumper conductor approaches the extended centre line of the line conductor at an angle of between 60°C and 75°C.

14.10.3 The bolt-on surface or palm of jumper terminals shall be machined to provide a flat and reasonable smooth contact surface which shall be protected against oxidation by approved means.

14.10.4 Jumper terminals shall be bolted to strain clamps by means of at least two M12 bolts. All jumper terminals shall be supplied complete with all necessary bolts, washers, spring washers and nuts as required.

14.10.5 Jumper terminals shall comply with the requirements for current carrying clamps.

14.11 **Tension joints** (Mid span joints)

14.11.1 If the use of a mid span joint is approved by the Engineer mid span tension joints shall be of the compression current carrying type and shall be of approved design.

14.11.2 Tension joints shall not allow any slip of the conductor and shall have a mechanical strength not less than 100% of the ultimate strength of the conductor when tested in accordance with BS 3288 Part I.

14.11.3 Compression type tension joints for steel reinforced aluminium conductor shall comprise of compression sleeves; an inner steel sleeve to transmit mechanical tension from steel core to steel core of the conductor, and an outer aluminium compression sleeve mainly for current transfer.

14.11.4 Steel compression sleeves shall be used for mid span jointing of earth wires, if approved.

14.11.5 Compression type joints shall comply with the requirements for current carrying clamps and joints specified elsewhere in this Specification.

14.12 **Conductor repair sleeves**

14.12.1 Should isolated strands of the conductor be damaged during erection, repair sleeves may be permitted at the discretion of the Engineer. The type and manner of fitting shall be to approval.

14.12.2 Conductor repair sleeves shall not be used on stranded conductor which has been kinked.

14.13 **Phase conductor spacers**

14.13.1 On twin conductor lines, the two conductors in each phase conductor shall be disposed horizontally and spaced throughout the entire span at the centre line spacing specified in the Schedule of Basic Parameters by means of suitable spacers of approved design.

14.13.2 Spacers shall be fitted at regular intervals not exceeding 75 m along each span with the first spacer in each span fitted at 10 m from the tower centre line.

14.13.3 Line spacers shall be of the flexible ring type allowing limited relative longitudinal movement between conductors as well as limited torsional movement of each conductor.

14.13.4 Rigid spacers shall be used on twin jumper connections as well as on twin down droppers and twin gantry spans. At least three spacers shall be fitted at intervals not exceeding 3 m.

14.13.5 All spacers shall be light and of robust construction.

14.13.6 Spacer clamps shall be designed so as to avoid any possibility of deforming the stranded aluminium conductor or separating the individual strands.

14.13.7 Spacer clamps shall be designed with an adequate radius of curvature at the clamp mouth to prevent the clamp “biting” into the conductor.

14.13.8 U-bolts employed on spacer clamps shall not clamp directly onto the conductor. Conductor keeper plates of suitable design shall be used to clamp down onto the conductor. Unless otherwise approved the spacer clamp body and keeper plate(s) shall be made of aluminium.

14.13.9 All bolts, nuts and washers and other ferrous part of spacers shall be galvanized to SANS 763. All nuts on spacers shall be locked in an approved manner.

14.13.10 Spacers shall comply with the test requirements of SANS 178 and/or BS 3288 Part I.

14.14 **Vibration dampers**

14.14.1 Stockbridge pattern vibration dampers shall be fitted to all phase conductors and to both earth wires on all spans exceeding 50 m to damp conductor vibrations.

14.14.2 The mass of vibration dampers on phase conductors shall be approximately 6 kg and that of earth wire dampers approximately 1.5 kg.

14.14.3 On all conductors the vibration damper shall be fitted at a distance of 1.25 m from the conductor support point or conductor attachment point. On spans exceeding 360 m a second damper shall be fitted on each conductor in a position 1.25 m out from the first damper.

14.14.4 All dampers shall be of approved design and construction.

15. OPTICAL FIRBRE MATERIAL

15.1 **Optical fibre ground wire (OPGW)**

15.1.1 A composite earth wire with sixteen (16) individually identified optical fibres shall be supplied and installed where specified.

15.1.2 The composite earth wire characteristics shall be similar or better than the conventional earth wire in operation.

15.1.3 The optical fibre earth wire will be used for the vital protection and control functions of the terminal substations where reliability and proven integrity under Tshwane’s service conditions are essential.

15.1.4 Full details of service experience giving type of system, length of line, location and years in service and the direct effect of lightning on the optical fibre shall be provided. Full Type Test information shall be provided.

15.1.5 The optical system will operate at 1 300Nm. The average maximum attenuation shall not exceed 0.15 dB per km.

15.1.6 The OPGW shall be in drum lengths commensurate with tension tower spacing in order to minimise the number of joints in the line.

15.1.7 The optical fibre contained within the OPGW shall be of the loose buffered type with fibres housed in individual grooves in a helically grooved extruded aluminium alloy former within an extruded aluminium tube. The earth wire itself shall consist of aluminium clad steel wire.

15.2 **Optical fibre cable**

15.2.1 Normal underground optical fibre cable for connection between the tower and the substation will be enquired and shall be non-armoured with 16 individually identified optical fibre cores with a strength member and orange coloured outer PVC sheath.

15.2.2 The optical characteristics shall be the same as the OPGW.

15.2.3 The non-armoured cable shall be installed in a 32 mm high density polythene pipe.

16. SETTING OUT AND NOTIFICATION

16.1 **General**

16.1.1 The power line(s) is/are to be erected along the route(s) shown on the route plan(s) to be provided by the Council. Unless otherwise specified or directed by the Engineer, the power line is to be erection the centre line of the route shown on the route plan.

16.1.2 The necessary way leaves and right of access will be obtained by the Council. Obstructions, which in the opinion of the Engineer have to be cleared, and certain trees on the route will be cleared by the Council to enable the Contractor to carry out the erection of the line. The Contractor will have to make his own arrangements and provide the necessary scaffolding or other means to cross over the remaining obstacles such as fences, structures, roads, railway lines, telephone lines, etc.

16.1.3 Access to the line route I available at several positions along the route, therefore no special access will be provided by the Council, Tenderers shall acquaint themselves fully as to the access required on site and provide in the contract price for any special access to be built, as no extra claims will be entertained by the Council at a later date.

16.1.4 Particulars of ground contours along the route on which the power line is to be erected are shown on the profile drawings. The necessary surveyed profile drawings will be provided by the Council on which side-slope information is indicated in positions where side-slopes in excess of 1:10 are encountered. The Contractor shall show the following information on such profile drawings all of which shall be approved by the Engineer before the Contractor commences setting out foundations:

16.1.4.1 Tower positions.

16.1.4.2 Tower type number and if applicable tower base extension type number at each tower position.

16.1.4.3 The sag curve of the bottom phase conductor at minimum operating temperature between towers.

16.1.4.4 The 7.5 m clearance curve from bottom phase conductor at maximum temperature.

16.1.4.5 Sag curve(s) of bottom phase conductor in spans crossing railway lines or proclaimed roads under broken line (adjacent span) conditions.

16.1.4.6 Minimum weight span length on every tower.

16.1.4.7 Maximum weight span length on every tower showing the contribution from each span adjacent to tower.

16.1.4.8 Wind span length on each tower showing contribution from each span adjacent to tower.

16.1.4.9 Position of maximum sag at maximum conductor operating temperature.

16.1.4.10 Position of maximum sag at minimum conductor temperature.

16.1.4.11 Equivalent span length of strain section.

16.1.4.12 Actual length of each span.

16.1.5 Prior to the stage of crossing any overhead services, public roads, railway lines or pipe lines with the stringing of conductors, or installation of counterpoise earth conductor, the contractor shall give adequate notice to the appropriate authority of the date and time of the proposed work and make the necessary arrangements for the protection of the services and the safety of the public at his own cost.

16.1.6 The contractor shall give adequate notice of the commencement of work to occupiers of all properties to be traversed and shall at his own expense make good any damage caused to crops, fences, gates, gardens, walls, roads, or other property.

16.1.7 At all crossings of public roads, railways, telephone, telegraph and other power lines the provisions of the Factories, Machinery and Building Work Act, 1941, as amended, shall be complied with to the approval of the Engineer.

16.1.8 Prior to erection, the Representative of the Contractor shall ascertain from the Engineer which part of the work, and at what stage, he wishes to inspect and approve contract work from time to time. Adequate notice shall be given to the Engineer to enable him t carry out such inspections.

16.1.9 As each part of the Contract Works is erected the Engineer shall approve it. This particularly applies to the setting out, installation of buried earths, foundation construction, the levelling, aligning and adjusting of the various parts. No approval given by the Engineer will exonerate the Contractor from his contractual obligations or his guarantees under the contract.

16.2 Tenderer to inform himself fully

16.2.1 The onus is on the tenderer to inform himself fully as to details of the Work involved and Plant and Equipment required for carrying out the contract. Tenderers shall visit the sites to familiarize themselves with all conditions on site before Tenderers are submitted. Tenderers shall allow for all conditions on site. No claims for extras will be allowed whatsoever if Tenderers failed to allow for all costs and any conditions peculiar to the site.

17. INSTALLATION, ERECTIONAND SITE WORK

17.1 Excavations

17.1.1 Prior to tendering, Tenderers are to inform themselves fully as to the nature of the ground to be excavated throughout the route, as the cost of excavation shall be included in the unit price for the installation of foundations and structure earthing regardless of the type of material which will be encountered. It shall be distinctly understood that the Council will not be responsible for any variations in the strata and type of material and under no circumstances will be Contractor be paid an extra price due to such variations.

17.1.2 Any additional excavation in excess of the excavation required for the standard foundation, in order to establish suitable subsoil or bearing area, shall be approved by the Engineer, and shall be paid for at the unit rates for such excavations to be quoted in the Price Schedules.

17.1.3 The Contractor shall at his own expense provide means for maintaining the excavations for foundations in a dry state free from storm-water, seepage water or any other water.

17.1.4 The excavated material shall be stacked as compactly as possible, consistent with safety of workmen and the Works and the Contractor will be held responsible for making good at his own expense any damage caused by the excavation of such stacked material.

17.1.5 As soon as possible after the shuttering has been struck the foundation shall be back-filled in even layers of not more than 300 mm thick, each of which shall be well rammed down.

17.1.6 The foundations shall in all respects comply with the requirements of clause 10 of the specification.

17.2 Erection of towers and structures

17.2.1 No tower or structure shall be erected on any foundation within 14 days after being cast.

17.2.2 Prior to the erection of any conductors all towers and other structure shall be vertical within a tolerance of 0.3 per cent the total structure height measured at the top of the structure.

17.2.3 Earthing resistance shall be measured on all foundations prior stringing as described under clause 11 of the specification.

17.2.4 All bolts and nuts below 3 m above ground level shall be locked by punching with a heavy centre punch to make the removal thereof without special tools impractical.

17.2.5 After back-filling the concrete encasement cap and the base steelwork shall be treated as detailed under clause 10.2.4.

17.3 Stringing and sagging of conductors

17.3.1 The method of stringing, the utilization of conductor lengths to minimize the number of joints and the type of equipment to be used for erection shall be to approval. Come-along clamps used for stringing shall be of the proper size, especially on the OPGW. No joints will be allowed in the crossing spans over roads, railways, buildings, other power lines or important communications lines or in any strain section of three spans or less.

17.3.2 The Contractor shall satisfy the Council that he has wide experience in the erection of power lines of this nature. If in the opinion of the Engineer, the work I carried out in an inefficient and unsatisfactory manner, the Engineer shall have the power to order the Contractor to employ additional plant, tools, labour or anything he may see fit in order that the work may thereafter be executed in a proper and efficient manner at no extra cost to the Council.

17.3.3 The Contractor shall take all precautions to prevent excessive loading of towers during erection and shall provide any temporary staying of towers where necessary.

17.3.4 Rubber faced snatch blocks, scaffolding and/or other approved devices shall be employed during stringing to avoid any contract between the conductor and the ground or other obstructions. No extra charges for providing such equipment or manhandling of materials during abnormal stringing and sagging operations over buildings, other overhead services, roads, railways and communication circuits or other obstructions will be allowed.

17.3.5 The cut ends of all conductors shall be tied by wire binders and painted or treated in an approved manner to prevent oxidation and the ingress of moisture.

17.3.6 Vibration dampers and conductor spacers shall be installed as soon as possible after the erection of the conductors.

17.3.7 Suitable dynamo meters, sag scopes, sighting rods or other approved devices shall be provided by the Contractor for the proper checking of the work.

17.3.8 The sagging of conductors shall be done on the equivalent span method, whereby the tension of the strain section will be calculated for the equivalent span and the equivalent span length is calculated from the formula:

$$Le = \sqrt{\frac{L_1^3 + L_2^3 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. L_n^3}{L_1 + L_2 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. L_n}}$$

Where Le = Equivalent (or ruling) span length
L_1 = Length of first span in strain section
L_2 = Length of second span in strain section
L_n = Length of nth span in strain section

17.3.9 Phase conductors and earth wires shall be erected with such sags in still air that, at a conductor temperature of minus5°C and under maximum wind loading conditions and with the assumed maximum simultaneous work loads specified in clause 8, the failing strength of the conductor and failing loads of the tower, tower foundation, insulator sets or fittings are not exceeded whilst maintaining the minimum factors of safety specified in the Schedule of Basic Parameters, The everyday-stress in the conductor shall also not exceed 25% of the ultimate strength. The design maximum working tension in phase conductors and earth wires shall be stated in the Schedule of Particulars and Guarantees.

17.3.10 In calculating the sags and tensions for the different spans at erection temperature, due allowance shall be made for the elasticity and coefficients of expansion of the conductor materials.

17.3.11 In order to allow for any permanent settlement of the conductors after erection, the conductors shall be over-tensioned to approved curves and sag charts clearly indicating the initial and final sags and tensions at deferent temperatures of the line and earth conductors.

17.3.12 The Contractor shall submit for approval curves or tables showing the correct initial and final sags and tensions of the line and earth conductors at various temperatures and spans, the former making allowance for such permanent stretch as might take place in service.

17.3.13 The actual sag of any conductor shall not differ more than 3 per cent from the calculated sag for that span, and shall not differ by more than 100 mm from the mean of the sag of all the conductors in that span. For twin conductor lines the difference in sag of the conductors of a pair shall not exceed 30 mm. Any adjustments required to comply with these requirements shall be carried out by the Contractor at the end of the maintenance period at no extra charge to the Council.

17.3.14 The appropriate ambient temperature shall be determined by means of a thermometer inserted in the end of a 1.5 m section of conductor from which a 150 mm length of centre strands have been removed. The conductor with the thermometer inserted shall be hung at cress-arm level for at least two hours before the temperature is read.

17.3.15 The Contractor shall also be responsible to ensure that the mass carried by any suspension insulator string under the above tensions at minus 5°C in still air, be not less that the minimum weight span specified in the Schedule of Basic Parameters. If required, the Contractor shall prove this to the Engineer and shall be responsible for any alterations which may be required in order to comply with the above specified requirements.

17.3.16 The Contractor shall satisfy himself as to the correctness of all connections made between plant and apparatus supplied under this Contract and Plant and apparatus supplied under any other contract before any of the former is put into operation.

17.3.17 The carrying out of all work included in this contract shall be supervised throughout by a sufficient number of qualified representatives of the Contractor who have had thorough experience in the erection and operation of apparatus similar to that to be supplied.

17.3.18 Stringing of the optical fibre earth wire shall be done by the main contractor under the supervision of the OPGW supplier. The maximum permissible pulling tension for the offered OPGW and the pulley diameter for stringing shall be specified with the tender.

17.4 **Optical fibre work**

17.4.1 Joint boxes shall be mounted on the inside of the tower immediately above the anti-climbing device on a horizontal beam. The earth wire shall be properly clamped on the inside of the tower leg at 1.5 m intervals or less.

17.4.2 Where earth wires are specified to be insulated, the joint boxes shall be mounted on top of the earth wire tower cross arm.

17.4.3 All stringing clamps shall be installed with armour rods, to prevent damage on the inner aluminium tube. Bolts on all tension and suspension clamps shall be tightened with a torque wrench to the specified torque of the OPGW supplier.

17.4.4 The Contractor shall be responsible for jointing and shall, therefore be equipped with all the necessary specialised tools and test equipment and shall have staff capable of performing such a function.

17.4.5 The Tenderer shall describe the jointing method to be employed both on the optical fibre ground wire and the underground optical fibre cable.

17.4.6 The Contractor shall have a full after service facility so that the Council may call on these services with immediate response available to perform jointing and testing at the request of the council should this be necessary once the line is in service.

17.4.7 Where applicable each fibre optic splice shall have a loss of less than 0.15dB/joint.

17.4.8 The OPGW shall be terminated at each end in a tower mounted joint box. From this joint box, all optical fibres shall be extended into the respective substation or control room, as the case may be, by means of the required length of underground type optical fibre cable, laid from the outdoor termination box, through the substation yard in high density polythene pipes. The pipes shall be laid in the ground at a depth of 0.9m, where no ducts exist. The trench shall be backfilled and compacted in layers of 300 mm up to ground level. In the substation, or control room, the underground optical fibre in the indoor cubicle shall be spliced into a 5 m length of reinforced fibre pigtail, and where applicable, the fibre optic cores shall be terminated in an approved manner using type ST connectors.

17.5 **Incidental work**

17.5.1 If directed by the Engineer, the Contractor shall install access gates in fences on the power line servitude at the unit prices quoted in the Form of Tender.

17.5.2 Steel gates with tubular frames complying with the requirements of CKS.146:1972 shall be installed on steel posts with stays complying with the requirements of CKS.82:1973. All fencing wire used shall be galvanized in accordance with SANS 935:2007.

17.5.3 Facilities for locking the gate by means of a length of 10 mm chain and a padlock shall be provided. The padlocks will be supplied by the Electricity Department and the Contractor shall fit them. The chain shall be fixed to the gate post.

17.5.4 All posts and stays shall be set in concrete.

17.6 **Working in live yards**

17.6.1 Site work in energised (live) yards will only be permitted under cover of a Permit to Work, issued by the Chief Distribution Engineer (Operations) or his duly authorized representative and then only under such conditions as may be laid down in the said Work Permit. Work in live yards shall be carried out under the constant, direct and strict supervision of a competent responsible person so appointed in writing by the Contractor. In the above context “competent person” shall have the meaning as defined in Chapter I of the Regulations appertaining to the Machinery and Occupational Safety Act.

17.6.2 The contractor shall apply in writing for the necessary Work Permit(s) and shall submit with his application the following particulars:

17.6.2.1 Full name, designation and other particulars of the responsible person appointed by the Contractor together with a copy of his letter of appointment.

17.6.2.2 The date, time, period and detailed purpose for which access is required to each site or yard.

17.6.2.3 The names or identity numbers of all persons (including sub-contractor employees, if any) for whom access is required under the responsibility of the Contractor’s responsible person.

17.6.3 In order that the Council may make the necessary arrangements, each application for a Work Permit shall be submitted to the Engineer, together with all the required particulars, at least three full working days before access to the site or yard is required.

17.6.4 The Work Permit hall be made out to the contractor's responsible person who shall have the responsibilities and duties stipulated in Regulation C.1(6) issued under the Machinery and Occupational Safety Act who shall be responsible to see to it that the conditions laid down in the Work Permit are fully complied with by himself and all persons under his control.

17.6.5 When working in live yards the contractor shall ensure that all his workmen, employees and sub-contractors obey the Council's Safety Rules, a copy of which may be obtained from the Chief Distribution Engineer (Works).

17.6.6 With regard to safety, the Council in its own discretion may appoint one of its own employees to supervise safety aspects on a full or part time basis while work is carried out in live yards or in the vicinity of live equipment. The contractor's responsible person shall comply with, and shall see to it that safety instructions issued by the Council's supervisor, are complied with by all persons working under the responsibility of the responsible person.

17.6.7 On completion of the work in live yards the responsible person shall sign off the Work Permit and shall not leave the site without signing off the Work Permit and returning it to the issuer. Should the contractor fail to have this requirement strictly observed, he shall render himself liable to pay all direct and indirect costs which the Council may incur in having the Work Permit signed off, which cost may include the loss of revenue in respect of equipment remaining switched out or the purpose of giving the contractor access.

17.6.8 In the case of work to be carried out on existing power lines or equipment in operation or work to be carried out so close to existing live equipment that switching out is required, the contractor shall prepare a proposed programme of the work for discussion with the Council's Operation Staff, which programme shall be submitted for approval to the Engineer at least three weeks prior to the proposed access date. If required, the contractor of his duly authorized representative shall be present to discuss the proposed programme with the operation staff.

17.6.9 With regard to switching out of equipment to facilitate contract work to be carried out, it shall be distinctly understood that switch out dates, times and periods are subject to load and operational requirements. Operational and/or load requirements may dictate that contract work on the existing network be carried out over weekends or outside normal working hours, and the contractor shall therefore quote as an extra to contract for alterations to existing power lines to be carried out outside normal working hours.

17.6.10 For stringing new lines parallel and close to existing power lines, the contractor may apply for the nearest circuit on the existing line to be switched out to reduce induced voltages in the conductors to be erected. Should load and operational conditions permit it, the circuit will be switched out for such period(s) as it may be feasible but the Council reserves the right to switch back the circuit on very short notice to the contractor. Should it not be possible to switch out the nearest parallel circuit as contemplated above, the contractor shall take such safety precautions as may be required and provide such measures as the Engineer may direct to prevent damage to the existing line at no extra cost to the Council.

17.7 Security measures

17.7.1 Work inside electrical yards is subject to the Council's security measures and the contractor shall contact the Council's Chief Security Officer prior to the commencement of any work under the contract to make the required security arrangements. The cost of security measures shall be included in the rates for site work.

17.7.2 If so required by the Council, all employees of the contractor his subcontractors employed with regard to the execution of the contract shall be security cleared on such conditions as laid down by the Council.

17.7.3 Should any employee of the contractor or his subcontractor, for whatever security reasons, be declared unfit, the contractor or the subcontractor shall have the right to appoint any person in lieu of the employer who had been disqualified for security reasons, subject to the Council's security clearance.

17.7.4 The contractor undertakes –

17.7.4.1 To treat all information regarding the contract and the execution thereof as strictly confidential;

17.7.4.2 That he himself, his subcontractors and all employees concerned, will sign the Council's Declaration of Secrecy;

17.7.4.3 In the execution of the contract, to report to the Council's Chief Security Officer, without delay and confidentially, any information regarding:

1) Any suspected espionage in respect of the lay-out of the site where the work is being executed, or in respect of sites where protective measures are applied;
2) Actions which may be interpreted as sabotage, or any planning in this regard;
3) Any suspected subversive activities among these employees
4) The loss of any classified documents which came into his possession as a result of the contract
5) The contravening of any security measure by an employee
6) Housebreaking, theft, arson, vandalism, loss of identity documents, security keys or lock combinations
7) Corruption, blackmail, intimidation, striking or inciting or unauthorized access to an office or premises;
8) Any employee who has ties with a person who has recently come from a Communistic country, or who has relations with a person sympathizing with Communism; and
9) Any employee who is involved with the contract and who is suspected of bringing drugs, intoxicating liquor, a weapon, ammunition or explosives on the site of the Council.

17.7.5 The Council shall have the right to inspect, al all reasonable times, and through its Security Sub department, the contractor's and subcontractor's premises and offices where work in connection with the contract is executed or where documents in that connection are kept, in order to prescribe suitable security measures, and to determine whether the prescribed security measures are being implemented satisfactorily.

17.8 Storage of Materials

17.8.1 The contractor shall be solely responsible for all security arrangements for the safe storage of materials on site and the arrangements for the safe storage of materials on site and the arrangements for safe storage positions along the route. The Council will not be liable for any loss or damage of any materials or equipment whatsoever.

17.8.2 Prices for supply and delivery of materials shall allow for all rail age, transport, handling, loading and offloading on site.

17.8.3 The receiving on site of all materials and the handling thereafter is the responsibility of the contractor.

17.9 **Working hours**

17.9.1 Site work carried out for the execution of this contract, shall be confined, as far as possible, to normal working hours on normal working days (i.e. 07:00 – 17:00 on Mondays to Fridays) excluding Public Holidays.

17.9.2 Work to be done outside normal working hours shall be approved by the Engineer who shall be notified of the reasons in writing at least three working days in advance of any work to be done outside normal working hours.

17.10 **Clearing site**

17.10.1 On completion of the contract the contractor shall clear the site of all temporary offices, sheds, temporary structures and of all stumps, boulders, debris, surplus excavated material, waste material and rubbish. The contractor shall level off all ground on the site and shall reasonably prior to the commencement of such works, except where otherwise provided for, and shall leave the site in a clean and tidy order, to the satisfaction of the Engineer. Waste, rubble, rubbish and surplus excavated material shall be dumped at one of the Council's official dumping sites.

17.10.2 The cost of clearing the site shall be included in the various prices for work.

18. RECORDING

18.1 The contractor shall keep accurate records of the positions of all conductor joints, temperatures, sags and tensions for each strain section, the positions where counterpoise earthing is installed as well as tower types, extensions and positions of towers. On completion of the contract the contractor shall supply to the approval of the Engineer, fully marked-up transparencies of the profile drawings with all the complete schedules of particulars of all items used and installed on the line, for reference when repairs or modifications are to be made.

19. TESTS AND TESTING

19.1 **Testing general**

19.1.1 All materials and equipment supplied to this specification shall be tested in accordance with the requirements of the relevant Standard Specification referred to and in accordance with the requirements specified hereafter.

19.1.2 Notice of all testing shall be given to the Engineer in accordance with clause 69 of the Conditions of Contract.

19.1.3 All instruments required for testing shall be approved and if required, shall be calibrated at the expense of the contractor by the South African Bureau of Standards or such other body as may be approved.

19.1.4 Factory routine and sample tests shall be regarded as an integral part of the manufacturing of the various items and shall therefore be allowed for in the unit prices quoted for supplying.

19.1.5 Site and commissioning tests shall be regarded as an integral part of the installation of the various items and shall be allowed for in the unit prices quoted for installation.

19.1.6 Three copies of the manufacturer's records of all factory tests shall be furnished to the Engineer, immediately after such tests and before any material is shipped. No material shall be installed before these tests have been officially approved by the Engineer.

19.1.7 Three copies of the contractor's records of all site and commissioning tests shall be furnished directly to the city Electrical Engineer, P O Box 423, Pretoria, 0001, immediately after completion of such tests.

19.2 **Type tests**

19.2.1 The contractor shall satisfy the Engineer that the following equipment has been type-tested successfully, or is certified to have been type-tested successfully in accordance with the specified requirements laid down in the appropriate Standard Specification and if required by the Engineer, the Contractor shall furnish copies of the relevant type test certificates:

19.2.1.1 A.C.S.R. conductor to SANS 182-3: 2003 or BS 215 Part 2.
19.2.1.2 Earth wire and supplementary earthing conductor to SANS 182-3: 2003 or BS 183.
19.2.1.3 Insulators to SANS 61109:2008 or BS 137
19.2.1.4 Line fittings and clamps to SANS 178 or BS 3288
19.2.1.5 Galvanizing to SANS 763 and SANS 935:2007 or BS 729 and BS 443 (as applicable).

19.2.2 Type-testing of towers and supporting structures shall be to approval and shall be fully detailed in type test certificates.

19.2.3 Existing type test certificates will be considered on their merits and Tenderers are requested to submit copies of existing type test certificates with their tenders. Should reasonable doubt arise as to the validity of test certificates submitted after acceptance by the Engineer in relation to the equipment actually to be supplied, for example by virtue of modifications to the equipment, the Engineer may direct that a further certificate(s) be obtained on a sample unit(s) manufactured under the contract at the expense of the successful tenderer. Such further testing shall be carried out by an independent recognised testing institute.

19.2.4 If type-testing is to be done specifically for the purpose of this contract, testing shall be carried out in accordance with the following specified requirements by an independent recognised testing institute approved of by the Engineer at the prices to be inserted in the Form of Tender.

19.2.5 Type-testing of supporting structures

19.2.5.1 If required by the Engineer, one tower of each standard type, with or without base extension as specified, shall be assembled and erected at the approved testing station. Such towers shall be erected on a rigid test foundation and the erection shall be done consistent with the practice used on site.

19.2.5.2 Each tower shall then be subjected to such test loads as the Engineer may specify in order to prove compliance with the factors of safety stated in clause 8 in an approved manner, without showing signs of failure or permanent distortion in any part.

19.2.5.3 If required by the Engineer, tests to destruction shall then be carried out in an approved manner on all or any of the towers submitted for test.

19.2.5.4 Unless specially approved, steel towers submitted for test shall be galvanized.

19.2.5.5 No parts of any tower which has been submitted to test loads shall be used on the Contract Works.

19.2.5.6 Gantries shall be tested in a similar way.

19.2.6 Corona tests

19.2.6.1 If required by the Engineer, one suspension insulator set and one tension insulator set of each type (to be selected by the Engineer), complete with all fittings as in service and with insulator strings approved by the Engineer, shall be tested when clean and dry as follows:

19.2.6.1.1 A length of not less than 5 m of the specified conductor (or aluminium tubing with equivalent diameter; at the discretion of the Engineer) shall be fixed to the conductor clamp in the manner adopted in service. The tension set shall be supported vertically under a nominal tension of 1 000N parallel to and at a distance of 1 400 mm from an earthed vertical “wall”. The “dead” end of the et shall be earthed.

19.2.6.1.2 The test voltage shall be applied between the conductor and earth for not less than 10 minutes during which time the room shall be in complete darkness.

19.2.6.1.3 The voltage of any visible corona shall be noted with the aid of binoculars having 50 mm x 8 objectives.

19.2.6.1.4 No corona shall be visible on the fittings at any voltage below an applied voltage of 1.2 times nominal phase to neutral (earth) voltage.

19.3 Routine and sample tests

19.3.1 All routine and sample tests as laid down in the appropriate Standard Specification shall be carried out in accordance with the requirements of such Standard Specifications by the manufacturer at his factor (or at an alternative place of testing as specified or approved).

19.3.2 Samples of the materials for the towers and fittings shall be sample tested in accordance with the latest issue of BS 4360.

19.4 Fibre optic testing

19.4.1 A certificate giving the optical characteristics for each drum shall be submitted to the Engineer on delivery to site and thereafter the following tests on the fibre shall be performed.

19.4.1.1 TEST 1: Testing of the fibre per drum prior to stringing (continuity test).

19.4.1.2 TEST 2: Testing of the fibre after stringing (continuity test)

19.4.1.3 TEST 3: During jointing each connector loss (splice loss) shall be measured in dB using an optical time domain reflecto-meter (OTDR). The result shall be printed out and the corresponding distance and attenuation measurement determined from the plot.

19.4.1.4 TEST 4: A total test from both ends of the line including all joints. The object of the test is to measure the attenuation of each fibre from both ends including all fibre splices.

19.5 **Site and commissioning tests**

19.5.1 After erection of the towers but before any stringing operations, the contractor shall accurately measure and record the tower footing resistance of every tower and gantry installed under the contract.

19.5.2 The contractor shall carry out such site testing as the Engineer may reasonably call for to determine compliance with the specification, which testing shall be carried out in the present of the Engineer.

19.5.3 If so required by the Engineer, the contractor shall be available on site and shall render such assistance as the Engineer may reasonably require from him during commissioning of the equipment.

20. PAYMENTS, MEASUREMENTS AND RATES

20.1 **Payment general**

20.1.1 No invoices will be authorized for payment without the necessary substantiating documents to prove measurements or actual guaranties of work done as certified by the Engineer.

20.1.2 All payments shall be subjected to the "Terms of Payment" and shall be made in accordance with the Conditions of Contract. (See also clauses 12,17,75,76,77 and 78 of the Conditions of Contract)

20.1.3 Payments for conductors, towers and fittings will be adjusted for the actual measured and true quantities after completion of the work. Likewise progress payments will be made on application by the contractor (refer to clause 75 of the Conditions of Contract) for total quantities measured.

20.2 **Payment of clerk of Works**

20.2.1 The Council may appoint and pay a Clerk of Works for the specified period of the contract, as stated in clause 50 of the Conditions of Contract.

20.3 **Sum for plant and establishment**

20.3.1 The sum provided in the Price Schedule for plant, shall include for the supply, delivery, erection, maintenance and removal on completion, of all plant of every description together with all tools required for the complete carrying out of all work under this contract.

20.3.2 The Contractor's claim for the sum for plant and equipment will only be considered on completion of the contract provided no plant, equipment or labour has been withdrawn (without the Engineer's consent) from the contract, whereby completion of any part of the contract has been delayed.

20.4 **Measurement of work**

20.4.1 The measurements of lengths for the purpose of payment for conductors shall be to the nearest metre and shall be made by the contractor in the presence of the Engineer. These measurements shall normally be made along the centre line of the completed power line measured on ground level if suitably even or calculate as the straight line length between the centre lines of towers and no allowance shall be made for any sag. Measuring-up shall be subject to the provisions of clause 74 of the Conditions of Contract.

20.4.2 After inspection of any trenches required for supplementary earthing, (specified under clause 11) payment will be made on a basis of lineal metres of completed trench measured by the contractor in the presence of the Engineer after installation of the counterpoise cable but prior to back-filling. This payment for trenching shall include excavation, back-filling and reinstatement of the trench and shall be paid for as the installation of counterpoise as specified under clause 11.

20.4.3 Measurements of the mass of extra steel required shall be calculated from approved working drawings to the nearest kilogram, assuming a density for steel of 7,843 g/cc. These calculations shall be jointly made by the contractor and the Engineer.

20.5 Payment for foundations

20.5.1 The payment for foundations shall be at the unit prices for the applicable type of foundations quoted in the price schedules. These prices shall include the cost of soil investigations, excavations, drilling, provision and installation of earthing tapes (refer to clause 11.2), foundations steelwork and reinforcement, shuttering and/or templates as well as the dismantling thereof, the provision and installation of concrete and the proper back-filling and reinstatement of the excavations.

20.5.2 As specified under clause 17.1.1, no extra prices will be considered for foundation excavations due to changes in the types of materials to be excavated and no consideration shall be given to any claims for shuttering to be placed, as the Contractor is required to inform himself fully as to the nature of the materials to be excavated prior to tendering.

20.5.3 Excavation required in excess of that of the applicable standard foundation, in order to establish suitable subsoil, or bearing area, shall be measured and approved by the Engineer and shall be paid for at the appropriate unit rates for such additional excavations quoted in the price schedule.

20.5.4 The actual measured and approved quantities of all sub foundation filling as specified under clause 10.4.2 shall be paid for at the unit rate provided in the Schedule of Prices.

20.6 Payment for towers and fittings

20.6.1 All standard towers shall be paid for at the appropriate unit prices for towers quoted in the Schedule of Prices. The unit price for each type of tower shall include the following in accordance with the specified requirements:

20.6.1.1 Tower steelwork for standard towers including foundation steel and earth tape.

20.6.1.2 Bolts, nuts and washers.

20.6.1.3 Anti-climbing devices, climbing bolts, bird anti-perching guards, danger, property, number and phase plates and other tower accessories.

20.6.1.4 All line hardware such as the required number of insulator assemblies complete with insulator strings, shackles, links, sag adjusters, yokes and live-end arching horns, the required number of suspension clamps or strain clamps (compression dead ends), vibration dampers, jumper terminals, jumper loops, jumper spacers and all other conductor fittings for six phase conductors (single or twin as applicable) and two earth conductor suspension sets complete with suspension clamps or the required number of earth wire tension sets complete with earth wire tension clamps, bonding loops, earth wire terminals, and the required number of earth wire vibration dampers, all as required for the particular type of tower.

20.6.2 The above prices shall be based on the following:

20.6.2.1 Phase conductor insulator strings ……………………..… 10 discs only

20.6.2.2 Arching horns …………………………………………… Live end only

20.6.2.3 Earth wire assemblies ………………… without earth wire insulators

20.6.2.4 Vibration dampers ……. 1(one) per conductor on each side of tower

20.6.3 The unit rate for tower erection shall include the cost of measuring the tower footing resistance before stringing.

20.6.4 Should any additional items be required to a tower or its fittings, these quantities shall be approved by the Engineer and shall be paid for at the appropriate rate in the Schedule of Prices.

20.6.5 No payments will be made for any tower and its accessories prior to satisfactory completion by the contractor and inspection by the Electricity Department.

20.6.6 Where individual tower leg extensions are required on sloping ground, such extensions shall be measured in accordance with clause 20.4.3 and will be paid for at the rate for such steelwork in the Schedule of Prices.

20.6.7 Any special towers, major modifications to the main structure of standard towers or special foundations shall be approved by the Engineer and shall be paid for at the appropriate rates in the Schedule of Prices. Should provision not be made in the Schedules, the Tenderers shall advise and agree such rates with the Engineer beforehand, since failing to do so will result in the costs being taken as included in the normal prices and rates.

20.7 **Payment for time and material work**

20.7.1 Extra work which is ordered by the Engineer in writing and which is not covered by the contract shall be undertaken by the contractor on a day-work basis. Such day labour as may be required for such work shall be provided by the contractor at the rate(s) of wages inserted by the tenderer in the appropriate price schedule in the Form of Tender.

20.7.2 Where the contractor is required to supply material(s) in connection with such day-work as may be ordered, and no provision has been made in the price schedule(s) for the supply of such materials, the tenderer shall state in the Form of Tender the percentage over actual cost price on which the contractor agrees to supply such materials as may be required.

20.7.3 The contractor shall, when required by the Engineer, produce all variation orders, correspondence, quotations, invoices, vouchers and receipted bills, time sheets and any other particulars necessary to enable the Engineer to certify as to the correctness of claims for payment made in terms of this clause.

20.7.4 Vouchers specifying the time spent and materials used shall be delivered to the Engineer before the end of the week following that in which the work is carried out. Failure to comply with the requirement may render the claims liable to rejection.

21. DRAWINGS ISSUED WITH ENQUIRY

21.1 The drawings issued with the enquiry document for tender purpose are listed in Annexure II.

22. DRAWINGS & DESCRIPTIVE LITERATURE TO BE SUPPLIED BY TENDERERS

22.1 All Tenderers shall supply with their tenders paper copies of the following drawings relating to the equipment offered:

22.1.1 Dimensioned general outline and arrangement drawings for:

22.1.1.1 Each type of tower offered.

22.1.1.2 Available base and leg extensions for each type of tower offered.

22.1.1.3 Alternative cross-arm lengths available for each type of tower offered with alternative cross-arm lengths.

22.1.1.4 Each type and size of portal gantry offered.

22.1.2 Dimensioned and to scale clearance diagram clearly showing cross-arm arrangement, conductor to ground clearance and conductor to steelwork clearances in still air and under specified maximum conductor swing conditions for each type of tower and gantry structure offered.

22.1.3 Dimensioned drawings showing foundation lay-out and full details of foundations and foundation excavations for:

22.1.3.1 Standard block type foundations for each type of tower offered without and with base extensions up to the maximum height offered.

22.1.3.2 Block type foundations for each type and size of gantry column offered.

22.1.3.3 Special non-standard foundations offered (e.g. rock anchor foundations).

22.1.4 Dimensioned general arrangement drawing showing details, catalogue reference number and mass of each component, part or fitting in:

22.1.4.1 Double tension insulator assembly (set) for twin conductor line.

22.1.4.2 Tension insulator assembly (set) for single conductor line.

22.1.4.3 Suspension insulator assembly (set) for twin conductor line.

22.1.4.4 Suspension insulator assembly (set) for single conductor line.

22.1.4.5 Low duty tension set for twin conductor line.

22.1.4.6 Low duty tension set for single conductor line.

22.1.4.7 Reverse low duty tension set for twin conductor line.

22.1.4.8 Reverse low duty tension set for single conductor line.

22.1.4.9 Earth wire tension assembly (set).

22.1.4.10 Earth wire insulated tension assembly (set).

22.1.4.11 Earth wire suspension assembly (set).

22.1.4.12 Earth wire insulated suspension assembly (set)

22.1.4.13 Earth wire tension assembly (set) for OPGW.

22.1.4.14 Earth wire insulated tension assembly (set) for OPGW

22.1.4.15 Earth wire suspension assembly (set) for OPGW.

22.1.4.16 Earth wire insulated suspension assembly (set) for OPGW

22.1.5 Drawings showing the voltage gradient across each disc insulator unit in tension and suspension strings with arcing horn fitted to live end only and operating at system voltage.

22.1.6 Detailed drawings of:

22.1.6.1 Phase conductor tension clamp (compression type dead end).

22.1.6.2 Phase conductor suspension clamp

22.1.6.3 Earth wire strain clamp

22.1.6.4 Earth wire suspension clamp

22.1.6.5 Twin conductor line spacer.

22.1.6.6 Twin conductor jumper spacer.

22.1.6.7 Phase conductor mid span joint.

22.1.6.8 Phase conductor repair sleeve.

22.1.6.9 Phase conductor jumper terminal.

22.1.6.10 Earth wire mid span joint.

22.1.6.11 Earth wire terminal.

22.1.6.12 Counterpoise earth conductor terminal.

22.1.6.13 Phase conductor vibrat5ion damper.

22.1.6.14 Earth wire vibration damper.

22.1.6.15 Anti-perching guard.

22.1.6.16 Tower OPGW joint box.

22.1.6.17 Tower OPGW joint box with insulated gland plate.

22.2 Each Tenderer shall return with his tenderer one set of enquiry profile drawings on which his provisional power line design shall be shown with the positions and types of towers and types of extensions offered. The position and magnitude of maximum and minimum weight spans and wind span for both phase conductor and earth wire in respect of each span and individual tower shall be clearly shown for the provisional design.

22.3 Tenderers shall also return with their tenders one set of route plans on which the tower positions and types of towers with provisional tower numbers corresponding to his provisional design are clearly marked up.

22.4 Tenderers are invited to furnish such other drawings and descriptive literature as they may think fit with their tenders in amplification thereof.

22.5 Tenderers shall submit with their tenders the type test certificates and/or certified design certificates specified under Clause 9.1.10.

23. DRAWINGS AND LITERATURE TO BE SUPPLIED BY CONTRACTOR

23.1 The successful tenderer shall submit duplicate prints of the following drawings for approval to the Engineer, after which approval a durable set of transparencies of the said drawings, as approved, shall be supplied by the contractor for the permanent recodes of the Electricity Department not later than the delivery to site date of the equipment.

23.1.1 All drawings specified under clause 22.1 which drawings shall be to scale, fully detailed and show metric dimensions.

23.1.2 Fully detailed drawings to scale and showing metric dimensions of the following

23.1.2.1 Tower leg extensions to be used on the contract.

23.1.2.2 Arrangement of anti-climbing device on towers.

23.1.2.3 Arrangement of anti-climbing device on gantry columns.

23.1.2.4 Danger and property plate.

23.1.2.5 Town number and route identification plate.

23.1.2.6 Circuit identification plates or discs.

23.1.2.7 Phase identification plates or discs.

23.1.2.8 Full constructional details in respect of each type of tower and structure to be supplied showing the part and member reference codes or numbers called for in clause 9.4.2.

23.1.2.9 Erection information and drawings complete with structure lists detailing materials required for each tower or structure.

23.1.2.10 Special foundations or structures required under the contract.

23.1.2.11 Such other items of which the Engineer may require drawings.

23.1.2.12 Stress diagrams for all types of structures to be supplied.

23.2 Within two months of the contract being awarded, the contractor shall submit for approval a duplicate set of prints of profile drawings on which his proposed power line design together with all the relevant information called for in clauses 16.1.4 and 21.2 is shown. For this purpose a set of transparent surveyed ground profile drawings will be provided by the Council to the contractor. Within two months of completion of each separate section of line, the contractor shall supply a complete set of "as installed" profile drawings on durable plastic film for that section as approved by the Engineer.

23.3 The contractor shall also mark up on a set of route plans to be supplied by the Council the "as installed" final positions of towers.

23.4 The contractor shall also supply the other information to be recorded in terms of clause 18 in such form as the Engineer may approve. Counterpoise earthing installed by the contractor shall be shown in the strip plan on the profile drawings. A table listing the structure footing resistances shall be supplied.

23.5 The contractor shall supply two complete sets of profile templates to the Engineer before completion of the transmission line. The design and scales of the templates shall be to approval. If different templates are used for twin and single conductor lines, two sets for each type of line shall be supplied.

23.6 Before stringing the lines, the contractor shall supply the sag/tension curves/tables called for under clause 17.3.

23.7 **Drawings: general requirements**

23.7.1 All drawings, diagrams, sketches and plans to be supplied by the Contractor shall be clear, well laid out, of a high standard and in all respects subject to the approval of the Engineer. Legends, notes and descriptions shall be incorporated in each drawing or diagram or plan. Separate loose legend sheets or descriptions or other leaflets will not be acceptable.

23.7.2 The wording of drawing titles shall be to approval. The name of the manufacturer, supplier and/or contractor and the contract number shall appear prominently on all drawings, plans and diagrams.

23.7.3 Preference is given to drawing sheet sizes complying with the International A series within and including sizes A4 to A0.

23.7.4 All lay-out, constructional and detail drawings and all plans shall be to scale.

23.7.5 All drawings, diagrams or plans shall use S.I. metric units and the English or Afrikaans language.

23.7.6 Transparency drawings (sepias) shall be on durable transparency polyester film and shall render uncluttered prints.

23.7.7 The approval of drawings by the Engineer shall not relieve the contractor of his responsibility regarding the correctness there of, or of any subsequent failures as a result of faults or omissions by the contractor.

23.7.8 The cost of all drawings, diagrams and plans to be supplied on this contract shall be included in the tender price of equipment to be supplied. <u>The equipment will not be considered to be "delivered complete" if the drawings and certificates called for have not been supplied, which may result in payment being withheld.</u>

CITY of TSHWANE METROPOLITAN MUNICIPALITY
ELECTRICITY DEPARTMENT
SCHEDULE OF BASIC PARAMETERS FOR 300 /150 MVA POWER LINE
SPECIFICATION NO PL.60/0-93

CLAUSE	PARAMETER	VALUE / REQUIREMENT
24.1	General power line design requirements	
24.1.1	Nominal rated voltage (line-to-line); kV	132
24.1.2	Highest operating voltage (line-to-line) ;kV	145
24.1.3	Rated operating frequency; Hz	50
24.1.4	Power line insulation level at Pretoria altitude (1 530 m); kV (peak)	550
24.1.5	Number of three-phase circuits per tower	Two
24.1.6	Disposition of conductors on tower (per circuit)	Vertical
24.1.7	Vertical arrangement of conductors:	
24.1.7.1	Uppermost position wire	Earth
24.1.7.2	Top phase conductor	Red or blue phase
24.1.7.3	Middle phase conductor	Yellow phase
24.1.7.4	Bottom phase conductor	Blue or red phase
24.1.8	Conductor material and type of conductor to be used for phase conductors	A.C.S.R.
24.1.9	Code name of conductor	“BEAR”
24.1.10	Number of conductors per phase conductor for circuit rating of	
	a) 300 MVA	Twin “BEAR”
	b) 150 MVA	Single “BEAR”
24.1.11	Disposition of twin conductors	Horizontal
24.1.12	Centre line to centre line spacing of twin conductors:	
24.1.12.1	Tower to tower ……………………………. mm	380
24.1.12.2	Gantry spans ……………………………. mm	380
24.1.12.3	Down droppers ……………………………. mm	May be reduced to 330
24.1.12.4	Jumpers and jumper loops …………………... m	May be reduced to 330
24.1.13	Number of aerial earth-wires per tower …………….	Two
24.1.14	Position of earth-wires on tower …………………….	Above phase conductor
24.1.15.1	Stranded galvanized high tensile strength steel wire of number and diameter ……………. No / diameter mm	7/3, 251

24.1.15.2	Tensile strength of steel used in earthwire; MPa	1 060
24.1.16	Lightning protection angle:	
24.1.16.1	Outside shielding angle with no conductors swing (to vertical plane through earth-wire)	0° or negative
24.1.16.2	Outside shielding angle with maximum outward swing of top phase conductor	less than 30°
24.2	Optical fibre	
24.2.1	Number of fibres	-
24.2.2	Material of the tube	Aluminium
24.2.3	Type of fibre	Single mode
24.2.4	Optimum wave length of fibre …………………….. mm	1 300
24.2.5	Maximum average attenuation level ………… dB/km	0,5
24.2.6	Glass fibre core diameter error ………… micro meter	+/-1
24.2.7	Glass fibre cladding diameter error ……. Micro meter	+/-3
24.2.8	Core concentricity error …………………. Micro meter	1
24.3	Design spans	
24.3.1	Normal (or standard) span length; meter	300
24.3.2	Ruling (or equivalent) span length; meter	Varies
24.3.3	Maximum permissible single span length (unless specifically approved otherwise by Engineer) ; meter	510
24.3.4	Maximum wind span length; meter	330
24.3.5	Maximum weight span length; meter	600
24.3.6	Minimum weight span length on suspension towers with all conductors and earth-wires at minus 5°C in still air; meter	100
24.3.7	Maximum of sum of any two adjacent span lengths (unless specifically sanctioned otherwise by Engineer) without any line deviation at straight line towers; meter	600
24.4	Operating temperatures	
24.4.1	Minimum operating temperature of phase conductors; °C	Minus 5
24.1.2	Minimum operating temperature of earth-wires; °C minus 5	
24.4.3	Maximum normal operating temperature of phase conductor; °C	75
24.4.4	Maximum normal operating temperature of earth-wire; °C	4
24.5	Wind pressures	
24.5.1	Maximum wind pressure on each phase (horizontally at right angles to conductor centre line)	700 Pa on 0,6 of project conductor area
24.5.2	Maximum wind pressure on each earth wire (horizontally at right angles to conductor centre line)	700 Pa on 0,6 of project conductor area
24.5.3	Maximum wind pressure on steel lattice structure (including cross-arms or gantry times projected area of beam as applicable) (horizontally at right angles to centre line of power line)	700 Pa on 1,5 times projected area of all members on one face of structure exposed to wing
24.6	Tower loading	

24.6.1	Assumed maximum simultaneous working load on tower under normal balanced load conditions	See clause 8.3 of specification
24.6.2	Assumed maximum simultaneous working load on tower under unbalanced (broken conductor) conditions	See clause 8.3 of specification
24.7	<u>Safety factors : tower and supporting structures</u>	
24.7.1	Minimum factor of safety under balanced maximum simultaneous working load on supporting structure based on type tested failing load of structure	2,5 (See clause 8.3.5 of specification)
24.7.2	Minimum factor of safety under unbalanced maximum simultaneous working load on structure based on type tested failing load of structure specification	1,5 (See clause 8.4.4 of specification)
24.8	<u>Safety factor : foundations</u>	
24.8.1	Minimum factor of safety against overturning or uprooting under maximum simultaneous working load under normal balanced loading conditions	2,5
24.8.2	Minimum factor of safety overturning or uprooting under maximum simultaneous working load under maximum unbalanced loading conditions	1,5
24.9	<u>Safety factor : insulators and line fittings</u>	
24.9.1	Minimum factor of safety for insulators and fittings for phase conductors and earth-wires under maximum working load (worst case) based on type tested failing load of insulator or fittings as applicable	3,0
24.10	Minimum factor of safety with phase conductor operating at maximum tension (at minus 5°C and simultaneously subjected to maximum wind pressure of 700 Pa on 0,6 project area) based on rated ultimate tensile strength of phase conductor	2,5
24.10.1	Minimum factor of safety with phase conductor operating at maximum tension (at minus 5°C and simultaneously subjected to maximum wind pressure of 700 Pa on 0,6 projected ares) based on rated ultimate tensile strength of phase conductor	2,5
24.10.2	Minimum factor of safety with earth wire operating at maximum tension (at minus 5°C and simultaneously subjected to a maximum wind pressure of 700 Pa on 0,6 projected area) based on rated ultimate tensile strength of earth wire conductor ……………………..	2,5
24.11	<u>Conductor clearances to ground and other structures</u>	
24.11.1	Minimum conductor clearance under conditions of maximum sag at a conductor temperature of 75°C in still air with conductor swinging through any angle from zero degrees to 45°C from vertical	
24.11.1.1	To normal ground level within and outside townships and at all road crossings; meter	7,5
24.11.1.2	To road level at road crossings under broken conductor conditions (broken in adjacent span); meter	4,5
24.11.2	To railway formation level in spans crossing non-electrified railway lines; meter	11,2
24.11.3	To railway formation level in spans crossing electrified railway lines; meter	13,0
24.11.4	To conductors on railway electrification structures .. m	3,3
24.11.5	To buildings and other structures on which a person can stand unsupported; meter	4,5

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24.11.6	To communication lines, other power lines of a lower voltage or between power lines and cradles; meter	2,2
24.12	Minimum live metal to steelwork clearance	
24.12.1	Live metal to tower steelwork measured in any direction on suspension towers with insulator string hanging vertically (i.e. no swing) ; millimetre	1 500
24.12.2	Live metal to tower steelwork measured in any direction on tension towers with any line deviation angle up to maximum deviation angle with jumper loops hanging vertically (ie no swing) ; millimetre	1 500
24.12.3	Live metal to tower steelwork on suspension towers under maximum inward (transverse) insulator swing of 40° from the vertical ; millimetre	1 500
24.12.4	Live metal to tower steelwork measured horizontally on outside arms of angle towers erected at maximum line deviation angle under conditions of maximum inward jumper loop swing of 20° from vertical ; millimetre	1 300
24.12.5	Live metal to earthed steelwork or metal for all jumper loops other than line to line jumpers under no swing conditions ; millimetre	1 5--
24.12.6	Live metal to earth for all jumper loops other than line to line jumpers under conditions of maximum swing (assume 20° swing from position of equilibrium) ; millimetre	1 450
24.12.7	Minimum clearance between top phase conductor and earth wire ; millimetre	4 000
24.13	Minimum phase-to-phase clearance	
24.13.1	Minimum clearance between live metal of different phases ; millimetre	1 650
24.13.2	Minimum vertical clearance between phase conductors of same circuit ; millimetre	3 500
24.13.3	Minimum horizontal clearance in still air between phase conductors of opposite circuits on tower ; millimetre	6 500
24.14	Insulator parameters	
24.14.1	Insulator material	Polymer
24.14.2	Reference type number of disc insulator unit used in:	
24.14.2.1	Phase conductor normal tension strings (twin conductor)	U120BS/20
24.14.2.2	Phase conductor normal tension strings (single conductor)	U120BS/20
24.14.2.3	Phase conductor low duty and reverse low-duty tension strings (single and twin conductor)	U70BL
24.14.2.4	Phase conductor suspension strings (single and twin conductor)	U70BL
24.14.2.5	Earth-wire insulated tension set	U90-EWS
24.14.2.6	Earth-wire insulated suspension set	U90-EWS
24.14.3	Arcing horn gap setting on earth-wire insulator ; millimetre	10 1
24.14.4	Number of disc insulator units in insulator strings:	
24.14.4.1	Phase conductor normal tension string for single conductor	10
24.14.4.2	Phase conductor normal tension string for twin conductor	2 x 10
24.14.4.3	Phase conductor low duty and reverse low-duty tension string (single and twin conductor)	10

24.14.4.4	Phase conductor suspension string (single and twin conductor)	10
24.14.4.5	Earth-wire insulated tension set	1
24.14.4.6	Earth-wire insulated suspension set	1
24.15	Foundation parameters	
24.15.1	Assumed maximum density of earth; kg/mm^3	1 600
24.15.2	Assumed maximum density of concrete; kg/mm^3	2 200
24.15.3	Assumed maximum safe bearing pressure for sub soils under foundations for:	
24.15.3.1	Massively bedded fresh rock, igneous, metamorphic or sedimentary rock requiring blasting to remove; kPa	5 000

24.15.3.2	Fresh rock (fractured or jointed) and hard shale excavated with difficulty using pneumatic picks; kPa	1 000
24.15.3.3	Compact well graded gravels permanently above water table; kPa	400
24.15.3.4	Compact well graded gravels and soft shale from time to time below water table; kPa	200
24.15.3.5	Compact but poorly graded gravels, sands or mixtures thereof permanently above water table; kPa	200
24.15.3.6	Firm clays, sandy clays, sandy silts and silty sands permanently above the water table; kPa	By test only
24.15.3.7	Soft clays, sandy clays, sandy silts and silty sands; kPa	By test only
24.15.3.8	Loose sand and other poor non-cohesive soils	By test only
24.15.3.9	Make-up ground, waste dumps and the like	By test only
24.15.4	Assumed angle to the vertical of sides of inverted earth frustum resisting uplift for:	
24.15.4.1	Virgin cohesive soils; degrees	30°
24.15.4.2	Back-filled soil, loose sand, make-up ground and the like; degrees	0°
24.15.5	Maximum ultimate stresses allowable in concrete for foundation design under assumed maximum simultaneous tower loading conditions with a factor of safety of 2,5:	
24.15.5.1	Tensile stress in concrete due to bending; MPa	2,0°
24.15.5.2	Bond stress: galvanized steel to concrete; MPa	1,0°
24.15.5.3	Bearing stress of concrete made with ordinary Portland Cement; MPa	20
24.15.5.4	Punching shear stress; MPa	6
24.15.5.5	Diagonal shear stress; MPa	4
24.15.6	Minimum proportion of stub load to be provided for with cleats in concrete foundation	50%

PART C2.1 – PRICING INSTRUCTION

SECTION 5
SCHEDULE OF PARTICULARS & GUARANTEES

All Tenderers must complete the following schedules in full. Failure to provide the required detailed information called for in the schedules will result in the tender to be disqualified.

CONTENTS

8	**11kV Cable, Connection, Termination and Accessories:**	
8.1	**11kV Cable Connections between 132kV Transformers & 11kV Switchgear**	**Yes**
8.2	**Underground PVC-Insulated Multi-Core Control Cable**	**Yes**
8.3	**Termination and Connecting up of Cables & Cable Accessories**	**Yes**
8.4	**Trenching, Layout and the Installation of Multicore Cables**	**Yes**
8.5	**Medium Voltage Cable Sealing Ends, Terminations and Cables**	**Yes**
9	**Earthing:**	
9.1	**Earthing Grid**	**Yes**
10	**Transformer, NER and NEC:**	
10.1	**20 MVA Transformer**	**No**
10.2	**Neutral Earthing Compensators (NEC's) Combined with Neutral Earthing Resistors (NER's) and Auxiliary Power Transformers**	**No**
10.3	**35 MVA Transformer**	**Yes**
10.4	**Neutral Earthing Resistor (NER)**	**Yes**
10.5	**40 MVA Transformer**	**No**
10.7	**Repair and Refurbishment of Transformers and NEC**	**No**
11	**11 kV Switchgear:**	
11.1	**11kV Metal-Clad Switchgear**	**Yes**
11.2	**11kV Metal Enclosed Outdoor Switchgear**	**Yes**
12	**Protection and Control:**	
12.1	**Protection and Control Equipment**	**Yes**
12.2	**Addendum to Control and Protection**	**Yes**
13	**Auxiliary Equipment:**	
13.1	**Low Voltage AC Change-over and Distribution Panel**	**Yes**
13.2	**110 V Battery Charger**	**Yes**
13.3	**110 V Batteries and Battery Stands**	**Yes**
13.4	**Pilot Cable Termination Panel**	**Yes**

14 14.1	<u>Building and Civil Works</u>: Building and Civil Works	 Yes
15 15.1	<u>Electrical Installation of Substation Building, Yard Lighting and Lightning Protection</u>: Electrical Installation of Substation Building, Yard Lighting and Lightning Protection	 Yes
16 16.1	<u>Steel Lattice Construction Portal Type Gantries for Overhead Busbars</u>: Steel Lattice Construction Portal Type Gantries for 132 kV Overhead Busbars	 Yes
17 17.1	<u>Communications</u>: Optical Fibre Based Teleprotection- and Communications Equipment	 Yes
18 18.1	<u>SCADA</u>: SCADA Interface	 Yes
19 19.1 19.2 19.3	<u>Power Lines/Cables</u>: 132kV Overhead Power Lines 33kV Power Lines - General Quality Specification 132kV Underground Cables/Lines	 No No No

SECTION 5: SCHEDULE OF PARTICULARS AND

PART 1.3: QUALITY CONTROL / ASSURANCE

SPECIFICATION No: PT.61/0-2003 - Rev 2 (Previous No: PT.61/0-98)

1 All Tenderers shall complete the following schedules in full. Failure to provide the required detailed information called for in the schedules will cause a tender to be disqualified.

2 All information provided by the Tenderer, or specified by the Council and not qualified by the Tenderer will be regarded as offered and guaranteed by the Tender.

ITEM NO	DESCRIPTION	YES	PARTLY	NO
1	**PROCEDURE:**			
1.1	Have you a formal procedure for approval and implementation of design changes?			
2	**PRODUCTION PLANNING:**			
2.1	Do you provide written work instructions?			
2.2	Do they list the inspections required?			
2.3	Do you provide written quality and inspection			
3	**PURCHASING:**			
3.1	Have you a procedure for approving and checking the performance of sub-contractors?			
3.2	Do you specify minimum requirements for quality control by your sub-contractor?			
3.3	Do you check the quality control activities of your sub-contractors?			
3.4	Does your purchase documentation include drawings, specifications, quality standards and other requirements?			
4	**MANUFACTURING CONTROL:**			
4.1	Do you have written procedures for checking the accuracy of special manufacturing equipment?			
5	**INSPECTION STATUS:**			
5.1	Do you have a system for identifying the inspection status of work in progress?			
6	**FINAL INSPECTION AND TEST:**			
6.1	Are all items subject to final inspection and test to ensure compliance with contract requirements?			
6.2	Are the final inspection and test witnessed and approved by the Quality control Department?			

7	**CORRECTIVE ACTION:**			
7.1	Do you have written procedure for correcting deficiencies in quality?			
8	**CONTROL OF NON-CONFORMANCE MATERIAL:**			
8.1	Do you have formal procedures for the identification of defective items and for re-work, repair or disposal?			
8.2	Do you have a system for segregating defective items?			
9	**DOCUMENT AND CHANGE CONTROL:**			
9.1	Do you maintain a complete list of all documents, drawings and forms in current use?			
9.2	Have you a formal system for the issue and revision of drawings, documents, manuals, instructions and the like?			
10	**INSPECTION EQUIPMENT:**			
10.1	Have you an organization and facilities for the control, storage and calibration of all inspection and testing of equipment?			
11	**HANDLING, STORAGE AND DELIVERY:**			
11.1	Do you have separate storage areas for incoming material, work in progress and finished products?			
11.2	Is access to all stores restricted to authorized personnel?			
11.3	Are all items in the store identified and issued in rotation?			
11.4	Are items in store periodically inspected?			
11.5	Can the stored goods be traced back to material certificates, test reports and purchasing orders when required?			
11.6	Are packing instructions detailed?			
12	**RECORDS:**			
12.1	Do you record the satisfactory completion of inspection and quality checks?			
13	**REVIEW AND ASSESSMENT:**			
13.1	Do you regularly monitor all production planning and quality control functions?			

Eskom	Standard	Technology

Title: **OUTDOOR CIRCUIT BREAKERS FOR SYSTEM WITH NOMINAL VOLTAGES FROM 6.6KV UP TO AND INCLUDING 765KV STANDARD**

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Supported by SCOT/SC

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Plant Equipment SC Chairperson

Date: 22/9/2015

PCM Reference: **< 240-53459006 >**

SCOT Study Committee Number/Name: **< Plant Equipment Study Committee >**

Content

Figures

Tables

1. Introduction

This standard sets out Eskom's specific and standardised requirements for outdoor air-insulated circuit-breakers for use in three-phase 50 Hz alternating current systems with nominal voltages from 6,6 kV up to and including 765 kV. The requirements for circuit-breakers are based on SANS 62271-100 (High-voltage alternating-current circuit-breakers). The standard covers both live-tank and dead-tank circuit-breakers. The circuit-breakers may be specified with or without current transformers (CTs). The circuit-breaker designs that offer environmental friendliness and meet this standard shall be considered. These shall have been designed and type tested in accordance with IEC62271-100 standard.

NOTE: In special cases this standard shall be used for high voltage DC applications, e.g. traction, bypass bridges, DC-pole switching, whereby a separate technical schedule A and B shall be issued.

2. Supporting clauses

2.1 Scope

2.1.1 Purpose

This standard provides the specific and standardised requirements for outdoor air-insulated circuit-breakers in accordance with SANS 62271-100. The circuit-breakers are intended for use in substations having three-phase 50 Hz alternating current (a.c.) nominal operating voltages from 6,6 kV up to and including 765 kV. Circuit-breakers are required for general purpose power switching and protection applications as well as for special purpose applications such as the switching of earthed shunt capacitor banks, shunt reactors, capacitor-reactor combinations and generator unit synchronising. In special cases this standard shall be used for high voltage DC applications, e.g. traction, bypass bridges, DC-pole switching, whereby a separate technical schedule A and B shall be issued.

The standard covers both live-tank and dead-tank circuit-breakers. The circuit-breakers may be specified with or without current transformers (CTs). The circuit-breaker designs that offer environmental friendliness and meet this standard shall be considered. These shall have been designed and type tested in accordance with IEC62271-100 standard.

A set of technical schedules A and B accompanies this standard, which are as per Appendix B (Generic). Additional and special requirements are also included in schedule A.

The standard covers the design, manufacture, testing, supply, delivery, storage, installation, pre-commissioning and guarantee of circuit-breakers and associated equipment specified herein.

This standard includes the requirement for the full detailed maintenance analysis FMECA (Appendix D). It also includes the option of the digital secondary plant interface (Appendix C).

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

NOTE: IEC standards (including IEC documents adopted as SANS standards without changes)

[1] SANS 60137, Insulated bushings for voltages above 1000V

[2] SANS 60044-1, Current Transformers

[3] SANS 60044-6, Current Transformers – Part 6: Requirements for protective current transformers for transient performance

[4] SANS 60060-1, High-voltage test techniques — Part 1: General definitions and test requirements.

[5] IEC 60073, Basic and safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators

[6] IEC 60376, Specification of technical grade sulphur hexafluoride (SF6) for use in electrical equipment.

[7] IEC 60447, Basic and safety principles for man-machine interface, marking and identification – Actuating principles

[8] SANS 60529, Degrees of protection provided by enclosures (IP code)

[9] SANS 60815-1:2009, Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles.

[10] SANS 60815-2:2009, Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramic and glass insulators for a.c. systems.

[11] SANS 60815-3:2009, Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 3: Polymer insulators for a.c. systems.

[12] SANS 61462, Composite hollow insulators — Pressurized and unpressurized insulators for use in electrical equipment with rated voltage greater than 1 000 V — Definitions, test methods, acceptance criteria and design recommendations.

[13] SANS 62155, Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V.

[14] SANS 62271-1, High-voltage switchgear and controlgear – Part 1: Common specifications.

[15] SANS 62271-100, High-voltage switchgear and controlgear – Part 100: High-voltage alternating-current circuit-breakers.

[16] SANS 62271-110, High-voltage switchgear and controlgear – Part 110: Inductive load switching.

[17] SANS 62271-203, High-voltage switchgear and controlgear – Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV.

[18] SANS 62271-301, High-voltage switchgear and controlgear – Part 302: Dimensional standardisation of high-voltage terminals.

[19] SANS 62271-302, High-voltage switchgear and controlgear – Part 302: Alternating current circuit-breakers with intentionally non-simultaneous pole operation.

[20] Occupation Health and Safety Act (OHS Act) No 85 of 1993 – Construction and Electrical Machinery Regulations.

[21] NRS 029, Current transformers for rated a.c. voltages from 3,6 kV up to and including 420 kV (maximum voltage for equipment).

[22] NRS 087, Guidelines for the management of SF6 (sulphur hexafluoride) for use in electrical equipment.

[23] SANS 1091, National colour standard.

[24] IEC 6189-1, Instrument transformers – Part 1 General requirements

[25] IEC 61850/ SANS 61850 (All parts) Communication networks and systems for power utility automation

[26] SANS 62271-3/ IEC 62271-3 High-voltage switchgear and controlgear — Part 3: Digital interfaces based on IEC 61850

[27] 240-42066934 IEC 61850 Protocol implementation document for the purposes of substation automation

[28] 240-64685228 Generic specification for protective Intelligent Electronic Devices (IEDs)

[29] 240-68107841 Eskom IEC61850 standard requirements for PICS, PIXIT and TICS

[30] 240-68235024 Eskom IEC 61850 station bus interoperability test standard

[31] ESP 32-846: Operating Regulations for High Voltage Systems (ORHVS).

[32] 240-56062328, Distribution Standard Part 0: KIPTS natural ageing and pollution performance test procedure for outdoor insulator products section 0 – general requirements.

[33] 240-56062515 (DISSCAAK9), Distribution Standard Part 15: Specification for labels on control panels, relay panels and other indoor and outdoor equipment.

[34] DSP 34-1658, Distribution Standard Part 4: Corrosion protection specification for new indoor and outdoor Distribution equipment manufactured from steel.

[35] 240-56065202, Distribution Standard Part 7: Switchgear training requirements from original equipment manufacturers.

[36] 240-56030489, Distribution Standard Part 7: Standard requirements for the wiring of outdoor switchgear used in systems of nominal voltage up to and including 132 kV.

[37] QM-58, Supplier contract quality requirements specification.

[38] 240-56063765, Eskom health and safety management – supplier requirements.

[39] Technical Bulletin: 06TB-027: CAP's Requirements For KIPTS Test reports.

[40] DST_240-53902499, Standard for the transport, handling, storage and preservation of HV and MV switchgear.

[41] 240-56062864, Current transformers Eskom specific requirements up to 132kV in accordance with NRS 029 standard

[42] Appendix A – Supplier and Eskom's responsibilities

[43] Appendix B – Technical Schedules

[44] Appendix C – Technical Schedules for the digital secondary plant interface

[45] Appendix D – Maintenance Analysis

[46] D-DT-5200-1, Outdoor 132 kV circuit-breaker foundation details

[47] D-DT-5200-2, Outdoor 66/132 kV circuit-breaker support details

[48] D-DT-5201, Outdoor 66 kV circuit-breaker foundation details

[49] D-DT-5407, Wiring of outdoor circuit-breakers up to and including 132 kV

[50] 0.54/7471-0-0, 275 kV circuit-breaker foundation details

[51] 0.54/7472-0-0, 400 kV circuit-breaker foundation details

[52] 0.54/7479-0-0, 275 kV and 400 kV circuit-breaker support details

[53] 0.54/07529, Wiring of outdoor 220 kV, 275 kV, 400 kV and 765kV Live Tank circuit-breakers

[54] 0.54/8557, Wiring of outdoor 220 kV, 275 kV, 400 kV and 765kV Dead Tank circuit-breakers

[55] 240-46425564, Technical evaluation criteria for High Voltage Switchgear standard

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

Definition	Description
routine inspection	visual investigation of the principal features of the switchgear and controlgear in service without dismantling. **NOTES** a) This inspection is generally directed toward pressures and/or levels of fluids, tightness, position of relays, pollution of insulating parts, but actions such as lubricating, cleaning, washing, etc. which can be carried out with the switchgear and controlgear in service are also included. b) Observations resulting from inspection can lead to the decision to carry out an overhaul. c) As indicated in note 1 above, routine inspection may include scheduled maintenance activities in accordance with the manufacturer's maintenance manual. d) Routine inspection may also be referred to as 1st line maintenance. e) This is the definition of "inspection" given in 3.1.8 of SANS 62271-1.
minor maintenance	the execution of scheduled or preventive maintenance work in accordance with the manufacturer's maintenance manual and requiring the switchgear and controlgear to be taken out of service (i.e. in a down state). **NOTES** a) Observations resulting from minor maintenance can lead to the decision to carry out an overhaul. b) Scheduled maintenance is defined in 3.1.7 of SANS 62271-1. c) Minor maintenance may be time-based and/or condition-based. d) Minor maintenance may also include circuit-breaker examination (refer to 3.1.10 of SANS 62271-1) with diagnostic tests (refer to 3.1.9 of SANS 62271-1). e) Minor maintenance may also be referred to as 2nd line
major maintenance (overhaul)	work performed with the objective of repairing or replacing parts which are found to be out of tolerance by inspection, test, examination, or as required by manufacturer's maintenance manual, in order to restore the component and/or the switchgear and controlgear to an acceptable condition (within tolerance). **NOTES** a) This is the definition of "overhaul" given in 3.1.11 of SANS 62271-1. b) Major maintenance involves the execution of specialised maintenance where specialised knowledge and skills are required and is also sometimes referred to as specialised maintenance.
breakdown maintenance	unplanned (or unscheduled) maintenance work required to repair a fault and thus restore the switchgear and controlgear to an acceptable condition after a failure
specialised tools	any purpose-built tools that are necessary to carry out major (or specialised) maintenance on a circuit-breaker and its components
working clearance	straight line distance (clearance) from the closest live part at service voltage to ground level required to safely conduct work.
Intelligent Electronic Device (IED)	A device incorporating one or more processors with the capability to execute application functions, store data locally in a memory and exchange data with other IEDs (sources or sinks) over a digital link [IEC 61850-5].

Definition	Description
Process Interface Unit (PIU)	Also referred to as a 'digital merging unit' or 'binary input/output device'; an Intelligent Electronic Device (IED) that collects binary data from process devices, typically electrical primary plant equipment, by way of status contacts, and processes and publishes this data to other IEDs in a digital format (e.g. IEC 61580-based communication). The device similarly converts digital commands from other IEDs into electrical control signals to the primary equipment.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
AMSL	Above mean sea level
ARC	Auto re-closing
DN20	20 mm SF6 coupling. D = Diameter, N = Nominal and 20 = 20 mm inside diameter to determine the gas flow capacity. Coupling thread size is M 45 x 2
DN8	8 mm SF6 coupling. D = Diameter, N = Nominal and 8 = 8 mm inside diameter to determine the gas flow capacity. Coupling thread size is M 26 x 1,5.
OEM	Original equipment manufacturer
SCD	Specific creepage distance
USCD	Unified specific creepage distance
SPS class	Site Pollution Severity class
FMECA	Failure Modes, Effects and Criticality Analysis
ACSI	Abstract Communication Service Interface [IEC 61850-7-2]
GOOSE	Generic Object Oriented Substation Event [IEC 61850-8-1]

2.5 Roles and responsibilities

PDE HV Plant shall ensure that the approved standard is in place for use by Eskom.

The detailed list of Supplier and Eskom responsibilities are covered under Appendix A.

2.6 Process for monitoring

None

2.7 Related/supporting documents

Technical A & B schedules.

3. Specification for outdoor circuit-breakers for System with Nominal Voltages from 6.6kV Up To and including 765kV Standard

3.1 Ratings

3.1.1 Rated voltage (U_r) and number of phases

a) The rated voltage of circuit-breakers shall be in accordance with the values given in Table 2. The rated voltage required will be specified in schedule A. The rated voltage offered shall be stated in schedule B.

NOTE: The nominal system voltages (U_n) in Eskom are 6,6 kV, 11 kV, 22 kV, 33 kV, 44 kV, 66 kV, 88 kV, 132 kV, 220 kV, 275 kV, 400 kV and 765 kV.

NOTE: In special cases this standard shall be used for high voltage DC applications, e.g. traction, bypass bridges, DC-pole switching, whereby a separate technical schedule A and B shall be issued. The nominal system voltage for HVDC scheme is +/- 533kV DC, the Thyristor Bridges and poles are rated for 133.3kV DC.

b) The number of phases shall be three.

3.1.2 Rated insulation levels

The rated insulation levels of circuit-breakers shall be in accordance with the values given in Table 2. The rated insulation levels offered shall be stated in schedule B. No additional altitude correction factors need be applied for equipment installed up to 1800 m AMSL.

Table 2: Rated voltage and insulation levels

Nominal system voltage U_n [kV (r.m.s.)]	Rated voltage [kV (r.m.s.)]	Rated short-duration power-frequency withstand voltage U_d [kV (r.m.s.)] U_r		Rated lightning impulse withstand voltage U_p [kV (peak)]		Rated switching impulse withstand voltage U_s [kV (peak)]	
		Phase-to-earth and between phases	Across open switching device	Phase-to-earth and between phases	Across open switching device	Phase-to- earth and across open switching device	Between phases
6,6 & 11	12	28		95		-	-
22	24	50		150		-	-
33	36	70		200		-	-
44	52	95		250		-	-
66	72,5	140		350		-	-
88	100	185		450		-	-
132	145	275		650		-	-
220	245	395		950		-	-
275	300	395	435	1050	1050 (+170)	850	1275
400	420	520	610	1425	1425 (+240)	1050	1575
400	550[e)]	620	800	1550	1550 (+315)	1175	1760
765	800	830	1150	2100	2100 (+455)	1550	2480
+/- 533 DC	e)						

NOTES

a) In this table, the withstand voltages apply at the standardised reference atmosphere (temperature, pressure and humidity) in accordance with SANS 62271-1.

b) The information in this table is based on SANS 1019 and SANS 62271-1.

c) The specification of the insulation levels given in this table is based on the SANS 1019 philosophy – i.e. by the judicious selection of protective devices and their location with respect to equipment to be protected, it is generally possible to adopt the same insulation level for internal insulation and external insulation for equipment suitable for use at altitudes up to 1 800 m AMSL (Above Mean Sea Level). This enables manufacturers and users to adopt internationally accepted designs for use in South Africa.

d) No additional altitude correction factors need be applied for equipment installed up to 1800 m AMSL.

e) The circuit-breakers specified for 550kV rating shall be installed on Eskom's 400kV network upon special requirements. The circuit-breakers required for generator synchronising, shall be provided with proof of having passed the power frequency withstand (Wet conditions) in accordance with IEC 60060-1.

f) The circuit-breakers specified for DC application shall be installed on Eskom's +/- 533kV HVDC network upon special requirements. The voltage across open contacts is 133.3 kV DC rating.

3.1.3 Rated frequency (f_r)

The rated frequency shall be 50 Hz.

3.1.4 Rated normal current (I_r) and temperature rise

a) The rated normal current of circuit-breakers shall be 1600 A, 2500 A, 3150 A and 4000 A.

b) The rated normal current required will be specified in schedule A. The rated normal current offered shall be stated in schedule B.

c) The standard rated normal currents of circuit-breakers are given in Table 3.

Table 3: Standardised rated normal currents (I_r)

Nominal system voltage ***U*n** *[kV]*	**Rated normal current (I_r)** *[A]*				
	1600	**2000**	**2500**	**3150**	**4000**
6,6 & 11	x	-	x	-	-
22	x	-	x [b)]	-	-
33	x	-x	x [b)]	-	-
44	x	x	x [b)]	-	-
66	x	x	x [a)]	x [b)]	-
88	x	x	x [a)]	-	-
132	x	x	x [a)]	x [b)]	-
220	-	-	x	x	-
275	-	-	x	x	x
400	-	-	-	x	x [c)]
765	-	-	-	x	x
+/- 533 DC			1800 DC x [d)]		

NOTES

a) Required for Distribution substation applications (HV sub-transmission and MV Distribution networks). Rationalisation of a 3150 A circuit-breaker may be considered, when commercially viable.
b) Required for Transmission substation applications.
c) Same rating shall be applicable to the 550kV rated circuit-breaker requirement
d) For Eskom's +/- 533kV HVDC system requirement, the rated normal current shall be 1800A DC as a minimum. It shall be demonstrated if the circuit-breaker can carry the current of 3300A upon emergency or future requirements.

e) The associated temperature rise limits for the rated normal current given in Table 3 shall be in accordance with SANS 62271-1.

f) Based on the actual results of the circuit-breaker temperature rise type testing, the calculated maximum continuous current that the circuit-breaker can carry, without exceeding the maximum allowable temperatures for the major components, shall be stated in schedule B for a maximum ambient temperature of i) 40 ^{o}C and ii) 45 ^{o}C (refer to a)).

g) Based on the actual results of the circuit-breaker temperature rise type testing, the highest measured temperature rise values for the major components (refer to SANS 62271-1 Table 4) when carrying rated current shall be stated in schedule B.

3.1.5 Rated short-time withstand current (I_k)

The rated short-time withstand current of circuit-breakers shall be in accordance with the values given in Table 3. The rated short-time withstand current required will be specified in schedule A. The rated short-time withstand current offered shall be stated in schedule B.

3.1.6 Rated peak withstand current (I_p)

The rated peak withstand current of circuit-breakers shall be in accordance with the values given in Table 3. The rated peak withstand current required will be specified in schedule A. The rated peak withstand current offered shall be stated in schedule B.

3.1.7 Rated duration of short circuit (t_k)

The rated duration of the short circuit (t_k) shall be 3 seconds.

Table 4: Standardised rated short circuit-breaking, short-time and peak withstand currents

Nominal system voltage U_n [kV]	Rated short-circuit breaking and short-time (3 sec) withstand current I_{SC}, I_k [kA (r. m. s.)]	Rated peak withstand current I_p [kA (peak)]
6,6 & 11	20 / 25	50 / 62,5
22	20 / 25	50 / 62,5
33	20 / 25 / 31,5	50 / 62,5 / 78,75
44	20 / 25 / 31,5	50 / 62,5 / 78,75
66	20 / 25 / 31,5	50 / 62,5 / 78,75
88	20 / 25 / 31,5	62,5 / 78,75
132	25 / 31,5 / 40	62,5 / 78,75 / 100
220	31,5 / 40 / 50	78,75 / 100 / 125
275	40 / 50	100 / 125
400*)	50 / 63	125 / 157,5
765	50	125
+/- 533 DC **)	20	50

*) - denotes that both 420kV and 550kV rated circuit-breakers are required to meet this criteria
**) - denotes that the +/- 533kV DC rated circuit-breakers are required to meet this minimum criteria. The voltage across open gap is 133.3kV DC

3.1.8 Rated supply voltage of closing and opening devices and of auxiliary and control circuits (U_a)

a) The rated d.c. supply voltage (U_a) of closing and opening devices and of auxiliary and control circuits shall be 110 V or 220 V. The rated d.c. supply voltage required will be specified in schedule A.

b) The rated a.c. supply voltage (U_a) of heaters and other a.c. auxiliary circuits shall be single-phase 230 V.

3.1.8.1 Rated supply frequency of closing and opening devices and of auxiliary circuits

The rated supply frequency of heaters and other a.c. auxiliary circuits shall be 50 Hz.

3.1.9 Rated short-circuit breaking current (I_{SC}) of the circuit-breaker

a) The rated short-circuit breaking current (I_{SC}) of circuit-breakers shall be equal in value to the rated short-time withstand current (I_K) specified in Table 4. The rated short-circuit breaking current required will be specified in schedule A. The rated short-circuit breaking current offered shall be stated in schedule B.

b) Under certain system neutral earthing conditions, the single-phase (phase-to-earth) fault level may exceed the three-phase (phase-to-phase) symmetrical fault level and a higher single-phase-to-earth rated short-circuit breaking current may be required. The factor (up to 1,15) by which the 100 % symmetrical and asymmetrical single-phase rated short-circuit breaking current of the circuit-breaker exceeds the same three-phase rating will be specified in schedule A. The factor offered shall be stated in schedule B.

3.1.10 Transient recovery voltage related to the rated short-circuit breaking current of circuit-breakers

a) The first-pole-to-clear factor $_{(kpp)}$ for circuit-breakers used in systems of nominal voltage up to and including 132 kV shall be 1,5 in accordance with SANS 62271-100, i.e. as applicable to circuit-breakers used in non-effectively earthed systems. For circuit-breakers used in systems of nominal voltage above 132 kV, the first-pole-to-clear factor shall be 1,3 in accordance with SANS 62271-100, i.e. as applicable to circuit-breakers used in effectively earthed systems. The first-pole-to-clear factor shall be stated in schedule B.

NOTE: 44 kV to 132 kV networks are usually solidly earthed. However, in the interests of standardisation, due to the fact that certain 44 kV to 132 kV networks may be non-effectively earthed – a first-pole-to-clear factor of 1,5 is specified.

b) The standard values of prospective transient recovery voltages given in SANS 62271-100 shall apply according to the circuit-breaker class specified in Table 4 for the relevant circuit-breaker application and as defined in SANS 62271-100.

3.1.11 Rated short-circuit making current of circuit-breakers

The rated short-circuit making current of circuit-breakers shall be equal in value to the rated peak withstand current specified in Table 3. The rated short-circuit making current required will be specified in schedule A. The rated short-circuit making current offered shall be stated in schedule B.

3.1.12 Rated operating sequence for circuit-breakers

a) The following rated operating sequence shall apply to all three-pole operated circuit-breakers intended for rapid auto-reclosing. The rated operating sequence required will be specified in schedule A.

Three-phase auto-reclosing: O – t – CO – t' – CO (all poles), where t = 0,3 s and t' = 3 min.

NOTE: Preference will be given to circuit-breakers offered with a rated operating sequence where t' = 15s.

b) The following rated operating sequence shall apply to all single-pole operated circuit-breakers intended for rapid auto-reclosing. The rated operating sequence required will be specified in schedule A.

Single-phase auto-reclosing: O (one pole) – t – C (one pole) – O (all poles) – t' – CO (all poles), where t = 0,3 s and t' = 3 min.

NOTE: Preference will be given to circuit-breakers offered with a rated operating sequence where t' = 15s.

c) The following rated operating sequence shall apply to all circuit-breakers not intended for rapid auto-reclosing. The rated operating sequence required will be specified in schedule A.

O – t – CO – t' – CO (all poles) where t = t' = 3 min.

d) The rated operating sequence offered shall be stated in schedule B. The minimum resting time (in minutes) required, in order to ensure dependable interruption capability within the circuit-breaker's rated characteristics, following the rated operating sequence under the most unfavourable conditions shall be stated in schedule B.

e) All circuit-breakers, irrespective of whether they are intended for rapid auto-reclosing, shall be able to open-close-open before the closing spring needs to be charged again.

3.1.13 Characteristics for short-line faults

These characteristics are applicable to class S2 circuit-breakers (refer to Table 4) intended for direct connection to overhead lines in systems with a solidly earthed neutral and all circuit-breakers having a rated voltage of 100 kV and above. They are therefore applicable to all circuit-breakers for use in systems of nominal voltage above 66 kV. Refer to 4.105 of SANS 62271-100 for standardised characteristics for short-line faults.

NOTE: 44 kV to 132 kV networks are usually solidly earthed.

3.1.14 Rated out-of-phase making and breaking current for circuit-breakers

The rated out-of-phase breaking current required will be specified in schedule A in accordance with 4.106 of SANS 62271-100. The rated out-of-phase making and breaking currents of the circuit-breaker offered shall be stated in schedule B.

3.1.15 Rated capacitive switching currents for circuit-breakers

a) The classification of circuit-breakers according to their restrike performance for line- and cable-charging current switching shall be in accordance with Table 4 for the specified circuit-breaker application. The circuit-breaker class offered for line- and cable-charging current switching shall be stated in schedule B.

b) The rated line- and cable-charging breaking currents for circuit-breakers shall be in accordance with the preferred values given in SANS 62271-100.

c) If specified in schedule A, the circuit-breaker shall be classified as a class C2 circuit-breaker and shall be capable of switching capacitor banks with a very low probability of restrike during capacitive current breaking. In this case, the following requirements are applicable:

- the circuit-breaker shall be capable of switching single capacitor banks as well as back-to-back capacitor banks;

- the rated capacitor bank switching currents shall be in accordance with the preferred values given in SANS 62271-100. The circuit-breaker class offered, rated capacitor bank switching currents (i.e. the rated single capacitor bank breaking current, the rated back-to-back capacitor bank breaking current and the rated back-to-back capacitor bank inrush making current) and inrush current frequency shall be stated in schedule B; and
- all circuit-breakers supplied for capacitor-bank switching shall be capable of capacitor switching without the need for controlled opening and/or closing.
- shunt capacitor banks will either be connected to a substation busbar or will form part of another device such as a thyristor switched reactive power (VAr) controller (thyristor controlled reactors).

NOTES

- The backup circuit-breakers in the particular substations may not have adequate capacitive switching capabilities. This means that the circuit-breakers intended for shunt capacitor bank switching will have to be relied upon to satisfactorily and reliably (i.e. with a very low probability of restrike) switch the capacitive currents associated with the shunt capacitor banks.
- The shunt capacitor bank circuit-breaker will be required to switch more than once a day - in a single and/or back to-back situation of the rating specified - with up to three banks installed on a single substation busbar.
- For the sake of standardisation, preference will be given to general-purpose circuit-breakers offered that are capable of capacitor bank switching duties. However, special-purpose circuit-breakers will be considered.
- Current-limiting reactors will normally be installed by Eskom between the circuit-breaker and the shunt capacitor bank being switched in order to obtain transient currents of manageable proportions for the power capacitor elements as well as the circuit-breaker.
- The use of controlled switching to provide optimal capacitor-bank switching is recommended. Refer to 3.2.18.

3.1.16 Inductive load switching for circuit-breakers

No rating is assigned. Circuit-breakers shall be capable of switching shunt reactors and shall be designed to withstand re-ignitions. Refer to SANS 62271-110 (applicable only to three-phase alternating current circuit-breakers having rated voltages of 52 kV and above). The chopping number of the circuit-breaker offered shall be stated in schedule B.

NOTES

- The use of controlled switching to provide re-ignition-free shunt reactor switching is recommended. Refer to 3.2.18. In the absence of controlled switching, re-ignitions during opening of the contacts cannot be avoided due to the random operation (opening) of the circuit-breaker. By means of controlled opening, all poles of the shunt reactor circuit-breaker can be given a sufficiently long arcing time to ensure re-ignition-free interruption. The use of controlled switching will minimise high magnitude fast-fronted (steep) switching transients created during re-ignition events and will prolong the maintenance intervals of the circuit-breaker.
- Information obtained from tests conducted in accordance with SANS 62271-110, i.e. the circuit-breaker chopping number (used to determine the suppression peak overvoltage factor) and the re-ignition behaviour, can be used to correctly configure the controller.
- The maximum ratings of existing (earthed) shunt reactors are typically 40 MVAr to 50 MVAr at 132 kV, 100 MVAr at 400 kV and 400 MVAr at 765 kV (i.e. 133 MVAr per phase).

3.1.17 Rated time quantities for circuit-breakers

Refer to SANS 62271-100. The rated opening time, break-time, closing time, open-close time, reclosing time, close-open time and pre-insertion time (where applicable) of the circuit-breaker offered shall be stated in schedule B.

3.1.18 Number of mechanical operations for circuit-breakers

The number of mechanical operations of circuit-breakers shall be in accordance with the mechanical endurance class specified in Table 4 for the specified circuit-breaker application and as defined in SANS 62271-100. The circuit-breaker class offered shall be stated in schedule B.

3.1.19 Classification of circuit-breakers as a function of electrical endurance

The classification of circuit-breakers as a function of electrical endurance shall be in accordance with 5 for the specified circuit-breaker application. The circuit-breaker class offered shall be stated in schedule B.

Table 5: Classification of circuit-breakers (SANS 62271-100)

Circuit-breaker	Circuit-breaker application	Circuit-breaker class 3)	Electrical endurance 4)	Re-strike performance during capacitive current breaking (line- and cable- charging)	Mechanical endurance
11 kV, 1600 A, 20 kA[5)]	As per Technical A/B Schedule	S1	E2 [1)]	C1	M1
11 kV, 2500 A, 25 kA[5)]	As per Technical A/B Schedule	S1	E2 [1)]	C1	M1
22 kV, 1600 A, 20 kA[6)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
22 kV, 2500 A, 25 kA[6)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
33 kV, 1600 A, 20 kA[7)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
33 kV, 2000 A, 25 kA[7)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
33 kV, 2500 A, 31,5 kA[7)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
44 kV, 1600 A, 20 kA[7)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
44 kV, 2000 A, 25 kA[7)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
44 kV, 2500 A, 31,5 kA[7)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
66 kV, 1600 A, 20 kA	As per Technical A/B Schedule	S2	N/A	C2	M2
66 kV, 2000 A, 25 kA	As per Technical A/B Schedule	S2	N/A	C2	M2
66 kV, 2500 A, 31,5 kA	As per Technical A/B Schedule	S2	N/A	C2	M2
66 kV, 3150 A, 31,5 kA	As per Technical A/B Schedule	S2	N/A	C2	M2
88 kV, 1600 A, 20 kA	As per Technical A/B Schedule	S2	N/A	C2	M2
88 kV, 2000 A, 25 kA	As per Technical A/B Schedule	S2	N/A	C2	M2
88 kV, 2500 A, 31,5 kA	As per Technical A/B Schedule	S2	N/A	C2	M2
132 kV, 1600 A, 25 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
132 kV, 2000 A, 31,5 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
132 kV, 2500 A, 31,5 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
132 kV, 2500 A, 40 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
132 kV, 3150 A, 40 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
220 kV, 2500 A, 31,5 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2

Circuit-breaker	Circuit-breaker application	Circuit-breaker class 3)	Electrical endurance 4)	Re-strike performance during capacitive current breaking (line- and cable- charging)	Mechanical endurance
220 kV, 2500 A, 40 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
220 kV, 3150 A, 40 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
220 kV, 3150 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
275 kV, 2500 A, 40 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
275 kV, 3150 A, 40 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
275 kV, 2500 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
275 kV, 3150 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
275 kV, 4000 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
400 kV, 3150 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
400 kV, 3150 A, 63 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
400 kV, 4000 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
400 kV, 4000 A, 63 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
550 kV, 4000 A, 63 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
765 kV, 3150 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2[8)]	M2
765 kV, 4000 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2[8)]	M2
+/- 533kV DC [9)]	As per Technical A/B Schedule	N/A	N/A	C2[8)]	M2

NOTES

1. Class E2: Extended electrical endurance without auto-reclosing duty capability.
2. Class E2: Extended electrical endurance intended for auto-reclosing duty for overhead line feeder application.
3. Class S2 circuit-breakers (i.e. circuit-breakers intended to be used in line systems) are restricted to systems of rated voltages equal to or higher than 15 kV and less than 100 kV – in accordance with SANS 62271-100. Circuit-breakers for use at 11 kV are therefore classified as class S1 circuit-breakers. Class S2 circuit-breakers are specified due to the fact that they may be used in systems with direct connection to overhead lines / outdoor busbars without intervening cables. In the case where circuit-breakers are used in cable systems, class S2 circuit-breakers are suitable.
4. Class E1 and E2 circuit-breakers are restricted to distribution circuit-breakers of rated voltage up to and including 52 kV in accordance with SANS 62271-100.
5. Unless otherwise mention on the Technical A/B Schedules, the 11 kV 2500 A circuit-breaker is used for transformer and bus-section applications at 11 kV only. Unless otherwise mention on the Technical A/B Schedules, the 22 kV 1600 A circuit-breaker is for transformer, bus-section and feeder application at 22 kV.
6. The 33 kV 1600 A circuit-breaker is for transformer, bus-section and feeder application at 33 kV.
7. Cable-charging breaking current switching duties are not applicable to 765 kV circuit-breakers.
8. General-purpose circuit-breakers are required for transformer / bus-section / feeder applications.
9. For +/- 533kV HVDC scheme application, the current shall be 1800A DC. It shall be demonstrated if the circuit-breaker does have the capability of carrying up to 3300A for the system emergencies and future requirements.

3.2 Design and construction

NOTE: During the period covered by a particular contract or product acceptance cycle, the Supplier shall not make any changes to the equipment or materials without receiving approval from Eskom. All concessions shall be approved by Eskom. No changes will be permitted to the mounting details of the equipment or in other points of interfacing with Eskom standard structures. If the Supplier decides to make any changes to the agreed-upon design of the circuit-breaker, then the change(s), together with the reasons for making the change(s), shall be forwarded to the Eskom contract manager and relevant technical specialists in writing for approval (refer to 3.5.4 and QM-58 specification).

3.2.1 Service conditions

a) The normal service conditions for outdoor switchgear and controlgear specified in SANS 62271-1 shall apply. The following additional specific requirements shall be taken into account:

i. a minimum ambient air temperature of -10 °C;

ii. a maximum ambient air temperature of +45 °C (refer to 3.1.4 f));

iii. rapid temperature changes. The condensation of water vapour can take place within operating mechanism enclosures and hollow components. The average humidity is 95 %;

iv. wind velocity of 34 m/s (N);

v. solar radiation up to a level of 1 100 W/m^2 (on a clear day at noon);

vi. the circuit-breakers shall be installed up to altitudes of 1 800 m;

NOTE: Due (in part) to the fact that the switchgear and controlgear shall be used up to altitudes of 1800 m AMSL (Above Mean Sea Level), altitude-corrected insulation withstand levels are specified in this document. No further altitude correction factors are therefore required for altitudes above 1000 m AMSL in accordance with SANS 62271-1.

- the class of pollution characterising the site severity will be specified in schedule A in accordance with SANS 60815-1:2009 (e.g. class "e" corresponding to "very heavy"); and
- The class of corrosion characterizing the site severity will be specified in Schedule A in accordance and the details required under clause 3.2.6 shall be supplied with tender documentation.
- seismic activity up to 0,3g.

b) Circuit-breakers for use in systems of nominal voltage up to and including 132 kV shall be suitable for operation in systems that incorporate a non-effectively earthed neutral. Circuit-breakers for use in systems of nominal voltage above 132 kV shall be suitable for operation in systems that incorporate an effectively earthed neutral.

NOTE: 44 kV to 132 kV networks are usually effectively earthed. However, certain 44 kV to 132 kV networks may be non-effectively earthed.

3.2.2 General

Note: Notwithstanding the requirements on 3.2.2.1 below, the Supplier of the switchgear shall respond to the following with the tender documentation:-

- Full maintenance analysis FMECA of the compact switchgear assemblies unit as per Appendix D.
- Response to the Digital secondary plant interface option clauses 3.2.19.1 and 3.21.1 and Appendix C.
- Provide the detailed Factory Failure Rate (FFR) percentage over the period of 5 years.
- Provide information on On Time Delivery (OTD) percentage over the period of 5 years.
- Provide technical response to Non-Conformance (NCR's) percentage over a period of 1 year

3.2.2.1 The following are the requirements for the circuit-breakers:-

a) Outdoor circuit-breakers shall comply with the requirements of SANS 62271-100 and the requirements of this standard. In case of the dead-tank circuit-breakers, it shall also comply with the requirements of SANS 62271-203. Where conflicting requirements exist, the requirements of this standard shall take precedence.

b) Circuit-breakers shall be of the live-tank or dead-tank design. The type of design required will be specified in schedule A. The type of design offered shall be stated in schedule B.

c) Dead-tank circuit-breakers shall be supplied with integrated ring-type current transformers (CTs). CTs shall be located at the base of the outdoor bushings.

The compartment/ tank metallic enclosure shall be made of aluminium or aluminium alloys for all standard Eskom requirements, unless the requirement is for coastal application, a different specification metal shall be indicated on the Technical A schedule. Other metals for compartment/ tank metallic enclosures with their corrosion treatment method in accordance with clause 3.2.6 shall be shall be submitted with the tender documentation and will be subject to approval by Eskom.

d) Circuit-breakers shall be supplied complete with all the necessary components for the assembly. Live-tank circuit-breakers for use in systems of nominal voltage up to and including 132 kV shall be supplied suitable for a pole-beam support arrangement (two-column support with common base frame). Live-tank circuit-breakers for use in systems of nominal voltage from 132 kV up to and including 400 kV shall be supplied suitable for a three-column support arrangement. It will be specified in schedule A whether circuit-breakers shall be supplied with the steel support structure.

NOTES

- For further information relating to the Supplier's and Eskom's scope of responsibility, refer to Appendix A.
- For live-tank circuit-breakers for use in systems of nominal voltage up to and including 132 kV, the steel common base frame is supplied with the circuit-breaker (refer to c)). The circuit-breakers are supplied without the steel support structure columns (legs). Refer to Table 5 for further information on the standard Eskom support structure drawings.

e) Circuit-breaker operating mechanisms:

- Circuit-breakers shall be either three-pole ("3P") operated (i.e. single operating mechanism) or single-pole ("1P") operated (i.e. three operating mechanism), as specified in schedule A.
- Circuit-breakers shall be designed for stored energy operation where energy is stored in a spring, unless otherwise approved by Eskom. The spring-hydraulic operated mechanisms shall be considered for Dead-tank circuit-breakers with the rated voltages of above 145 kV. The spring-hydraulic operated mechanisms may be accepted for use in the Live-tank circuit-breakers with the rated voltages of 550 kV and 800 kV.

NOTE

i. Other hydraulic operated or pneumatic operated mechanisms will not be accepted for all voltages.

- It shall be possible to charge the circuit-breaker operating mechanism spring both manually and electrically. Electrical charging shall be via a spring charging motor, unless otherwise approved by Eskom. Both manual and electric energy release shall be provided. The mechanical energy stored in the charged spring shall be stated in schedule B. A mechanical device shall be provided to prevent over-charging of the closing spring when the manual charging facility is employed.
- Operating mechanisms shall be designed in such a way that in the case of failure to latch or of a command to trip during a closing operation, safe conditions are produced for the elements controlling the circuit-breaker.
- When a feeder circuit-breaker is in the closed position and the spring has been charged, it shall be able to "TRIP-CLOSE-TRIP" before the spring needs to be recharged

f) The insulation and/or extinguishing medium of the circuit-breaker shall be either SF6 gas or environmental friendly medium. The type of interrupting and insulation and/or extinguishing medium technology offered shall be stated in schedule B. For SF6 gas circuit-breakers, the type of interrupter design (e.g. puffer, self-blast, etc.) as well as the configuration of the moving contacts (e.g. single, double or triple motion design) shall be stated in schedule B.

NOTE

i. The circuit-breaker designs that offer environmental friendliness and meet this standard shall be considered. These shall have been designed and type tested in accordance with IEC62271-100.

g) Circuit-breakers shall be designed for minimal maintenance in accordance with the electrical and mechanical endurance class as specified in 5. The minimum expected lifespan shall be 40 years. Premature failures experienced in service of similar design circuit-breakers supplied elsewhere by the manufacturer shall be made known to Eskom, together with the recommended modifications. This information shall be provided with the tender documentation (refer to 3.2.23.1).

h) Dead-tank circuit-breakers detailed information on how CT's are accessed for primary injection testing and CT replacement, without having to interfere with the SF6 circuit shall be provided with the tender documentation.

3.2.3 Construction requirements

The design and layout of the circuit-breaker, including control cable interfacing, shall facilitate installation with a minimum of on-site assembly work. The degree of assembly work in the factory shall be optimised such that on-site installation work is minimised. The following principles shall apply to the design of the equipment:

a) the various elements of the circuit-breaker shall be standardised. Standardisation of parts shall be pursued;

b) modular, pre-assembled elements shall be designed to facilitate handling and installation;

c) the equipment shall be designed to facilitate construction and maintenance activities for personnel; and

d) SF6 filter material housing shall be located (at the circuit-breaker pole) in such a manner so as to provide easy access when maintaining the unit.

3.2.4 Circuit-breaker operating mechanism enclosure requirements

a) Circuit-breaker operating mechanisms, local control facilities and all parts requiring lubrication shall be protected by weatherproof enclosures. The degree of protection provided by these enclosures shall comply with the following minimum requirements in accordance with SANS 60529. The degree of protection offered shall be stated in schedule B.

- enclosures containing exposed bearings, auxiliary switches, motors and other electrical devices shall comply with IP 55 (i.e. operating mechanism enclosure);
- where applicable, all open areas in the circuit-breaker common base frame as well as externally mounted indicating devices where there is a high probability of birds nesting, shall be suitably covered to IP 2X; and
- all other enclosures provided shall comply with IP 54.

b) The operating mechanism enclosure, handles and fixings shall be manufactured from 3CR12 stainless steel with corrosion protection in accordance with 3.2.6. The use of factory painted aluminium shall be considered if corrosion protection is in accordance with 3.2.6, and no parts exposed. The mechanism enclosures of the exposed aluminium shall not be acceptable.

c) Operating mechanism enclosures shall be arranged to facilitate easy access for inspection and scheduled maintenance which may include permissible in-situ cleaning, lubrication, repairs and adjustments to the operating mechanism. Any removable covers provided shall have bolt fastenings, subject to Eskom approval. All bolts shall be inherently corrosion resistant and have hexagon heads. Self-tapping screws, captive head nuts or cage nuts are not acceptable.

d) The circuit-breaker shall be designed for operation from the front of the operating mechanism enclosure.

e) Access to the operating mechanism enclosure(s) shall be through a hinged access door allowing accessibility to components installed in the enclosure (e.g. control levers, push-buttons, MCBs and secondary wiring terminal strips) in accordance with SANS 62271-1.

f) In the case of circuit-breakers for use in systems of nominal voltage up to and including 132 kV, servicing shall be possible from the ground level. In the case of circuit-breakers for use in systems of nominal voltage above 132 kV, where the servicing level may be above ground level, it shall be possible to view all circuit-breaker status indications and make necessary readings from the ground level. Details of special equipment required (including inspection platforms) to fulfil this requirement shall be provided with the tender documentation (refer to 3.2.23.1).

g) The front access door shall be secured with a heavy-duty locking mechanism.

h) The operating mechanism enclosure shall be capable of being padlocked to prevent unauthorized access. The locking facility shall accommodate padlocks that have a shackle diameter of 6 mm

i) The front access door of the operating mechanism enclosure shall be equipped with a travel stop, which shall retain the door in the open position. The facility shall be robust enough to withstand the force of wind in accordance with 3.2.1.

j) A rigid, corrosion resistant, documentation pocket shall be provided for the safe-keeping of all relevant documentation (i.e. the installation, operating and maintenance instructions for the circuit-breaker and all routine test certification), on the inside of the operating mechanism enclosure front access door. The documentation pocket shall be securely attached and the means used (e.g. pop rivets) to secure the pocket shall not protrude through the door.

k) Suitable facilities for storage and securing of the hand-operating tool(s) shall be provided on the inside of the operating mechanism enclosure front access door.

l) Earthing of the operating mechanism enclosure shall be via the steel support structure (e.g. via the common base frame and support legs or via the steel column support). If additional / visual earthing is required for the operating mechanism enclosure, all earthing terminals, fastenings and conductors shall be supplied and fitted by the Supplier and will be subject to approval by Eskom. In the latter case, the conductors shall be kept as short as possible and the earthing terminal on the operating mechanism enclosure shall be located towards the top of the enclosure housing. Earthing conductors shall be manufactured using galvanised steel. A 30 mm long, Ø25 mm (min) metallic boss, with an M12 thread throughout and welded to the equipment shall be used for all external earthing conductor fastenings. The boss shall be fitted with a M12 x 25 mm long setscrew, washer and spring washer. The boss and the setscrew on the enclosure shall be stainless steel of grades 304 and 316, respectively, unless otherwise approved by Eskom. The boss and the setscrew on the circuit-breaker steel support structure (e.g. the common base frame or the steel column support) shall be galvanised steel.

NOTES: The use of copper or aluminium is considered to present a theft risk and will not be accepted if metal is visually exposed. Such method shall meet clause 3.2.6. The proposal to prevent visual exposure shall be presented to Eskom for approval with the tender documentation.

m) Operating mechanism enclosures shall make provision for the entry of Eskom control cabling from below. Refer to c) for the requirements of the control cable entry gland plates. All circuit-breaker cabling (i.e. to / from density monitoring devices and between poles) shall also enter the operating mechanism enclosure(s) from below, unless otherwise approved by Eskom.

NOTE The use of plug-in type cable is not acceptable. Eskom prefers the normal gland plate and terminations made on terminals.

n) Where applicable, metallic cable racking used to mechanically protect and/or support circuit-breaker cabling (e.g. inter-pole cabling) shall be manufactured using galvanized steel, unless otherwise approved by Eskom.

NOTES

- The use of aluminium cable racking is considered to present a theft risk and will not be accepted.
- Where Eskom support structure legs are provided, no provision is made for securing or mounting inter-pole cable racking on the legs - requiring the (armoured) inter-pole cabling to be buried in the ground in accordance with 240-56030489, unless otherwise approved by Eskom.
- The use of plastic material cable ties shall not be accepted.

o) Upper surfaces of enclosures shall be shaped or sloped to prevent the accumulation of water.

p) Gaskets shall be made of neoprene rubber, nitrile rubber or cork, unless otherwise approved by Eskom. Felt or natural rubber gaskets are not acceptable. The gasket material offered shall be stated in schedule B.

q) A gauze-covered drain hole with a minimum diameter of 25 mm and having no internal rim or ledge that is likely to obstruct drainage shall be provided at the lowest point of the operating mechanism enclosure.

r) Suitable lifting eyes shall be provided at the top of the operating mechanism enclosure. The lifting eyes shall be designed to provide for the lifting of the complete operating mechanism enclosure. Lifting eyes with a minimum diameter of 30 mm shall be provided.

s) The colour for the enclosure shall be "light grey" (G29) in accordance with SANS 1091 unless otherwise specified in schedule A or approved by Eskom.

t) All circuit-breakers shall be fitted with a mechanical trip facility which does not require any voltage to operate and must be located inside the mechanism enclosure. It shall be clearly marked with warning labels.

3.2.5 Circuit-breaker support structure and foundation

a) The following mechanical loads and parameters relating to the design of the circuit-breaker support structure and foundation shall be stated in schedule B and be shown on the general arrangement drawing (refer to 3.2.23.1):

- "static" dead weight of the circuit-breaker (N);
- the rated "static" terminal forces F_{shA}, F_{shB} and F_{sv} (loads) of the circuit-breaker (N) due to connected conductors;

NOTE: Static terminal loads (forces) due to flexible and tubular conductors (not including wind, ice load or the dynamic loads on the circuit-breaker itself) can be assumed to be in accordance with Table 14 of SANS 62271-100. Refer to 6.101.6 of SANS 62271-100.

- "dynamic" horizontal force (load) exerted during operation on the foundation (N);
- "dynamic" vertical force (load) exerted during operation on the foundation (N);
- "dynamic" moment (torque) exerted during operation about the foundation (Nm);
- "dynamic" horizontal force exerted between circuit-breaker poles (centre phase interrupter chamber) during a rated (terminal fault) short-circuit (N);
- wind force (load) exerted on the circuit-breaker due to a wind velocity of 34 m/s (N);
- maximum torque required for the foundation holding down bolt nuts used to secure the support structure column to foundation (Nm);
- mounting and fastening arrangement for the circuit-breaker support structure onto the foundation including the minimum required length of foundation holding down bolts; and
- centre of gravity of the circuit-breaker.

b) If specified in schedule A, the steel support structure and/or concrete foundation shall be designed by the manufacturer. A drawing showing the steel support structure and concrete foundation design details shall be provided with the tender documentation (refer to 3.2.23.1) and the drawing number(s) shall be stated in schedule B.

The steel support shall be designed according to the following requirements (if part of the supply):

- Steel shall be in accordance with SANS 1431
- Steel shall be Grade 350W
- Steel shall be hot-dip galvanised in accordance with SANS 121
- Welding shall conform to the requirements of SANS 10044.
- Welds shall be seal welded.

- Steelwork shall be fabricated, erected and leveled to a tolerance of ±1.5mm.
- Bolts and nuts shall be in accordance with SANS 1700:5.
- Bolts and nuts shall be Grade 8.8.
- Bolts, nuts and washers shall be hot-dip galvanised in accordance with SANS 121.
- Holes shall have diameter of 18mm for M16 bolts.
- All works shall comply with the requirements of SANS 1200

c) In the case of live-tank circuit-breakers for use in systems of nominal voltage up to and including 132 kV, the circuit-breaker common base frame (i.e. for a pole-beam support arrangement) shall be supplied with the circuit-breaker and designed to interface with the standard Eskom steel support structure and concrete foundation in accordance with the drawings specified in Table 5.

d) Unless it is specified in schedule A that the steel support structure and/or concrete foundation is to be designed by the manufacturer, the circuit-breaker shall be designed to interface with the standard Eskom steel support structure and/or concrete foundation in accordance with the drawings specified in Table 5.

e) If specified in schedule A, in the case of circuit-breakers for use in systems of nominal voltage up to and including 33 kV, galvanised steel surge arrester mounting brackets shall be provided and fitted adjacent to each circuit-breaker pole. The minimum surge arrester mounting bracket interface dimensions shall be 70 x 70 mm. Each surge arrester mounting bracket shall be provided with a pre-drilled 14 mm diameter hole for mounting the surge arrester. Each surge arrester mounting bracket shall be designed with a suitable clearance to accommodate a surge arrester having a M12 x 50 mm mounting stud. The surge arrester mounting brackets shall be used as the surge arrester discharge path to earth and shall be electrically bonded to the circuit-breaker base frame. The surge arrester mounting brackets shall be designed to carry the rated fault current and the interfacing surface shall not be painted.

NOTE: Surge arrester mounting brackets may only be required for medium-voltage applications.

Table 6: Eskom standard civil design drawings for outdoor live-tank circuit-breaker steel support structures and concrete foundations

System voltage *[kV]*	Steel support structure drawing number (live-tank circuit- breakers)	Concrete foundation drawing number (live-tank circuit- breakers)
11, 22 and 33	TBA[1)]	TBA[1)]
44 and 66	D-DT-5200-2	D-DT-5201
88 and 132	D-DT-5200-2	D-DT-5200-1
220 and 275	0.54/7479-0-0	0.54/7471-0-0
400	0.54/7479-0-0	0.54/7472-0-0
765	TBA[1)]	TBA[1)]
+/- 533 DC	TBA[1)]	TBA[1)]

NOTES
1. Standardised drawings are not (yet) available.
2. These drawings shall be applicable to equipment with the higher rated voltages

3.2.6 Corrosion protection and lubrication

a) All exposed metal shall be protected against corrosion in accordance with DSP 34-1658 for outdoor “high” to “very high” ‘C4’ and ‘C5’ (i.e. marine) corrosivity rating environments.

b) The minimum detailed specification (“DS”) for all exposed metal in accordance with DSP 34-1658 shall be “DS-11” (3CR12), ‘DS-18 (Stainless steel) and ‘DS-13” (Hot-dip galvanised).

NOTE: Plastic or fibre-reinforced plastic materials for operating mechanism enclosures, or other applications where exposure to the elements is involved will be not accepted.

c) The corrosion protection system (i.e. the equivalent detailed specification "DS" number in accordance with DSP 34-1658) offered by the manufacturer for the following components shall be stated in schedule B. Details shall be provided with the tender documentation (refer to 3.2.23.1):

- enclosures;
- nuts, bolts, studs and washers;
- structural steel (i.e. common base frame, support structure legs, etc.); and
- other exposed metal (excluding main terminals).

- The detailed material and Corrosion Protection Information in accordance with the Table 6 below whall be provided by the Supplier with the tender documentation the information on each supplied live-tank circuit-breaker and dead-tank circuit-breaker type as specified below:-

Table 7: Material and Corrosion Protection Information

Material and Corrosion Protection Information		
Eskom specified requirements	**To be completed by Supplier**	**Completed Example**
Item or part Description		*Support bracket*
Drawing number		*DEMO1*
Material type		*EN8*
Material grade		*(BS 970 080M40)*
Type of corrosion protection		*HD galvanising*
Minimum thickness of protective coating		*85 micro*
Verification tests carried out on coating e.g. Thickness with thickness gauge		*6 measurements along profile*
Expected life of coating (Industry/marine)		*Marine = 5 years Industry = 8 years*
Maintenance frequency of protection coating		*Repair installation damage on commissioning and thereafter once a year*
Maintenance type of protection coating		*Patch repair with Zincfix*
Bi-metallic corrosion prevention		*Coat both sides*
Crevice corrosion prevention		*Seal with crevice with Zincfix*
Item or part weight in Kilogram		*7kg*
Field experience		*Equipment used at coast in USA*
Remarks/General comments		*Debris, scratches and indentation have been removed prior to galvanising.*

d) The behavior of lubricants that are exposed to air, SF6 gas and its arcing products shall be stable over the intervals between maintenance. The Supplier is required to identify the lubricants used and to submit details with the tender documentation (refer to 3.2.23.1) of tests carried out to prove suitability for the application. If possible, a list of equivalent lubricants from South African sources shall be provided. All liquids or chemicals shall be supplied with Material Safety Data Sheets (MSDS).

e) For all circuit-breaker types, the Supplier shall give details with the tender documentation (refer to 3.2.23.1) of the measures taken to prevent flange corrosion. These details shall include drawings of the flange arrangements, treatments and service experience.

f) Material and Corrosion Protection Information

The Supplier shall provide with the tender documentation the information on each supplied equipment type specified below: Circuit-breaker operating mechanism enclosure heaters

i. Suitably rated electric heater(s) shall be installed to prevent moisture condensation inside the circuit-breaker operating mechanism enclosure. The heater size offered shall be stated in schedule B.

ii. Heaters shall maintain a dew-point greater than the ambient temperature and shall circulate the air constantly to all parts of the enclosure.

iii. The electrical supply for heaters shall be single-phase 230 V a.c.

iv. Heater control and alarm circuits shall comply with the requirements of 240-56030489. In the case of circuit-breakers for use in systems of nominal voltage up to and including 132 kV, heater fail alarm circuits shall be wired to terminals in accordance with D-DT-5407. In the case of circuit-breakers for use in systems of nominal voltage above 132 kV, heater fail alarm circuits shall be wired to terminals in accordance with 0.54/07529 and 0.54/8557.

3.2.7 Terminal requirements

a) Main (HV) terminals

i. The type of circuit-breaker main terminals required will be specified in schedule A. Unless otherwise specified in schedule A, the circuit-breaker main terminals shall be in accordance with SANS 62271-301 and specifically;

ii. an 8 hole (2 x 4 hole pattern) aluminium flat pad with a 50 mm pitch (distance between holes) and having a minimum thickness of 20 mm. The diameter of the holes shall be 14 mm (M12).

NOTE: For the 220 kV and above circuit-breakers, an 9 hole aluminium flat pad with a 40 mm pitch having a minimum thickness of 20mm shall be acceptable. The diameter of the holes shall be 14 mm (M12).

iii. The arrangement of the HV main terminals shall be such that they can be removed without interfering with the integrity of the circuit-breaker.

b) Earthing terminals

NOTE: Earthing of the circuit-breaker to the main substation earth grid is achieved through the support structure and the foundation holding down bolts, unless otherwise specified or approved by Eskom.

- If the continuity between the circuit-breaker and support structure is not achieved, then a suitably rated conductor (preferably not exposed copper and aluminium) shall be provided between the circuit-breaker and the support structure.
- In the case where the steel support structure is supplied with the circuit-breaker, an additional M16 (Ø18 mm hole) hole shall be provided in the steel support structure approximately 100 mm above the base of the support structure (i.e. above the concrete foundation) for the connection of external earthing conductors.

Details of the circuit-breaker HV main terminals and earthing shall be provided on the general arrangement drawings as described in 3.2.23.1.

3.2.8 Safety clearances and personnel safety

a) Live parts shall be isolated by means of elevation.

NOTE: The use of protective fences to prevent contact with live parts is not acceptable.

b) The electrical clearance from ground to live parts at system voltage, which based on the minimum safety clearances as required by statutory requirements contained in the Occupational Health and Safety Act No. 85 of 1993, shall be complied with. Electrical working clearances are given in Table 6.

Table 8: Minimum electrical working clearances

System voltage *(kV]*	**Working clearance** *(mm]*
11 and 22	2 820
33	2 930
44 and 66	3 270
88 and 132	3 950
220	4 350
275	4 850
400	5 700
765	8 000
+/- 533 DC	Supplier to comply as per **NOTE**
NOTE: The working clearance is calculated by summating the height of a person with his/her arm in an extended upward position (i.e. 1800 + 700 = 2 500 mm) and the minimum safety clearance as required by the Occupational Health and Safety Act No. 85 of 1993.	

c) The distance from ground level to the base of any high-voltage (i.e. > 1000 V) insulation shall not be less than 2 500 mm.

d) Pressure relief devices shall be orientated so as not to pose any hazard to personnel or adjacent equipment. Details of pressure relief devices offered shall be provided with the tender documentation.

e) In the case of dead-tank circuit-breakers, the requirements for internal faults (internal arc) and pressure relief devices shall be in accordance with SANS 62271-203. The Supplier shall provide details with the tender documentation (refer to 3.2.23.1) regarding the time during which an arc due to an internal fault up to a given value of short-circuit current will cause no external effects. The definition of this time shall be based on test results or an acknowledged calculation procedure. Refer to clause D.1 of SANS 62271- 203. The duration of current without burn-through for different values of the short-circuit current may be estimated from an acknowledged calculation procedure.

3.2.9 Insulation requirements

a) Hollow insulators

- The insulator material shall be ceramic or of the silicone rubber composite type. If applicable, the material type will be specified in schedule A. The type of insulator material offered and manufacturer shall be stated in schedule B.
- Insulators of the ceramic type shall be in accordance with the requirements of SANS 62155 and SANS 60815-2.
- Insulators of the silicone rubber composite type shall be in accordance with the requirements of SANS 61462 and SANS 60815-3.

- Only for items in which it is requested in the technical schedules, KIPTS (Koeberg Insulation Pollution Test Site) certificates must be supplied for Medium ("c"), Heavy ('d") to Very heavy ('e") site pollution severity (SPS). The KIPTS test facility limitation is currently (2014) up to 132kV. Therefore the test requirement is split according to nominal system voltage level as follows:
  - o $U_n \leq$ 132kV: For insulators for applications up to nominal system voltages of 132kV (i.e. lightning Impulse withstand up to and including 550kV), the Eskom KIPTS "Natural aging and pollution performance test" is to be conducted in place of the IEC 60507 artificial pollution test. The test shall be according to Eskom procedures 240-56062328 and 240-56030420. The test commencement date and test duration shall be as defined in 240-56030420.
  - o $U_n >$ 132kV: For insulators for applications with nominal voltages greater than 132kV (i.e. lightning impulse withstand greater than 550kV), the results from the test on 132kV insulator will be extrapolated to longer insulators having the same design in addition to performing the IEC 60507 artificial pollution test.

b) Minimum creepage distances

- The minimum unified specific creepage distance (USCD) required in accordance with SANS 60815-1 for external insulation shall be as specified in schedule A. The unified specific creepage distance (USCD) for external insulation has been rationalised to:-
  - o 34,7 mm/kV for "c - medium" site pollution severity (SPS) class;
  - o 43,3 mm/kV for "d - heavy" site pollution severity (SPS) class; and
  - o 53,7 mm/kV for "e - very heavy" site pollution severity (SPS) class.

NOTE: 34,7 mm/kV, 43,3 mm/kV and 53,7 mm/kV corresponds to a previous specific creepage distance (SCD) of 20 mm/kV, 25 mm/kV and 31 mm/kV respectively.

- The actual creepage distance offered shall be stated in schedule B.

c) Clearances in air

- The phase-to-phase clearance, measured by the taut string method, shall be as follows:
  - i. for 11 kV: 600 mm[1)]; and
  - ii. for 22 kV: 400 mm; and
  - iii. for 33 kV: 700 mm.

NOTES

- [1)]: The specified phase-to-phase clearances for 11 kV are based on the fact that twin conductors are required for the 2500 A current rating.
- Eskom reserves the right to call for clearances greater than those already successfully proven by dielectric tests.

d) phase-to-phase and phase-to-earth clearances, measured by the taut-string method, shall be stated in schedule B.

3.2.10 Position / status indication

a) The circuit-breaker main contact position indication shall be clearly visible from ground level and from outside the circuit-breaker operating mechanism enclosure when the front access door is closed.

b) The following symbols and colours shall be used for the position indication of the circuit-breaker main contacts:

- Circuit-breaker closed: "I" in white lettering on a red background

- Circuit-breaker open: "O" in white lettering on a green background

c) Lettering size shall be at least 30 mm, unless otherwise approved by Eskom.

d) The closing-spring condition (i.e. charged or discharged) shall be indicated by a mechanical device. It shall be clearly visible from outside the circuit-breaker operating mechanism enclosure when the front access door is closed. The words "SPRING CHARGED" and "SPRING DISCHARGED" shall be displayed in black lettering on a white background. The lettering height shall be at least 15 mm. The use of symbols to indicate spring condition will not be accepted.

e) Each circuit-breaker shall be provided with an operation counter that is advanced each time the circuit-breaker main contacts open or alternatively each time the main contacts close (i.e. not both). Mechanical operation counters are preferred, but electrical counters are also acceptable. The circuit-breaker operation counter shall be non-resettable. The counter shall have, at least, a capability of counting up to 99 999 operations. The operation counter shall be connected prior to routine testing to reflect all factory and pre-commissioning operations. The type of operation counter shall be stated in schedule B. The Supplier shall submit full details of the operation counter on request by Eskom.

f) In the case of SF6 circuit-breakers, pressure gauges (compensated for temperature and responding to SF6 gas density) shall be provided. These devices shall be sheltered from the elements to ensure that the reading provided is correct and to prevent ageing of the device, and this requirement shall apply to all circuit-breaker types with other insulation and/or extinguishing medium.

g) All indicating devices shall be clearly visible and legible by persons with normal vision standing at ground level. In addition, it shall be possible to carry out all routine inspection activities from the ground level.

3.2.11 Labels

a) Operating labels associated with local operation of the circuit-breaker shall be securely attached to the inside of the operating mechanism enclosure front access door and be as follows (black text on white background, in English):

- Instructions for tripping and closing the circuit-breaker: These instructions shall be titled “TO TRIP” circuit-breaker and “TO CLOSE” circuit-breaker, respectively. Additional information required to perform these functions shall be referred to Eskom; and
- Instructions for charging the closing spring: The instruction shall be titled “TO CHARGE SPRING” and located near the actuator for local mechanical spring charging.

b) The actuator(s) for local opening and closing of the circuit-breaker shall be identifiable by all three of the following methods:

- by labelling, in English, printed with black text on a white background reading “TRIP” and “CLOSE”, respectively. The symbols “O” and “I” may be used as additional means to identify the respective trip and close controls;
- by actuating direction or position. A rotary switch shall be turned anti-clockwise to trip the circuit- breaker and clockwise to close the circuit-breaker. Trip and close push buttons shall be oriented vertically or horizontally and shall have the trip button at the bottom or to the left of the close button [IEC 60447]; and
- by colour coding. The colour green shall be associated with the trip control and red with the close control. Alternatively the controls shall be without unique colour.

NOTE: The Eskom colour coding convention for trip/close actuators is opposite to that specified in IEC 60073 (i.e. IEC requires trip red and close green).

c) An appropriate warning label shall be displayed to draw attention to the danger of performing manual operations without an adequate amount of insulation and/or extinguishing medium inside of the circuit-breaker.

NOTE: The warning label for the mechanical trip facility shall be displayed.

d) A warning label shall be displayed within the operating mechanism enclosure to draw attention to the minimum time interval required between repeated CO operations during testing.

e) All relays, instruments, fuses, MCBs, control switches, luminous indicators and links, the functions of which are not clearly identified by signs or pictograms, shall be clearly labelled to indicate their functions. These labels shall be in text using black letters at least 5 mm high on a white background.

f) Where applicable, all labels shall be manufactured in accordance with 240-56062515 and shall be attached using inherently corrosion-resistant rivets or self-tapping screws. No stick-on labels, double sided tape or glue is accepted, unless otherwise approved by Eskom.

3.2.12 Requirements for sulphur hexafluoride (SF6) gas (where applicable)

NOTE: Requirements below, where applicable, shall be fulfilled by the Supplier for all circuit-breakers that are using environmental friendly insulation and/or extinguishing medium. Furthermore, the Supplier shall provide additional specific details.

a) SF6 gas used as an insulation and/or extinguishing medium shall comply with the requirements of IEC 60376.

b) When installation is called for, SF6 circuit-breakers shall be filled with new SF6 gas at the rated normal pressure. All SF6 circuit-breakers shall be factory filled with new SF6 gas at the rated transportation pressure. This shall be applicable to other environmental friendly insulation and/or extinguishing medium.

c) The maximum SF6 gas leakage rate for the complete equipment shall be 0,5 % per year. The leakage rated offered shall be stated in Schedule B. This shall be stated for all the gas in the equipment as well as for any individual gas-filled compartment.

d) A certificate guaranteeing SF6 purity to IEC 60376 shall be supplied with the circuit-breaker. Upon filling and testing the circuit-breaker, a SF6 purity analysis shall be carried out by the Supplier not less than 7 days after commissioning or as recommended by the OEM. All gas filling shall be done by an accredited person. The following parameters shall be checked, recorded and a report submitted to Eskom after filling:

- SF6 content (purity) - not less than 98%
- Dew-point (humidity/ moisture content) maximum, at rated filling pressure and +20°C – at commissioning shall not be above -10 °C. When equipment is in service it shall not exceed the critical limit of -5 °C.

NOTE: As the reference unit, in accordance with SANS NRS 087:2008 clause E.1.1 the volume concentration of the moisture contained in a gas shall be expressed in microliters per litre (μL/L).

e) The following requirements are applicable to SF6 gas-filled circuit-breaker filling and pressure monitoring (also the other environmental friendly insulation and/or extinguishing medium):

- In the case of circuit-breakers for use in systems of nominal voltage up to and including 132 kV, gas filling/evacuation points with DILO DN8 connections shall be provided.
- In the case of circuit-breakers for use in systems of nominal voltage from 220 kV up to and including 765 kV, gas filling/evacuation points with DILO DN20 connections shall be provided.
- Access to gas filling/evacuation points shall be at a height of not more than 2 400 mm above ground level. This allows for access to the filling/evacuation point without leaving the ground level.
- The gas filling/evacuation point and the gas pressure gauge shall be separated i.e. it shall not be necessary to remove the pressure gauge in order to access the filling/evacuation points.

- A dial type gauge responding to medium density and indicating pressure compensated for temperature shall be suitably sized (typical 80-100 mm diameter).
- A medium density monitoring device (density switch), which may also be integrated into the dial type gauge as a dual function device, shall be provided. The density monitoring device switch shall provide the necessary contacts specified in 240-56030489.
- Pressure gauges shall be numerically marked and calibrated in Pascal's (kPa or MPa). Gauges shall measure "absolute" pressure and shall be clearly labelled 'ABSOLUTE'. Rated pressure shall be no more than 80% of the full-scale reading.
- The density monitoring device shall be suitable for outdoor application and resistant to operating vibrations, outdoor elements (hail/snow), etc.
- The type of gauge utilised shall be designed such as to prevent any corrosion of moving parts and contacts inside the gauge.

NOTE: Gauges filled with an inert gas to prevent corrosion and the ingress of moisture are acceptable.

- Medium density monitoring devices shall be shielded against direct sunshine and internal operating mechanism enclosure heater elements which could give rise to false readings and alarms.
- Non-return valves shall be fitted on all DN8 / DN20 fittings and pipe-work such that the gas pressure is maintained in the system and pipe-work when a circuit-breaker pole or the density monitoring device is removed / disconnected. The Supplier shall submit details of the arrangements offered together with the tender documentation (refer to 3.2.23.1).
- Any pipe work shall be made of stainless steel and mounted in such a manner that it is mechanically protected. The use of copper pipes is acceptable if painted in the factory before mounting to the circuit-breaker common base frame.
- For circuit-breakers with physically separated poles and associated operating mechanisms, a separate filling/evacuating and medium density monitoring point per pole shall be provided. For circuit-breakers with a common base frame, a single common filling/evacuating and medium density monitoring point for all poles may be provided.
- Electrical connections to the density monitoring device shall preferably not be the plug-in type. However, density-monitoring devices with locking facilities will be accepted.
- Cabling to the medium density monitoring device shall be secured, protected from the elements and run into enclosures through a suitable compression gland or rubber grommet.
- Complete details of all insulation and/or extinguishing medium pressure devices, including drawings, manufacturer’s specifications, performance and test data, details of production tests and a quality control programme, shall be included with the tender documentation (refer to 3.2.23.1).
- Electrical interlocks and alarms provided by the gas density monitoring device shall be in accordance with 240-56030489.

f) The management of SF_6 gas shall be in accordance with NRS 087.

3.2.13 Current transformers (CTs) for dead-tank circuit-breakers

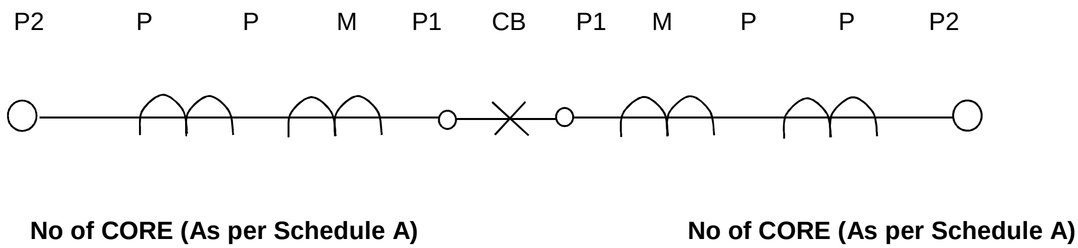
a) Current transformers (CTs) shall be of the integrated ring-type, manufactured and tested in accordance with IEC 61869-1, SANS 60044-1 (IEC 61869-2), SANS 60044-6 and NRS 029 (IEC 61869-6).

b) The number and type of CT cores required per phase, together with their position relative to the circuit-breaker and their respective standards or specifications will be specified in schedule A.

c) The CT terminal numbering and wiring interface shall be in accordance with the drawing specified in schedule A.

d) It shall be possible to remove and replace the ring-type CTs without dismantling the circuit-breaker bushing. The method to perform this shall be provided with tender documentation.

e) Specific requirements for dead-tank circuit-breaker CT's:-



NOTE: P1 and P2 are indicating the dead-tank circuit-breaker's HV bushings main terminal and plug-in point

Figure 1: Typical arrangement of the CTs on the dead-tank circuit-breaker

3.2.13.1 Cores and class for CT's on dead-tank circuit-breakers

For Feeder bays, Coupler bays and Transformer bays CT's on dead-tank circuit-breakers

i. 765kV CT's:

Number of CT cores: 4 x Protection class TPY; 2 x Metering class 0.2

Table 9: 765kV ratios for multi ratio (MR) and fixed metering current transformers

Nominal ratio	Proposed Tapping points on secondary windings	Ratios available	Burden capability VA	Accuracy class	Ratio
3200/1	800/800/1200/400	3200/2800/2400/2000/1600/1200/800/400/1	10	0,2	800/1
800/1*	Fixed	800/1	10	0.2	800/1

NOTE: The asterisk (*) on the nominal ratio denotes that it is requirement for the 765kV Reactor Dead-tank circuit-breakers

Table 10: 765kV ratios for multi ratio (MR) and fixed protection current transformers

Nominal ratio	Proposed Tapping points on secondary windings	Ratios available	Maximum secondary winding resistance at 75°C(1)	Class	Eal	Double duty cycle
3200/1	800/800/1200/400	3200/2800/2400/2000/1600/1200/800/400/1	12.8	TPY	2000	C-O-C-O
800/1*	Fixed	800/1	12.8	TPY	2000	C-O-C-O

NOTE: The asterisk (*) on the ratio denotes that it is the requirement for the 765kV Reactor Dead-tank circuit-breakers

Table 11: Values where TPY cores are used on dead-tank circuit-breakers

	Unit	765kV CT	400kV CT in Trfr Bay
Current transformer class		TPY	TPY
Number of Protection cores		4	2
Rated primary current (Ipn)	A	3150	3150
Rated secondary current	A	2	2
Rated frequency	Hz	50	50
System voltage and insulation level	kV	765	400
System voltage and insulation level	kV	1550	1050
Ith (Ipsc)	kA	50 for 1 sec	50 for 1 sec
Idyn	kA	127.5	127.5
Ratio to which specified data applies	-	3200/1 (MR)	3200/1 (MR)
Alf (Symmetrical short circuit)	-	20	20
Kssc (Asymmetrical short circuit)	-	15	15
Tp	msec	100	100

	Unit	765kV CT	400kV CT in Trfr Bay
DC Component	%	55	55
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	100	100
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	40	40
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	500	500
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	100	100
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	40	40
Rb	Ω	12	12

- CT requirements for Shunt Reactor bays: Number of CT cores:

Dead-tank circuit-breaker CT's:2 x Protection class TPY (fixed 800/1) and 1 x Metering class 0.5 @ 800/1 5VA

Table 12: Values for the 765kV Reactor dead-tank circuit-breaker

	Unit	Dead-tank CB CT
Current transformer class		TPY
Rated primary current (Ipn)	A	800
Rated secondary current	A	2
Rated frequency	Hz	50
System voltage	kV	765
Insulation level	kV	1550
Ith (Ipsc)	kA	50 for 1 sec
Idyn	kA	127.5
Ratio to which specified data applies	-	800/1 (Fixed)
Alf (Symmetrical short circuit)	-	20
Kssc (Asymmetrical short circuit)	-	15
Tp	msec	100
DC Component	%	55
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	100
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	40
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	500
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	100
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	40
Rb	Ω	12

ii. 220kV – 400kV CT's:

Number of CT cores: 2 x Protection class TPS; 2 x Bus Zone class TPS; 2 x Metering class 0.2

NOTE: The 400kV dead-tank circuit-breaker used on the 765kV transformer bay on the 400kV side shall have the core requirements: 2 x Protection class TPY; 2 x Bus Zone class TPS; 2 x Metering class 0.2

iii. 132kV CT's:

Number of CT cores: 2 x Protection; 2 x Bus Zone; 2 x Metering.

NOTE: Class as per NRS 029 and 240-56062864 Table 2.

3.2.13.2 Magnetizing curves

Details of magnetizing curves (on a log-scale) for the dead-tank circuit-breakers CT's shall be provided for the TPY cores with tender documentation. The other cores' magnetizing curves shall be provided upon Eskom request.

3.2.14 Switching surge control (where applicable)

a) In order to reduce complexity, circuit-breakers that require auxiliary devices in the main circuit (e.g. pre-insertion closing resistors or inductors for switching surge control during no-load transmission line switching) may be considered for use in systems of nominal voltage 765 kV and will be subject to approval by Eskom. Information required for the selection of an appropriate resistance for the pre-insertion closing resistor will be provided by Eskom with the tender documentation.

NOTE: The inclusion of pre-insertion resistors may impact on the mechanical endurance class of the circuit-breaker (e.g. reduce the number of mechanical operations from 10 000 (M2) to 2 000 (M1) operations). This should be considered when evaluating various alternative solutions.

b) For the switching of capacitor banks, reactor banks and transformers, the preferred solution for switching surge control is by means of precise and repeatable operating characteristics in conjunction with an electronic controller (refer to 3.2.18) and/or the application of metal oxide surge arresters connected in parallel with the circuit-breaker interrupters.

NOTE: The electronic controller shall be IEC61850 protocol compliant.

3.2.15 Grading capacitors (where applicable)

a) Where grading capacitors are required for the distribution of voltage stresses across the interrupters of circuit-breakers having two or more interrupting units in series, this shall be stated in schedule B together with the capacitance (in pF) per interrupting unit, the type of insulation material e.g. oil/paper and the manufacturer and type.

b) The Supplier shall provide details with the tender documentation (refer to 3.2.23.1) of how to verify the condition of grading capacitors during the life of the circuit-breaker. The grading capacitors are required to last for the lifetime of the circuit-breaker without maintenance.

3.2.16 Extreme asymmetrical short-circuit interrupting capability (where applicable)

If required, the capability of the circuit-breaker to interrupt short-circuit currents with a higher degree of asymmetry than required by the SANS 62271-100 standard will be specified by Eskom in schedule A. Details will be provided with the tender documentation. Such capability shall be demonstrated by tests or calculations that show that the influence of the arc voltage will produce a current zero within the normal arcing time of the circuit-breaker.

NOTE: Circuit-breakers typically placed on the high-voltage side of large generator step-up transformers may experience short-circuit currents that may, due to the extreme asymmetry of the short-circuit current, not have a current zero for a number of cycles, preventing interruption of the current. In such circumstances, the duty of the circuit-breaker can be eased, for example, by delaying its opening. Alternatively, it may be proven by tests or calculations that the arc voltage of the circuit-breaker is high enough to damp the d.c. component of the current so much that a current zero will occur.

3.2.17 Requirements for simultaneity of poles during single closing and single opening operations

a) All interrupters in a pole and in all three poles of the circuit-breaker shall operate simultaneously on opening and closing – including infrequent operation and under extreme temperature conditions. Contact synchronism shall be retained within rated values during the expected maintenance intervals of the circuit-breakers. The expected degree of synchronism shall be in accordance with SANS 62271-100 and therefore as follows:

- the time interval between contact touch for all poles of the circuit-breaker shall not exceed 5 ms (a quarter of a cycle of rated frequency);
- the time interval between contact touch for interrupters in the same pole shall not exceed 3,3 ms (a sixth of a cycle of rated frequency);
- where applicable, the time interval between contact touch for individual pre-insertion closing resistors shall not exceed 10 ms (a half of a cycle of rated frequency); and
- where applicable, the time interval between contact touch for individual pre-insertion closing resistors in the same pole (series connected) shall not exceed 6,6 ms (a third of a cycle of rated frequency);
- the time interval between contact separation for all poles of the circuit-breaker shall not exceed 3,3 ms (a sixth of a cycle of rated frequency); and
- the time interval between contact separation for interrupters in the same pole shall not exceed 2,5 ms (an eighth of a cycle of rated frequency);

b) Refer to 5.101.1 of SANS 62271-302 for general guidance for circuit-breakers intended for operation with intentionally non-simultaneous poles (controlled switching - refer to 3.2.18).

3.2.18 Controlled switching

NOTES

- For switching of shunt capacitor banks, shunt reactors and power transformers, circuit-breakers supplied may be required to perform controlled (point-on-wave) switching duties. The Supplier shall provide all accessories and cabling required for the point-on-wave relay.
- SANS 62271-302 provides guidance on the design, construction, specification and testing of circuit-breakers with intentional non-simultaneous pole operation which are excluded from the scope of SANS 62271-100. Circuit-breakers with intentional non-simultaneous pole operation are mainly used for the implementation of controlled switching.
- The Supplier shall provide proof that the controlled switching device (point-on-wave) is compliant to IEC61850 protocol with the Tender documentation.
- The controller and its associated circuitry are to be provided as a separate contract item.
- The controller and its associated circuitry are located at a remote location in the control room associated with the particular circuit-breaker.
- Mechanically staggered poles used for controlled switching applications will not be accepted due to the limitation placed on the circuit-breaker mechanical endurance, unless otherwise accepted by Eskom.

a) Full details of the controlled switching system offered, i.e. the manufacturer's technical specification/manual for the controller and necessary sensors and auxiliary equipment required to achieve controlled switching, shall be supplied with the tender documentation (refer to 3.2.23.1). However, the circuit-breaker shall be capable of switching without the use of a controlled switching system.

b) The Supplier shall state in schedule B whether the circuit-breaker offered has been tested in accordance with SANS 62271-302. The Supplier shall indicate whether the circuit-breaker offered was tested independent from any particular controller or whether it was tested with a dedicated controller and the necessary sensors and auxiliary equipment which form part of the tested equipment.

c) The Supplier shall provide details with the tender documentation (refer to 3.2.23.1) regarding the mechanical characteristics of the circuit-breaker which affect the mechanical operating time, e.g. influence of ambient temperature, substation d.c. control voltage, standing time, operating pressure, contact wear. The cause of deviations in operating times shall be indicated in all cases, e.g. arising in the operating coil/latch assembly, energy storage device, etc.

d) The Supplier shall provide details with the tender documentation (refer to 3.2.23.1) of the circuit-breaker dielectric characteristic – as a function of time (closing) and as a function of SF6 gas filling pressure up to the maximum rated design pressure. The Supplier shall also supply the upper and lower limits of the dielectric characteristic which can be expected over the service life of the circuit-breaker. The critical arcing time window shall be indicated for re-ignition-free shunt-reactor switching. For controlled closing of shunt capacitor banks as well as for controlled opening of shunt reactors, a tolerance of less than ± 1 ms is required as a function of the above mentioned parameters. If special measures are required to maintain operating times within these limits, this shall be stated with the tender documentation.

3.2.18.1 Additional requirements for the point-on-wave controller for digital secondary plant interface option

The point-on-wave switching controller shall form an additional Process Interface Unit (PIU) in the digital secondary plant interface to the switchgear as per clause 3.2.21.1.

The point-on-wave switching controller shall implement the IEC 61850 logical node CPOW – Control Point-on-wave switching.

3.2.19 Pole discordance (PD) or phase discrepancy

NOTES

- A pole discordance (PD) or phase discrepancy condition is when one or more poles of a single-pole operated circuit-breaker (i.e. "1P") do not perform an operation in harmony with the other poles.
- The PD timer and its associated circuitry are to be provided as a separate contract item.
- This timer will receive its signal from a combination of normally-open and normally-closed auxiliary switch contacts.
- The PD timer and its associated circuitry are located on the control panel at a remote location in the control room associated with the particular circuit-breaker.

a) If a pole discordance condition persists for at least 100 ms, then the control circuitry associated with the circuit-breaker shall immediately initiate a trip command to all poles. The duration for which the discordance condition persists before tripping all poles, shall be controlled using a settable timer.

b) In order to determine the correct settings for this timer, the Supplier shall provide the following information with the tender documentation (refer to 3.2.23.1) about the timing events (with tolerances) between:

  - main contact timing and the auxiliary contacts timing of the same pole for both opening and closing operations;
  - main contact timing and the auxiliary contacts timing between all poles for both opening and closing operations assuming the open and close command is received simultaneously by all poles; and
  - designation of auxiliary contacts (required for future testing);

c) In the case of single-pole auto-reclosing, where an intentional PD will exist for times in excess of 1 000 ms, the control circuitry shall deliberately permit this condition.

3.2.20 Auxiliary and control circuits

a) The auxiliary and control circuits shall be designed and implemented in accordance with the requirements of 240-56030489.

b) In the case of circuit-breakers for use in systems of nominal voltage up to and including 132 kV, the circuit-breaker auxiliary and control circuit wiring interface shall be in accordance with D-DT-5407. In the case of circuit-breakers for use in systems of nominal voltage above 132 kV, the wiring interface shall be in accordance with 0.54/07529 (Live-tank circuit-breakers) and 0.54/8557 (Dead-tank circuit-breakers).These schematics shall be applicable to equipment with the higher rated voltages.

c) A removable 3 mm thick brass or aluminium gland plate (undrilled) having a minimum usable area of 200 mm x 100 mm shall be fitted at the bottom of the enclosure below the terminal strips for the bottom entry and glanding of all control cables. The gland plate shall be secured by a minimum of six M8 set screws with nuts and washers, unless otherwise approved by Eskom. In the case where CTs are supplied with the circuit-breaker, two gland plates each having a minimum usable area of 200 mm x 100 mm shall be fitted below each terminal strip. Earthing of the gland plate shall be via the set screws.

d) To facilitate LV control cable entry and connection, the distance between any part of the terminal strip and the gland plate shall not be less than 150 mm. The terminal strips shall be positioned and spaced to provide easy access to the terminals to insert the wiring.

e) A suitable earthing point shall be provided inside the operating mechanism enclosure to allow earthing of at least 10 spare secondary control cabling cores. This shall be achieved using a tinned copper earthing bar with M6 fasteners or a suitable number of earthed terminal blocks.

f) Induced electromagnetic disturbances in the secondary system of the circuit-breaker shall not cause spurious operation or damage. This applies under both normal operation and switching conditions, including interruption of fault currents in the primary system.

g) It shall be possible to change the d.c. control voltage at which the circuit-breaker operating mechanism operates by only replacing the opening and closing coils, operating mechanism motors and motor contactor coils.

NOTES

- Switchgear shall only be required to operate at one d.c. control voltage i.e. the closing and opening devices, operating mechanism motors and motor contactor coils to be supplied with the switchgear are required to be suitable for operation at either 110 V d.c. or 220 V d.c. as specified in schedule A.
- A readily available d.c. supply voltage "conversion kit" may be required by Eskom from the Supplier in order to convert the circuit-breaker operating mechanism from 110 V to 220 V d.c. or vice versa. Refer to 0.

3.2.20.1 Requirements for the digital secondary plant interface option

An option shall be provided for a digital interface to the auxiliary and control circuits based on IEC 61850 [25] GOOSE Messaging. The digital interface shall be applicable to binary controls and binary status signals. Analogue instrument transformer signals (where applicable) shall be retained, that is implementation of IEC 61850 Sampled Measured Values is not required. The digital interface shall be achieved via Intelligent Electronic Devices (IEDs) to be referred to herein as Process Interface Units (PIUs).

The digital interface shall be an add-on option to the standard wiring interface of the switchgear, and shall be installed within the mechanism box, or in an additional bolt-on enclosure which shall be provided. The mechanism box/enclosure shall also be able to accommodate the point-on-wave closing controller. All wiring between the PIUs and the interface terminal strips shall be provided.

The digital interface shall be in accordance with SANS 62271-3 [25]. In particular:

a) The PIUs shall be specified to conformance class b ("including the services required to implement the complete IEC 61850 series' data model with self-descriptive capabilities") or higher.

b) The ACSI basic conformance shall include B11 (Server side of Two Party Application Association), B31 (GSE Publisher side) and B32 (GSE Subscriber side).

c) The total processing delay of the communication device (t_1) for trip and close signals for primary switchgear rated above 145kV shall be less than or equal to 7 ms. The processing delay for all other signals shall be less than or equal to 12 ms.

Two physically separate PIUs shall be provided. Separate auxiliary DC power supplies shall be provided by the Purchaser for each PIU. Each PIU shall be provided with all status and alarm contacts relating to the switchgear and the additional alarms indicated below. The "Main" PIU shall control the main tripping coil. The "Main 2"/"Back-up" PIU shall control the back-up tripping coil. Both PIUs shall have control over the closing coil by means of a dedicated DC supply (via the point on wave closing controller where applied).

The functions specified for a specific PIU may be distributed amongst multiple devices, but the physical separation of the main (1) and back-up/main 2 PIUs shall be retained.

PIUs shall be specified in accordance with Eskom Standard [28] 240-6465228. In particular, the devices:

a) Shall be rated for operating over the temperature range -25°C to +70°C (Section 3.1.1) without forced cooling.
b) Shall be equipped with a multi-session fibre optic Ethernet port in accordance with Section 3.16. Alternatively, separate optical Ethernet ports may be provided for IEC 61850 [25] communication and remote engineering access.

Tenderers shall complete the Schedules A&B of Eskom Standard 240-6465228 [28] which have been tailored for PIU devices.

The PIU hardware design shall allow for the unplugging of all interface wiring without the need to disconnect individual wires. Pre-wired test plugs shall be available for the input and output wiring, allowing the normal interface wiring plugs to be substituted by testing plugs for test purposes (i.e. to connect the PIU inputs and outputs to a secondary injection test set). All plugs shall be keyed so as to avoid replacement into the incorrect sockets. Keying of plugs shall be user settable and re-settable.

The PIUs shall support the following minimum sets of logical nodes in accordance with IEC 61850-7-4 and Eskom Standard 240-42066934 [27]. The PIUs shall support sufficient instances of the logical nodes and binary inputs and output contacts for the intended application.

a) LPHD – System: Physical device
b) CSWI – Control: Switch controller (circuit-breaker, disconnectors, earthing switches)
c) SCBR – Supervision and monitoring: circuit-breaker monitoring
d) SIMG – Supervision and monitoring: insulation medium supervision (gas) and/or SIML – Supervision and monitoring: insulation medium supervision (liquid) as applicable
e) SSWI - Supervision and monitoring: circuit-switch monitoring (for integral disconnectors and/or earthing switches)
f) XCBR – Switchgear: Circuit breaker
g) XSWI – Switchgear: Circuit switch (for integral disconnectors and/or earthing switches)

The digital interface IEDs shall have sufficient binary inputs and Logical Nodes for the assimilation and communication of the following additional alarms:

a) Main/Back-up DC supply fail (cross reporting by the main and back-up IEDs)
b) Closing DC supply fail
c) Motor DC supply fail
d) Main/Back-up IED unhealthy (cross reporting by the main and back-up IEDs)
e) Point-on-wave device unhealthy
f) Spring charged

The IEC 61850 Protocol Implementation Extra Information (PIXIT) requirements for the GSE Model and the Time Synch Model and the Technical Issue Conformance (TICS) requirements shall be in accordance with Eskom Standard [29] 240-68107841.

It shall be possible to place the digital interface IEDs in a test mode whereby output contact operation is blocked, yet information regarding attempted contact operation is made available via (preferably) IEC 61850 Edition 2 test mode (see IEC 61850-7-1 Section 7.8.4) and/or an engineering personal computer that is temporarily connected to the network. Simulation of binary inputs shall be supported.

3.2.21 Nameplates

a) The circuit-breaker nameplate shall contain the necessary information specified in SANS 62271-100 and the following:

- Eskom order and contract number
- Eskom stock (SAP) number
- Rated single-phase short-circuit breaking current - where applicable (refer to b))

b) The operating device nameplate shall contain the necessary information specified in SANS 62271-100 and the following:

- Trip-coil rated voltage, current, d.c. resistance (at 20 ^{0}C)
- Close-coil rated voltage, current, d.c. resistance (at 20 ^{0}C)
- Motor rated voltage and current (starting peak current and nominal running current)

NOTE: These values shall be the nominal values (with tolerances) according to the routine test parameters.

c) Circuit-breakers tested in accordance with SANS 62271-302 for controlled switching should make specific reference to SANS 62271-302 on their nameplates. The nameplates of circuit-breakers intended for controlled closing should indicate the rated making window in accordance with SANS 62271-302.

d) The nameplates and their fixings shall be weather-proof and inherently corrosion-resistant. They shall be either engraved aluminium or stainless steel and are subject to approval by Eskom. All the letters and figures on the nameplates shall be permanently marked. The nameplates shall be securely fastened to the equipment in a reliable manner as in 3.2.12 f (requirement for labels). The method used shall be stated in schedule B. The nameplate material offered shall be stated in schedule B.

e) Where applicable, duplicate nameplates of the CTs shall be attached to the inside of the operating mechanism enclosure front access door in order for them to be read from ground level. The details on the nameplates shall be in accordance with NRS 029.

f) The actual ratings to which the circuit-breaker has been type-tested (and not merely the values specified) shall be displayed.

3.2.22 Tools and spares

a) A full set of operating tools necessary to carry out all mechanical (manual) operations of the circuit-breaker shall be supplied with each circuit-breaker (e.g. racking handle, spring charging handle, etc.). A full list of operating tools shall be provided with the tender documentation (refer to 3.2.23.1). If additional sets of operating tools are required, this will be specified in schedule A.

b) All operating tools shall be fitted on the inside of the front access door of the operating mechanism enclosure.

c) A detailed list of standard tools required for minor maintenance shall be supplied with the tender documentation (refer to 3.2.23.1). Where applicable, the following tools are required for minor maintenance:

- slow operating device(s);
- hoses and fittings for draining and filling with SF6 gas or other insulation and/or extinguishing medium; and

- other tools which may be required (e.g. contact alignment tools, insulation and/or extinguishing medium density meter checking device).

d) Should the circuit-breaker require additional specialised tools for major maintenance purposes, a full list of specialised maintenance tools shall be provided with the tender documentation (refer to 3.2.23.1).

e) A full list of spares required for maintenance shall be provided with the tender documentation (refer to 3.2.23.1).

f) The Supplier shall provide the written letter with the tender documentation that states that in case of the design obsolescence, they shall notify Eskom and present all spares manufacturing drawings and specification (i.e. metal, Bill of material, masses) for the maintenance spares required for circuit-breaker life expectancy.

3.2.23 Documentation requirements

3.2.23.1 The documentation to be submitted with tender documentation

The Supplier shall provide the following documentation with the tender documentation:

a) completed technical schedule B for each circuit-breaker size. The technical schedule B shall not be left blank. Where numerical values (e.g. rated values, dimensions, etc.) or specific information is required, the actual value/information offered shall be stated. In such cases, use of the words "COMPLY", "TBA", etc. is not acceptable;

b) a full set of general arrangement (GA) drawings showing the following minimum information:

   i. manufacturer's drawing number and revision number. Provision shall be made for an Eskom-allocated drawing number as well as for the Eskom contract number - for population after awarding of the contract;

   ii. a descriptive title of the drawing (e.g. "400 kV 3150 A 1-pole Operated Circuit-breaker General Arrangement");

   iii. critical dimensions such as overall dimensions, structure dimensions, phase to phase spacing, phase to phase and phase to earth air clearances, working clearance, height of lowest part of insulation above ground, height of top of operating mechanism enclosure above ground, operating mechanism enclosure dimensions, overall height, width and depth of circuit-breaker, etc.;

   iv. properly annotated drawing with a complete list of major components (bill of materials);

   v. details of main terminals including dimensions of the fixing holes, terminal hole spacing, plate thickness and maximum permissible forces (loads) on main terminals (with directions) expressed in Newtons (N);

   vi. details of the main earthing terminal and operating mechanism enclosure earthing terminal;

   vii. mass of circuit-breaker in kilograms (kg), which shall include the empty mass, mass and description of heaviest component, total mass of circuit-breaker ready for service and mass of filling medium;

   viii. any special trenches or steelwork required between phases;

   ix. the steel support structure dimensioned outline and general arrangement;

   x. the steel support structure label mounting holes;

   xi. in the case where the steel support structure is designed by the manufacturer, the steel support structure earthing terminal;

   xii. the concrete foundation dimensioned outline, design detail and general arrangement;

xiii. mounting and fastening arrangement for the circuit-breaker support structure onto the foundation including the minimum required length and diameter of foundation holding down bolts as well as the relative position of levelling nuts, spacers, washers, etc. in relation to the base plate;

xiv. maximum torque required for the foundation holding down bolt nuts used to secure the support structure base plate (Nm);

xv. static and dynamic forces (loads), centre of gravity - refer to a).

xvi. relative location of circuit-breaker poles, base frame, operating mechanism enclosure(s), grading capacitors (where applicable) and closing resistors (where applicable);

xvii. location of all enclosure doors and handles;

xviii. location and annotation of control facilities (gas filling/evacuation points, SF6 density monitoring device with its environmental protection shelter/cover, etc.);

xix. location and layout of LV control cable gland plates;

xx. insulation and/or extinguishing pressure and quantity requirements; and

xxi. location of nameplate on circuit-breaker;

c) for all external insulation (i.e. post-insulators, circuit-breaker chamber insulators, bushings, etc.), detailed drawings showing the insulator material, shed profile dimensions including shed and insulation body/core diameters, shed spacing, creepage distance and dry arcing distances, etc.;

d) drawings showing the generic layout of all the nameplates (circuit-breaker, operating device(s), CTs) in accordance with 3.2.21. Provision shall be made for an Eskom-allocated drawing number as well as for the Eskom contract number - for population after awarding of the contract;

e) generic auxiliary and control circuit schematic wiring diagrams for the circuit-breaker. Provision shall be made for an Eskom-allocated drawing number as well as for the Eskom contract number - for population after awarding of the contract;

f) a general arrangement drawing of the operating mechanism enclosure. Provision shall be made for an Eskom-allocated drawing number as well as for the Eskom contract number - for population after awarding of the contract;

g) full list of spares required for maintenance (refer to e) and section 3.5.1)

h) full list of operating tools (refer to a));

i) detailed list of standard tools required for minor maintenance (refer to c));

j) detailed list of additional specialised tools for major (specialised) maintenance (refer to d));

k) full list summary of type-tests as well as copies of type test reports and/ or certificates (refer to 3.3.1.2);

l) generic routine test certificates for the circuit-breaker (refer to 3.3.1.2);

m) transport, storage, installation, operating and maintenance manuals (refer to section 9);

n) training material (refer to section 10); and

o) generic quality inspection and test plan (QITP)

p) the submission, where applicable, of the following additional information:

i. premature failures experienced in service of similar design circuit-breakers supplied elsewhere by the manufacturer, together with the recommended modifications (refer to g));

ii. where applicable, details of any special equipment required to view all circuit-breaker status indications and make necessary readings from the ground level (refer to f));

iii. details of corrosion protection and lubricants offered (refer to d));

iv. measures taken to prevent flange corrosion (refer to e));

v. where applicable (i.e. dead-tank circuit-breakers), details of the internal arc behaviour of the circuit-breaker (refer to d))

vi. details of the arrangements offered to maintain insulation and/or extinguishing medium pressure in the system when the circuit-breaker or a pole is removed or replaced (refer to e) point 11);

vii. details of all insulation and/or extinguishing medium pressure devices, including drawings, manufacturer's specifications, performance and test data, details of production tests and a quality control programme (refer to e) point 16);

viii. information on how to verify the condition of grading capacitors during circuit-breaker life (refer to 3.2.15);

ix. information required for controlled switching (refer to 3.2.18);

x. information about the timing events for PD timers (refer to a));

xi. quality control plans indicating all inspection hold points (refer to c));

xii. details of equipment requiring maintenance during storage (refer to a));

xiii. a written commitment from the Supplier regarding the submission of the maintenance DVD (refer to 3.5.2); and

xiv. spares availability philosophy (refer to 3.5.3.2).

3.2.23.2 The documentation to be delivered with each circuit-breaker

Unless otherwise specified in schedule A, the manufacturer shall submit the following documentation with each circuit-breaker delivered to Eskom:

a) an auxiliary and control circuit schematic wiring diagram of the circuit-breaker;

b) a complete set of routine test certificates;

c) a commissioning and hand-over test sheet; and

d) one set of transport, storage, installation, operating and maintenance manuals.

NOTE: In addition to the documents supplied with the circuit-breaker, all documents shall be made available in electronic format for publication on the Eskom internal equipment database.

3.2.23.3 Storage of supplied documents

The above documents supplied with the circuit-breaker shall be stored in the documentation pocket on the inside of the circuit-breaker operating mechanism enclosure front access door.

NOTE: In addition to the documents supplied with the circuit-breaker, all documents shall be made available in electronic format for publication on the Eskom internal equipment database.

3.2.23.4 Documents to be supplied upon awarding or contract

The Supplier shall submit the following documentation to the contract manager and relevant Eskom specialist upon awarding of a contract:

a) circuit-breaker analyser data required for condition monitoring (refer to 3.5.5);

b) detailed scope of works (job plan) for each type of prescribed maintenance intervention;

c) detailed work instructions (task manual) for each type of prescribed maintenance intervention; and

d) detailed works reports (check sheet) for each type of prescribed maintenance intervention.

e) quality inspection and test plan (QITP) in accordance with QM-58 clause 6c and Appendix I.

3.2.24 Packaging and preservation requirements

a) Each circuit-breaker shall be “unit-packed”. In other words, the components making up a complete circuit-breaker shall be delivered to site in one or more packing containers which shall contain only the component for one complete individual circuit-breaker.

NOTE: Eskom will not accept equipment if the various components of the different circuit-breakers are delivered in the same packing containers.

b) All circuit-breaker components shall be packed in containers (e.g. wooden crates) that are suitable for transport and storage over long periods (for up to 18 months). Refer to QM-58 how to handle preservation.

c) Durable waterproof packaging shall prevent damage to the circuit-breaker components during transportation and storage on site and shall be such that suitable ventilation is allowed in order to minimise condensation.

d) The packaging shall be able to withstand impact loadings of at least 18 kN. The mechanical strength of the packaging shall not be dependent on the strength of the top cover, i.e. it shall be possible to remove and subsequently replace the top cover without losing any mechanical strength of the packaging.

e) Where more than one crate is used per circuit-breaker, each crate shall be clearly and sequentially marked in order to identify each crate as belonging to a specific circuit-breaker (e.g. “CRATE 1 of 3”, “CRATE 2 of 3”, etc.).

f) Each container/crate shall be clearly marked with a durable label using an indelible font at least 30 mm high indicating the following information:

- Eskom order number;
- Eskom SAP number;
- short circuit-breaker description (including the rated voltage, normal current, rated short-circuit breaking current, auxiliary d.c. control voltage; specific creepage; “1P” or “3P”) ;
- manufacturer’s name (i.e. make of circuit-breaker);
- manufacturer’s circuit-breaker product designation/code (i.e. type of circuit-breaker);
- manufacturer’s serial number(s);
- contents of the crate (i.e. a parts list);
- the crate number (e.g. “CRATE 1 of 2”, “CRATE 2 of 2”);
- the crate overall dimensions (in mm); and
- total mass of each crate (e.g. “TOTAL MASS: 1000 KG”);
- pictograms / symbols showing correct storage and stacking instructions for crates

g) Exposed shafts, bearings and machined surfaces shall be treated with a temporary anti-corrosive coating.

h) Loose components or components that are subject to damage from exposure to dust or water shall be packed in hermetically sealed plastic bags.

i) All components shall be clearly marked. Components that are physically impossible to mark shall be individually packed and the packaging shall be marked.

j) Fork-lift lifting points shall be provided on the packaging, where applicable. These points shall be braced as though it were a lifting pallet (for mechanical support during lifting activities).

k) A readily accessible (i.e. without the need to remove / disturb the external packaging) external temporary 230 V a.c. supply connection point for the heater circuit during storage shall be provided and wired to the Eskom side of the terminal strip in the factory. This shall consist of an electrical cord wired to a screw-type connection block for the connection of the temporary a.c. supply used during storage. Heater connections shall be designed in such a manner so as not to cause a hazardous situation when energised. No internal wiring should need be modified to remove the temporary supply leads. The connection point shall be labelled “230 V AC HEATER CONNECTION: CONNECT IF STORED > 2 DAYS” or similar.

l) A non-resettable impact recorder/detector shall be provided and located in such a position so as to record/detect the acceleration of the circuit-breaker body and not the packaging.

m) Where applicable, the circuit-breaker shall be transported with a positive gas pressure of maximum 150 kPa.

n) A copy of the BOM shall be provided with the delivery note for each circuit-breaker supplied in order to allow the recipient to confirm that all items on the BOM have been delivered, and for record purposes.

3.3 Tests

3.3.1 General

a) Manufacturer’s testing capabilities

The manufacturer shall be fully responsible for performing or having performed all the required tests as specified. Suppliers shall confirm the manufacturer’s capabilities in this regard when submitting tenders. Any limitations shall be clearly stated. The Supplier shall be responsible for all costs related to testing.

3.3.1.1 Witnessing of tests

Eskom reserves the right to be present at any of the tests specified. The Supplier shall ascertain the sequence of tests required in each particular case and whether witnessing of tests is required, and, after completion of all preliminary tests, shall then give Eskom sufficient, agreed upon, advanced notice of the firm date when the circuit-breaker and associated apparatus will be ready for the witnessing of testing.

NOTE: Where applicable, the minimum required notification period for overseas travel from South Africa is 8 weeks.

Eskom shall be notified as soon as possible of all test failures and corrective measures. This shall take the form of abbreviated reports that shall, upon request, be supported by more detailed reports. It is desirable that Eskom is notified of test failures to allow in situ inspection if desired.

3.3.1.2 Test certificates and reports

a) Type test reports and/or certificates together with each complete summary of type test (in English) shall be supplied with the tender documentation (refer to 3.2.23.1). The type test reports and/or certificates and the summary of type tests shall be in both printed copy and in electronic Portable Document Format (PDF). The type test reports shall be in electronic Portable Document Format (PDF).

i. The type test certificate which is the proof of official accreditation shall have the official signatures of the accredited test laboratory where the type-tests were performed which is responsible for its validity and contents. The type test certificate shall contain a record of series of type-tests carried out strictly in accordance with the IEC standard. It shall contain essential drawings and the equipment tested.

ii. Where the Supplier and OEM are using the type test certificate and type test report beyond that particular equipment that was type tested, to indicate that the other equipment types with their different ratings are covered by the type test certificate and type test report, a separate official signed off letter on the company’s letterhead shall be supplied by the Supplier with the tender documentation. This letter shall clearly state all particular tests and the tested parameters that are extrapolated form the type test certificate and type test report.

iii. The summary list of type-tests indicating the following:-

- o The type test performed,
- o The IEC standard it was type tested on,
- o The type test report document number;
- o The date of type test performed
- o The Test Facility where the type test was performed, the Test facility accreditation authority.

b) Generic routine test certificates/reports shall be supplied with the tender documentation (refer to 3.2.23.1) in electronic format (pdf). The test certificate shall indicate (make provision for) the tests performed, results, identification of the equipment tested, etc. The format of the test certificate/report shall make provision for approval by an authorised Eskom representative.

c) One hardcopy of the routine test certificates/reports shall be supplied with each circuit-breaker and stored in the documentation pocket inside the operating mechanism enclosure. In addition to the hardcopy, the routine test certificates/reports shall be made available in electronic format and submitted to Eskom

3.3.2 Type and routine test requirements

a) The manufacturer shall perform a complete set of type tests for each circuit-breaker design offered. The type test certificates and reports shall be submitted for review during the tender or product evaluation stage. The type test reports shall be according to IEC 62271-100. All type test done on IEC60056 shall not be accepted. If any type testing is carried out during a contract period, Eskom shall be invited as a witness.

NOTE: If, in the opinion of Eskom, repeat or new type-tests are necessary, the cost of these tests will be taken into account in the evaluation of tenders. In such a case, Eskom may request the supplier to submit details of the cost of carrying out each applicable type test.

b) The circuit-breaker shall be type tested in accordance with SANS 62271-100 and shall include the following tests:

- equipment insulation level (SANS 62271-100 6.2); dry lightning impulse withstand voltage test (BIL or LIWL) (SANS 60137 8.3) (for bushings on the dead-tank circuit-breaker);
- Dry power frequency withstand level voltage tests (PFWL) (SANS 62271-100), (SANS 60137 8; 9.3 & 8.1) (for bushings on the dead-tank circuit-breaker);
- Wet power frequency voltage withstand level (PFWL) test (SANS 62271-100), (SANS 60137 8; 9.3 & 8.1) for all bushing < 300kV (for bushings on the dead-tank circuit-breaker);
- dry switching impulse withstand level voltage test (SIWL) (SANS 62271-100), for bushings rated for U_r ≥ 300kV (SANS 60137 8.4) (for dead-tank circuit-breaker);
- wet switching impulse withstand test (SIL) for bushings rated for U_r ≥ 300kV (SANS 60137 8.4) (for dead-tank circuit-breaker);
- temperature rise and measurement of resistance of circuits (SANS 62271-100 6.5 & 6.4); temperature rise test (SANS 60137 8.7) (for bushings on the dead-tank circuit-breaker);
- current withstand - main circuit (SANS 62271-100 6.6);
- circuit-breaker short-circuit making and breaking capacities (SANS 62271-100 6.102 to 6.106); verification of thermal short-time withstand current (SANS 60137 8.8) (for bushings on the dead-tank circuit-breaker);
- critical current tests (where applicable) (SANS 62271-100 6.107);
- single-phase tests (for Un >_ 66 kV) (SANS 62271-100 6.108);
- double earth fault tests (for Un ? 132 kV) (SANS 62271-100 6.108);

- short-line fault tests (for class S2 circuit-breakers and Un >_ 66 kV) (SANS 62271-100 6.109);
- out-of-phase making and breaking tests (applicable if an out-of-phase rating is assigned) (SANS 62271-100 6.110);
- capacitive current switching tests (SANS 62271-100 6.111);
- switching of shunt reactors (for Un >_ 66 kV) (SANS 62271-110);
- electrical endurance tests (for class E2 circuit-breakers) (SANS 62271-100 6.112);
- circuit-breaker mechanical operation (SANS 62271-100 6.101.2.1 - 6.101.2.3);
- circuit-breaker extended mechanical endurance tests (for class M2 circuit-breakers) (SANS 62271-100 6.101.2.4);
- radio interference voltage tests (for Un >_ 132 kV) (SANS 62271-100 6.3);
- verification of the protection (IP coding) (SANS 62271-100 6.7) and, in the case of dead-tank circuit-breakers, verification of the protection (IP coding and mechanical impact test) (SANS 62271-203 6.7);
- tightness test (SANS 62271-100 6.8 / SANS 62271-203 6.8 (for dead-tank circuit-breakers));
- EMC tests (SANS 62271-100 6.9) - where applicable; (SANS 60137 8.6) (for bushings on the dead-tank circuit-breaker);
- X-radiation test procedures for vacuum interrupters (SANS 62271-100) - where applicable;
- static terminal load tests (for Un >_ 66 kV) (SANS 62271-100 6.101.6);
- cantilever load withstand test (SANS60137 8.9) (for bushings on dead-tank circuit-breakers);
- additional tests on auxiliary and control circuits (SANS 62271-100 6.10);
- proof tests for enclosures (compartment/ metallic tank) (for dead-tank circuit-breakers) (SANS 62271-203 6.103);
- internal pressure test on gas-filled, gas-insulated and gas-impregnated bushings (SANS 60137 8.11) (for dead-tank circuit-breaker);
- test under conditions of arcing due to an internal fault (for dead-tank circuit-breakers) (SANS 62271-203 6.105);
- insulator tests (for dead-tank circuit-breakers) (SANS 62271-203 6.106); and
- corrosion test on earthing connections (for dead-tank circuit-breakers) (SANS 62271-203 6.107).
- all type-tests applicable to CT's (for dead-tank circuit-breaker);

c) Time-current curves of the electrical tripping and closing circuits shall be provided, both for normal operation, and in the event that the tripping/closing plunger is prevented from moving. The resolution of the function times shall be clearly indicated in the test reports.

d) The circuit-breaker shall be routine tested in accordance with SANS 62271-100 and shall include the following tests:

- dielectric test on the main circuit (SANS 62271-100 7.1);
- dry power frequency withstand voltage tests for bushings (SANS 60137 8 & 9.3) (for dead-tank circuit-breaker);
- measurement of dielectric dissipation factor (tan δ) and capacitance at ambient temperature (SANS 60137 8 & 9.1) (for dead-tank circuit-breaker);

- measurement of partial discharge quantity (SANS 60137 8 & 9.4) (for dead-tank circuit-breaker);
- tests on auxiliary and control circuits (SANS 62271-100 7.2);

NOTE: In the case of switchgear supplied from an overseas OEM where the wiring of auxiliary and control circuits is done locally, the tests on auxiliary and control circuits are to be done locally as part of the local factory acceptance testing (refer to 7.1).

- measurement of the resistance of the main circuit (SANS 62271-100 7.3);
- tightness test (SANS 62271-100 7.4 / SANS 62271-203 7.4 (for dead-tank circuit-breakers)); (SANS 60137 9.8) (for bushings of the dead-tank circuit-breaker);
- design and visual checks (SANS 62271-100 7.5 / SANS 62271-203 (for dead-tank circuit-breakers) / SANS 60137 (for bushings on dead-tank circuit-breakers));
- pressure tests of enclosures (for dead-tank circuit-breakers) (SANS 62271-203 7.101); and
- Internal pressure test on gas-filled, gas-insulated and gas-impregnated bushings (SANS 60137 9.6) (for dead-tank circuit-breaker);
- mechanical operating tests on circuit-breaker (SANS 62271-100 7.101).
- all factory routine tests applicable to CT's (for dead-tank circuit-breaker);

e) The following characteristics, in addition to those specified in SANS 62271-100, shall be measured and recorded during the mechanical operating tests (where applicable):

- closing and opening speeds;
- timing tests on each type of auxiliary switch contact in relation to the main contacts (including relative timing between main and auxiliary contacts of single-pole operated circuit-breakers when operated simultaneously);
- settings of pressure switches / gas density monitoring devices; and
- time-current curves of the electrical tripping and closing circuits for normal operation. The resolution of the function times shall clearly be indicated on the test reports.

f) Where applicable, circuit-breakers intended for operation with intentionally non-simultaneous poles shall be tested in accordance with SANS 62271-302 (performance verification tests and parameter definition tests for controlled switching applications).

g) Only for items in which it is requested in the technical schedules, KIPTS (Koeberg Insulation Pollution Test Site) certificates must be supplied for Medium ('c'), Heavy ('d') to Very heavy ('e') site pollution severity (SPS). The KIPTS test facility limitation is currently (2014) up to 132kV. Therefore the test requirement is split according to nominal system voltage level as follows:

  - o $U_n \leq$ 132kV: For insulators for applications up to nominal system voltages of 132kV (i.e. lightning Impulse withstand up to and including 550kV), the Eskom KIPTS "Natural aging and pollution performance test" is to be conducted in place of the IEC 60507 artificial pollution test. The test shall be according to Eskom procedures 240-56062328 and 240-56030420. The test commencement date and test duration shall be as defined in 240-56030420.
  - o $U_n >$ 132kV: For insulators for applications with nominal voltages greater than 132kV (i.e. lightning impulse withstand greater than 550kV), the results from the test on 132kV insulator will be extrapolated to longer insulators having the same design in addition to performing the IEC 60507 artificial pollution test.

h) Where applicable, CTs shall be tested in accordance with SANS 60044-1 or NRS 029, as applicable.

i) Insulators of the ceramic type shall be tested in accordance with SANS 62155 and SANS 60815-2.

j) Insulators of the silicone rubber composite type shall be tested in accordance with SANS 61462 and SANS 60815-3.

3.3.3 Tests after installation on site (pre-commissioning tests)

a) Commissioning checks and a test programme (as determined by the manufacturer) shall be carried out in accordance with SANS 62271-100 10.2.101 and 10.2.102 for all circuit-breakers. The test programme shall be incorporated into the circuit-breaker inspection and test plan. This shall include checks after installation, mechanical tests and measurements, checks of certain specific operations and electrical tests and measurements.

b) Electrical tests shall include, but are not limited to, the following:

- measurement of the steady-state contact resistance of the main circuit; and
- measurement of the dynamic contact resistance of the main circuit.

c) The measurement of the time quantities shall be done at nominal and minimum coil control voltage.

NOTE: The measured times for nominal and minimum coil control voltage should be within ± 5 % of the times, as specified on the circuit-breaker pass sheet supplied by the OEM.

d) For each measurement of the operating time, a recording shall be made of each individual operating coil current - namely close, trip I and trip II. The resolution of the function times shall be clearly indicated in the test reports.

e) During the measurement of the re-charging time of the closing spring, the peak motor current in the spring charging process shall be measured as well as the continuous motor current. Measurements shall be made both at the nominal and minimum control voltage.

NOTE: The results should be within ± 2 % of the circuit-breaker pass sheet results supplied by the OEM.

f) For the recording of the mechanical travel characteristics, travel curves for each phase shall be recorded. The location of the travel transducers on the circuit-breakers shall be clearly indicated in the test report. The following measuring results shall be provided:

- the total travel (in mm)
- the over-travel (in mm)
- the rebound (in mm)
- the under-travel (in mm)
- the contact penetration (in mm)
- moving-contact or operating rod position at the time of make or break
- anomalies which are evident from the trace
- the average speed on closing (in m/s)
- the average speed on opening (in m/s)

g) For the measurement of the steady-state contact resistance of the main circuit, a d.c. current of at least 100 A shall be used. The dynamic contact resistance shall be measured during a close and open operation of the circuit-breaker. This shall be done for each main contact separately. A detailed diagram of the measurement set-up shall be given (sketched) in the pre-commissioning test report. If any difficulties have occurred during erection or commissioning, this shall be clearly stated in the pre-commissioning test report. The results shall be given in pQ and the resolution shall be at least 1 pQ.

h) Reasons for differences between the results of the tests made on-site and the results of the tests as they were carried out at the OEM’s works (the circuit-breaker pass sheet) shall be clearly stated and corrections shall be made.

i) Where applicable, circuit-breakers intended for operation with intentionally non-simultaneous poles shall be tested in accordance with SANS 62271-302 10.101 (commissioning of circuit-breakers for controlled switching applications)

j) The results of pre-commissioning tests after installation on site shall be documented, signed off and a copy of the results included with the switchgear documentation for hand-over as part of the quality process. All tests may be witnessed by Eskom. Refer to 3.4.7.2 for further information on the pre-commissioning test report.

3.4 Manufacturing, transport, storage, installation, pre-commissioning and after sales technical support

3.4.1 General

a) The manufacturing, transport, storage, installation and pre-commissioning of switchgear and controlgear, as well as their operation and maintenance in service, shall be carried out in accordance with the instructions given by the OEM.

b) The supplier shall provide instructions for the transport, storage, installation, operation and maintenance of the equipment according to the requirements set out by the OEM (refer to 3.2.23.1).

3.4.2 Inspection of manufacturing facilities and circuit-breakers

a) Eskom reserves the right to inspect and evaluate all manufacturing and testing facilities relating to the circuit-breakers offered - both before and at any time during manufacturing.

b) Eskom reserves the right to inspect any ordered circuit-breaker before shipment, or at any stage of manufacture. This inspection will entail a thorough check to ensure complete compliance with this standard, switchgear schedules and the approved manufacturer's drawings.

c) With the tender documentation (refer to 3.2.23.1), the supplier shall submit the quality control plans to Eskom, indicating all inspection hold points. Eskom may add the necessary inspection hold and/or witness points for Eskom or its appointed representative. The supplier shall make due allowance for these activities in the manufacturing programme and, to avoid delays, shall give sufficient, agreed upon, advanced notice of the date of inspection. Eskom will not accept late delivery on the basis of inspection delays.

NOTE: Where applicable, the minimum required notification period for overseas travel from South Africa is 8 weeks.

d) Any deviations in the circuit-breaker design shall be pointed out in accordance with the tendered deviation schedule and the type test certificates provided for the specific unit design. No clearance will be given where there is no satisfactory evidence of the relevant type test certificates, where such tests are required.

e) Clearance shall be obtained before dispatching the equipment. This clearance shall be confirmed on the routine test certificates. No clearance shall be given where there are any outstanding defects resulting from Factory Acceptance Testing (FAT) or from this inspection.

3.4.3 Conditions during transportation

NOTE: Refer to DST_240-53902499, for the requirements on transport, handling, storage and preservation.

a) Conditions can be expected to be onerous during transport, storage and installation. Adequate precautionary measures shall be provided for the packaging and protection of sensitive components such as insulating parts and operating mechanisms during transport, storage and installation (including corrosion of exposed parts).

b) Vibrations and impacts during transport shall also be mounted. Refer to l) for the requirements for non-resettable impact recorders.

c) The supplier shall demonstrate - either by testing or through previous satisfactory experience - that the equipment complies in this respect. Testing may include the following:

- shipping test: this test shall cover all the conditions to be encountered during transportation from factory to the designated site, including loading/off-loading from one mode of transport to another;
- vibration test: this test may be used to supplement actual shipping tests to check for unexpected shortcomings in the equipment and packaging; and
- weather-proof test: this test may demonstrate the adequacy of the packaging to prevent ingress of moisture and water from weather or sea conditions.

d) If the design of the equipment is mature, and the equipment has previously been shipped under similar conditions, the above tests may be waived at Eskom's discretion.

3.4.4 Transportation and off-loading

a) Refer to 3.2.23.4 for the requirements for packaging for transportation and storage.

b) The Supplier shall be responsible for the transportation and off-loading of the equipment on site. Off-loading includes transportation from the point of off-loading the equipment after transportation to the point of installation.

c) The Supplier shall provide his own means of off-loading at the point of installation.

3.4.5 Storage and preservation

a) If any equipment requires maintenance or attention during storage, this shall be clearly stated in the contract and Eskom's attention shall be drawn to this fact. This information shall be submitted with the tender documentation (refer to 3.2.23.1) as well as with orders upon awarding of a contract.

b) At the time of off-loading at an Eskom facility, the Supplier has the responsibility to ensure that the necessary steps are taken by Eskom to ensure satisfactory storage.

c) Where heaters need to be energised, a clearly marked electrical connection point (refer to k)) shall be provided to enable Eskom to supply power to the heaters.

d) The Supplier shall implement proper storage and handling (de-stuffing) procedures, which should always be part of site delivery documentation. A copy of the storage and handling procedures shall be made available to Eskom for acceptance (refer to 3.2.23.1). This shall indicate the maximum recommended period of storage, as well as recommended actions to be taken if a longer storage period (preservation) is required.

e) The Supplier shall provide the storage and preservation protocol from the OEM at tendering stage for Eskom evaluation, namely site requirements, spares requirement and stores facility requirement.

3.4.6 Installation

a) Unless otherwise specified and agreed (e.g. where OEM certified training and/or supervision is provided), the Supplier shall be responsible for the installation and pre-commissioning of the equipment. This includes the supply of all installation tools, lifting tackle and test equipment.

NOTE: Eskom will normally provide the support structures (unless otherwise specified) under a separate contract/order.

b) Installation includes mounting and securing the equipment and its support structure onto the concrete support foundation, leveling of the switchgear, filling of gas (other insulation and/or extinguishing medium), where applicable.

c) For each type of circuit-breaker, the installation instructions provided by the supplier (refer to 3.2.23.1) according to the OEM's instructions shall at least include the items listed below:

- unpacking and lifting instructions: all information required for unpacking and lifting safely shall be given, including details of any special lifting and positioning devices that are necessary;
- assembly: when the switchgear is not fully assembled for transport, all transport units shall be clearly marked. Drawings showing the assembly of these parts shall be provided with the switchgear;
- mounting: instructions for mounting the common base frame, poles, operating device(s) and auxiliary equipment shall include sufficient details to enable site preparation to be completed. These instructions shall also indicate:
  i. the total mass of the equipment, inclusive of insulation and/or extinguishing medium;
  ii. the mass of insulation and/or extinguishing medium; and
  iii. the mass of the heaviest part of the apparatus to be lifted separately if it exceeds 100 kg;
- qualification of personnel: all personnel employed by the Supplier who are involved in the installation and pre-commissioning of the circuit-breaker shall be trained and accredited by the OEM. Proof of this accreditation shall be included in the quality control plan and shall be submitted to Eskom for approval prior to installation and pre-commissioning of equipment by the individuals concerned; and
- final installation inspection and testing: instructions shall be provided for inspection and testing after the switchgear and controlgear has been installed and all the interfacing connections have been completed. These instructions shall include the following:
  i. procedures for carrying out any adjustment that may be necessary to achieve correct operation;
  ii. recommendations for any relevant measurements that should be made and recorded to help with future maintenance decisions; and
  iii. instructions for final inspection and testing.

d) The Supplier shall be responsible for ensuring the training and accreditation of persons employed for the installation and pre-commissioning of switchgear.

e) During the performance of the work at the substation site, the Supplier shall comply with all the relevant statutes, regulations, bylaws and codes, as well as all the safety and quality requirements pertaining to the work. The Supplier shall provide all apparatus including safeguards and personal protective equipment (PPE), including a Fall Arrest System (FAS), necessary for the performance of the work.

f) Installation tools / equipment and debris shall be removed from site when installation is completed.

g) Where a.c. power supplies cannot be made available to the Supplier for installation and pre commissioning purposes, the Supplier shall be responsible for providing his own a.c. power supply (e.g. generator) for the installation and pre-commissioning of switchgear.

3.4.7 Pre-commissioning

3.4.7.1 Testing of each circuit-breaker after installation

Each circuit-breaker shall be tested after installation in accordance with 3.3.3. This is to assure proper installation and that no damage occurred during transportation. The pre-commissioning tests shall be witnessed by an appointed Eskom representative/official. To facilitate the testing, adequate d.c. power supplies, test equipment and suitably qualified and accredited personnel shall be provided by the Supplier.

NOTES

a) For reasons of compatibility with Eskom's on-site test equipment, one of the following types of equipment shall be used to measure/record the time quantities and travel characteristics:

- Elcon - SA10 Instrument, Sweden
- Programma Elektrik AB - TM 1600 or TM 1800 Instrument, Sweden.

b) The software used shall be compatible with any one of the above instruments, and will be specified when ordering the circuit-breaker. The choice may depend on where the circuit-breaker will be used.

3.4.7.2 Pre-commissioning test report

The circuit-breaker pre-commissioning test report shall be submitted to Eskom, comprising the following parts:

3.4.7.2.1 Required measurements records

a) after the measurements at the substation site, a hand-written pre-commissioning test report shall be handed over to the appointed Eskom representative/official. Any special note that is on the OEM instruction manual and/or test protocol shall be incorporated by the Supplier on this report, e.g. “Activate anti-condensation heaters”;

b) within three weeks after the pre-commissioning tests, the Supplier shall submit an official report to Eskom (two hardcopies); and

c) an electronic copy of the official report shall be provided on a CD for each individual circuit-breaker. The software used shall be compatible with one of the types of test equipment mentioned above. Reports shall be in .pdf or Microsoft Word (.doc) format.

3.4.7.2.2 Measured values

All the measured values shall be clearly stated in the report as well as the following:

a) test/measuring equipment information/data:

- make and type of instruments;
- serial numbers of instruments;
- methods of triggering;
- measuring methods;
- the accuracy of the instruments; and
- calibration certificates of the measuring instruments used;

b) the circuit-breaker data:

- make and type;
- serial numbers of poles and operating mechanisms;
- rated voltage, normal current and short-circuit breaking current;
- the name of the substation and section;
- circuit-breaker identification and application;
- date of commissioning; and
- date and time of testing/measuring.

3.4.7.2.3 Clear copies attached to the official report

Clear copies of the complete printouts of the timing, travel characteristics and dynamic main contact resistance measurements shall be attached to the official report. The names of all parties concerned shall be clearly stated in the report. If the measured values differ from the values as they were measured at the manufacturer's works, an interpretation shall be given and, if Eskom deems it necessary, the deviation shall be corrected by the Supplier. If the circuit-breaker is found to be faulty during the tests, a fault report shall be completed in addition to the pre-commissioning test report.

3.4.7.3 The switchgear and controlgear shall be subject to a final inspection by Eskom

The switchgear and controlgear shall be subject to a final inspection by Eskom after pre-commissioning in accordance with the approved quality control plan.

3.4.7.4 Final inspection to hand-over

After the final inspection, the final commissioning of the plant is performed and the hand-over documents shall be provided to Eskom by the Supplier.

3.4.8 Safety related data (where applicable)

All liquids or chemicals used during installation shall be supplied with Material Safety Data Sheets (MSDS).

3.4.9 Requirements for pressure vessels (where applicable)

Circuit-breakers, which are subject to the provisions of the Occupational Health and Safety Act regarding pressure vessels, shall be provided with certificates for the associated pressure vessels. These certificates shall be issued by an independent inspection authority approved by Eskom. The costs of such an inspection authority appointment shall be borne by the Supplier. The Supplier shall supply to the appointed inspection authority calculation sheets, design drawings and welding procedures of all pressure vessels for approval before manufacture commences. In addition, copies of sub-orders for bought-out vessels or works orders (if manufactured internally) shall be supplied to the appointed authority. Sufficient proof shall be provided that all welders employed in the fabrication of pressure vessels are adequately qualified and that their qualifications are valid.

3.4.10 After sales technical support

The Supplier shall provide locally based technical specialist support on a full time basis for the duration of the contract.

3.5 Inspection and maintenance

3.5.1 General

The effectiveness of maintenance depends mainly on the way instructions are prepared by the OEM and implemented by Eskom. The Supplier shall supply maintenance information in the form of maintenance manuals, full maintenance analysis FMECA as per Appendix D, OEM test plan/ speed calculation datum points (for closing and opening circuit-breaker operation) field service bulletins and Digital Video Disk (DVD) material covering the following aspects:

a) Extent and frequency of maintenance:

For this purpose, the following factors shall be considered:

i. switching operations (accumulated switching amperage);

ii. total number of operations (a graph showing the maximum number of guaranteed operations as a function of short-circuit breaking current shall be provided as well as the maintenance and time required to restore the circuit-breaker once the accumulated switching amperage limit has been reached);

iii. environmental conditions;

iv. measurement and diagnostic tests for condition monitoring ; and

v. full maintenance analysis FMECA as per Appendix D.

b) Scope of work to be performed:

It shall include the following:

i. recommended place for the maintenance work (indoor, outdoor, in factory, on-site, etc.);

ii. procedures for inspection, diagnostic tests, examination overhaul;

iii. reference to drawings;

iv. reference to part numbers or standard kit of parts;

v. tools required, including special equipment or tools;

vi. precautions to be observed (e.g. cleanliness and possible effects of harmful arcing by-products);

vii. lubrication procedures; and

viii. cleaning materials.

c) Graphical information:

Detailed drawings and sketches of the circuit-breaker components, with clear identification (part number and description) of assemblies, sub-assemblies and essential components. Expanded detail drawings, which indicate the relative position of components in assemblies and subassemblies, are expected as a preferred illustration method. Graphs and similar means of portraying important information shall also be included.

d) Specified operational values:

Values and tolerances pertaining to which, when exceeded, make corrective action necessary, for example:

i. pressure levels (where applicable);

ii. operating times and contact velocities;

iii. resistance of the main current carrying circuits;

iv. insulation and/or extinguishing medium characteristics (e.g. the SF6 purity, dew point, acidity, etc.);

v. quantities and quality of gas;

vi. grading capacitor condition;

vii. contact condition (including contact dimensions);

viii. torque settings for fasteners; and

ix. important dimensions.

e) Specifications for materials:

This includes warnings of known non-compatibility of materials.

i. fluid; and

ii. cleaning and degreasing agents.

f) Tools, lifting and access equipment:

A list of standard and specialised tools shall be provided with description of their application and associated part number.

Tests after the maintenance work: All tests shall be clearly described and shall include the parameters to be observed.

g) Spare parts:

Description, reference number, quantities and advice for storage.

h) Time estimates:

Estimated time required to carry out maintenance activities.

i) Detailed information:

This relates to the recommended makes and types of transducers (linear or rotary) to facilitate the measurement of travel curves. Such transducers (as well as the brackets, fittings and so forth that are needed to apply them on the circuit-breaker) are part of the special maintenance tools for the circuit-breaker. The manual shall show clearly how the transducer, together with any brackets, fittings, etc, shall be mounted and applied on the circuit-breaker.

3.5.2 Maintenance DVD

It is anticipated that maintenance intervals for the circuit-breakers will be very long, e.g. several years. Consequently, it is essential that the instruction manual be supplemented and supported by a maintenance-orientated video recording. The video recording shall be converted into a suitable DVD format. A written commitment from the Supplier regarding the submission of the DVD shall be provided with the tender documentation (refer to 3.2.23.1). The actual DVD shall be supplied upon awarding of the contract following approval of the maintenance manual by Eskom. Copies of the DVD shall be issued to the contract manager and relevant technical specialists.

The DVD shall provide a record of the maintenance requirements and procedures for the equipment supplied. The DVD and related instruction and maintenance manuals shall be detailed enough to enable a trained maintenance crew (with some general knowledge of the equipment) to perform all inspections and maintenance required on the equipment. It is anticipated that the instruction manuals will list what maintenance is required, while the DVD will show how such maintenance is achieved.

The DVD shall cover routine inspection, minor and major maintenance (overhaul) of all equipment requiring such work, as well as some trouble-shooting techniques and tips. It shall explain the normal operation of the equipment in sufficient detail for the maintenance crew to be able to differentiate between normal and abnormal equipment performance. The DVD shall concentrate on equipment maintenance and shall not include any unnecessary sales or publicity material. Since the topics to be covered are extensive and complex, it may be considered an advantage to present the results in definite sections, covering the various aspects or portions of the equipment.

These sections may be on separate DVD's or if consolidated into a single DVD, there shall be adequate indexing to permit quick access to the desired section. For each piece of equipment requiring maintenance, the DVD shall show:

- the tools, equipment and materials required to perform the maintenance, especially any special tools;
- the tests required prior to maintenance operations to record the status of the equipment and/or to indicate the areas requiring maintenance/re-adjustment;
- the disassembly steps, including any marking of positions required prior to disassembly, any discharging of pressure and/or stored energy;
- the disassembly, removal, replacement and re-assembly of any sub-components requiring scheduled maintenance/replacement;
- the re-assembly, realignment and re-installation of all components, including any lubrication of moving parts;
- a brief summary of the evacuation, refilling and leak testing of the re-assembled equipment;
- the testing of the re-assembled equipment, including acceptable values and tolerances of the measured/tested parameters; and
- some trouble-shooting methods if the required tolerances are not achieved.

The trouble-shooting portion of the DVD shall record the normal/expected values of equipment performance, plus techniques and tips to analyse the cause of any abnormalities, and how to correct them.

3.5.3 Spares

3.5.3.1 General

Spares will normally be purchased at the same time that orders are placed for circuit-breakers. The Supplier shall provide a list of the minimum recommended spares (refer to e)) together with prices in the pricing schedules for the circuit-breakers concerned.

NOTE: Delivery to any of the specified destinations should remain valid for the duration of the contract period and be subject to the same Contract Price Adjustment formula as applied to the circuit-breakers.

3.5.3.2 Availability of spares

The Supplier (who represents the OEM), shall be responsible for ensuring the continued availability of spare parts required for maintenance for a period of not less than 25 years from the date of discontinuation of the switchgear and controlgear.

Spares required under emergency breakdown conditions shall be readily available with a maximum lead time of 24 hours from date of purchase order. The Supplier shall state the lead time offered in schedule B. This excludes spares required for scheduled maintenance.

The following spares shall be readily available locally (in South Africa) within 12 hours:

- trip coils;
- close coils;
- spring charging motors;
- SF6 density monitoring devices (If applicable, other insulation and/or extinguishing medium); and
- contactors and relays.

The Supplier shall undertake to supply to Eskom all the necessary replacement parts for the circuit-breaker throughout its expected service life. If the manufacture of the specific make and type of circuit-breaker (or any of its replacement parts) is discontinued, Eskom shall be advised in writing.

Written advice (relating to discontinuation) shall also be provided for parts of the equipment that the Supplier obtains from a third party (sub-supplier). In this situation, the Supplier shall supply the following information to Eskom:

- all design data;
- all material characteristics and parameters;
- all testing information (parameters, equipment, methods, criteria, etc.);
- all manufacturing information; and
- all relevant working drawings and information.

This information shall be supplied to Eskom in a legible and acceptable format in English when notice of discontinuation of the circuit-breaker or any of its replacement parts is given. In this case, Eskom will be able to make alternative arrangements to obtain the necessary replacement parts. Another option is to pool spare parts: the Supplier shall state his/her spares availability philosophy with the tender documentation (refer to 3.2.23.1).

3.5.3.3 Identification of spares

Spares shall be identified by a unique number and cross-referenced in the instruction manual. Large spares such as poles and operating shafts shall be packed in separate cases, clearly labelled and consigned to Eskom. Such large spare items shall be provided with a metal label bearing the appropriate identification.

A parts list shall be provided with each consignment of spares, clearly identifying each item by description, identification number and quantity supplied. The contract number shall appear on the packaging containing spares.

3.5.3.4 Packaging, preservation and storage of spares

Refer to QM-58 how to handle preservation. Care shall be taken to ensure that spares are protectively packed for satisfactory long-term storage. Maintenance spares will usually be stored indoors.

3.5.3.5 D.C. supply voltage conversion kits

D.C. supply voltage "conversion kits" shall be kept locally by the Supplier in South Africa for the duration of the contract to ensure that they are readily available as and when required. Separate conversion kits shall be available that are able to convert from 110 V d.c. to 220 V d.c. or from 220 V d.c. to 110 V d.c. Refer to a).

3.5.4 Modifications to circuit-breakers during their service life

If, during the normal service life of a circuit-breaker supplied, Eskom requires to be notified about a necessary modification, a field service bulletin shall be issued to the Eskom contract manager and relevant technical specialists giving details of the modification and the reason for it. Suitable training and parts shall be supplied to Eskom within 30 days of any modification required for all circuit-breakers supplied to Eskom. All concessions shall be approved by Eskom.

3.5.5 Condition monitoring of circuit-breakers

The Supplier is encouraged to develop practical and innovative methods to improve the reliability and maintainability of the circuit-breaker installation. This may include on-line condition monitoring and/or integrated diagnostic devices achieving the following functions:

- accumulated interruption amperage values (per pole);
- contact wear (per pole);
- continuous measurement of SF6 gas or other insulation and/or extinguishing medium density, the instrumentation for which will provide information enabling early warning of insulation and/or extinguishing medium leaks and planned outages for refilling or repairs;
- analyser for SF6 gas quality and decomposition products (with alarms); and
- continuous monitoring, recording and alarm signalling of the mechanical operating characteristics of the circuit-breaker.

The on-line condition monitoring and/or integrated diagnostic device shall be IEC61850 protocol compliant.

All information required to carry out condition monitoring of circuit-breakers (including, but not limited to, specification sheets, speed calculation points, travel curve values, etc.) shall be provided by the Supplier and OEM for each type of circuit-breaker. This information shall be given to the Eskom contract manager and relevant technical specialist upon awarding of the contract.

3.6 Manuals

3.6.1 General

Transport, storage, installation (erection), operation and maintenance information shall be submitted in the form of manuals (refer to 3.2.23.1 and 3.2.23.2). These manuals shall be in English and provided in the following formats:

- hard copy A4 form; and
- electronic copy (pdf) form copied onto an appropriate medium such as Compact Disc (CD).

The manual and contents shall be approved by Eskom. The approval process shall be initiated immediately upon contract award and completed within three months. The onus shall be upon the Supplier to meet this programme. If further material is required, then this shall be subject to negotiation.

3.6.2 Content

The instruction manual(s) shall cover transport, storage, installation, operation and maintenance and shall fulfil the following requirements:

- the manuals shall be written in English only;
- it shall be specifically compiled for the circuit-breaker with which it has been supplied;
- torque wrench settings, clearances, settings and other important information shall be listed, e.g. the typical operating times, speed curves and tolerances in synchronism;
- it shall give a clear description of the operation, and the diagrams, photos and description shall be easily read together;
- routine inspection, minor and major maintenance procedures shall be given together with a list of lubricants, recommended spares and/or special tools and so on, required for these activities;
- it shall contain high-quality diagrams and photos showing details of operating components of the circuit-breaker, which also identify and list separately each component making up the diagram;
- seals and gaskets requiring replacement during overhaul shall be detailed and the Suppliers of these components, together with the part number(s), shall be listed; and
- the names and addresses of suppliers of lubricants, oils, gases, compounds and so on shall be listed.

One set of sample manuals shall be supplied to Eskom with the tender documentation (refer to 3.2.23.1) for approval. After approval, the requisite number of manuals shall be supplied.

Qualified personnel will install, operate, maintain and repair the equipment with the aid of the manufacturer's instruction manuals and DVD aids. The manuals shall contain at least the following information (where applicable):

General

- title page: title of equipment, equipment ratings, contract and order numbers, Supplier's reference numbers. This information shall also appear on the outside of the binder and on the first page;
- table of contents: the manual shall be sectionalised and numbered sequentially;
- equipment make and type to which the manuals apply;
- list of all drawings, by number and title;
- description and summary of circuit-breaker operation;
- full details of method adopted for anti-pumping;
- where applicable, details of interlocking between phases;
- where applicable, details of auto-reclosing arrangements;
- schematic wiring diagram of circuit-breaker; and
- where applicable, full details of all valves, including information regarding materials of valves and valve seats. If materials such as synthetic rubber or other equivalent types are used, the method of bonding or clamping these materials shall be given.

Transport and storage instructions

- packaging requirements;
- transport instructions;

- storage instructions: indoor, outdoor and special information for equipment storage; and
- the measures required to make sure all the manufacturer's transportation and storage requirements are met.

Installation instructions

- complete step-by-step instructions and detailed drawings, including alignment, installation and dimensional tolerances for preparing the equipment for service;
- inspection procedures before and after unloading, pre-installation tests, gas-filling and monitoring procedures;
- the levels of expertise required for the construction team;
- a man-hour estimate for the installation work required on site;
- a list of special equipment and tools required for unloading and positioning components of the circuit-breaker on site; and
- tolerances for field assembly.

The Supplier shall supply a DVD to supplement installation information given in the installation manual. This visual information may be provided separately or may form part of the maintenance DVD required.

Testing

- functional testing, dielectric testing, controlled switching testing, operating instructions, operating limits and starting-up instructions (complete with sketches or drawings); and
- a separate set of record sheets, showing measurements and tolerances for each test for separate items of equipment.

Inspection and maintenance

- the maintenance manual shall contain the typical contents as described in 3.5.

Dismantling, repair, settings inspection and lubrication

- instructions for dismantling the equipment, as well as repair instructions and settings of critical clearances and adjustments, complete with photographs and sketches or drawings;
- special tools shall be clearly described;
- guide to inspection frequency;
- all gaskets, seals and o-rings which have to be replaced during scheduled maintenance or after a specified period, shall be identified;
- lubrication chart and schedule (including component quantities). Lubricants shall be clearly identified. If no lubrication is required, it shall be clearly stated;
- procedures for the discharge of stored energies in the mechanical and electric systems;
- procedures for the safe disposal of decomposed SF6 gas products shall be described; and
- trouble-shooting procedures shall be provided.

Spare parts

- spare parts list, including quantities and manufacturer's part numbers. Spare part numbers shall be cross-referenced with drawings in the instruction manual;
- drawings (sectional or "exploded" views, etc.) of the equipment/sub-assemblies shall identify every component (excluding standard bolts, nuts, washers, etc.) referenced to the spare parts list, including component description and manufacturer's part number; and
- delivery times for recommended spare parts shall be stated.

Drawings for equipment

- a complete set of approved drawings specific to the equipment being supplied. The drawings shall show dimensions and tolerances of the major components and assemblies. Details of the drawings required are given in 3.2.23.

3.7 Training

The Supplier shall provide first-hand training of an international standard on the supplied equipment by OEM accredited instructors for the duration of the contract.

Refer to [35] 240-56065202 for the switchgear training requirements from original equipment manufacturers. The supplier shall provide with the tender documentations, the detailed training programme in accordance with this training standard [35].

3.8 Safety, health, environment and quality

Refer to 240-56063765 for Eskom's health and safety management requirements for Suppliers. Refer to QM-58 for Eskom's quality management requirements for Suppliers.

All facets of this tender must comply with Occupation Health and Safety Act (OHS Act) No 85 of 1993 – Construction and Electrical Machinery Regulations.

4. Authorisation

This document has been seen and accepted by:

Name & Surname	Designation
	Rev 1 Document Approved by TDAC ROD 27 February 2013
	Rev 2 Document Approved by SCOT for HV Plant
Bheki Ntshangase	Senior Manager PDE HV Plant
Bheki Ntshangase	Plant Equipment SC Chairperson
Jabulani Cebekhulu	AIS Care Group Convener
Andre Marais	HV/ EHV GIS/ MTS Care Group Convener
Tjaart van der Berg	Transmission Switchgear Task Team Convener
Ajith Persadh	Distribution Switchgear Care Group
Sarel Pretorius	GIS Work group Convener
Naresh Rampersad	Transmission HV Plant Manager's Forum – Switchgear representative
Monde Bala	Senior Manager Limpopo OU - Maintenance and Operation & Distribution Plant Management Forum

5. Revisions

Date	Rev	Compiler	Remarks
Sept 2015	6	S. Nkosi	Final Document for Authorisation Reviewed clauses:- 1 and 2.1.1 – included the special requirement – traction and HVDC requirements; 2.2.1 – updated list of references by including – Note; [1] – added Bushing standard; [55] – added Technical evaluation criteria standard; 3.1.1; 3.1.2; 3.1.4; 3.1.7; 3.1.19, 3.2.5 and 3.2.8 – included HVDC requirements; 3.2.2 Note – updated by adding FFR, OTD and NCR's; 3.2.2.1 a) – included SANS 62271-203 for DTCB; c) – included the compartment/ tank metallic enclosure details; e) – energy storage device details updated; i) – added 3.2.6 – revised c) to include old f) with table 6. removed f) 3.2.23.1 k) – revised to align with 3.3.1.3 a) requirement; 3.3.1.2 a) – paragraph revised and introduced i., ii and iii.; 3.3.2 b) – included type-tests requirements for the bushings, CT's and the compartment/ metallic tank on DTCB; d) included routine test requirements for bushings and CT's on DTCB; 3.4.7.2.1 a) – included OEM instruction manual and/or protocol; 3.7 – revised; Annex A clause A.1 a) – updated with the reference to the Technical Evaluation Criteria and inclusion of i.;
June 2014	5	S. Nkosi	3.3.2 g) and 3.2.10 a) – Reviewed clauses on KIPTS

Date	Rev	Compiler	Remarks
May 2014	4	S. Nkosi	Reviewed clauses:- 2.1.1 – introduced maintenance analysis FMECA and digital secondary interface option 2.2 – updated list of references 3.1.1 a) revised the Note 3.1.2 included 44kV and 88kV requirements 3.1.4 included 1600A and 2000A requirements 3.1.7 included 20kA, 25kA, 31.5kA and 40kA 3.1.19 updated the classification table 3.2.1 and 3.2.6 – aligned to DSP 34-1658 3.2.2 Note – introduced FMECA and the option of the digital secondary plant interface 3.2.2.1 – new numbering 3.2.10 b – updated SPS class and included SCD of 25 mm/kV 3.2.19.1 and 3.2.21.1 – the option of the digital secondary plant interface 3.5 – included FMECA requirements 3.8 – updated number of Safety standard Appendix A.3 changed to Appendix B Appendix C – new digital secondary plant interface option Technical schedules A & B Appendix D – Maintenance analysis and templates 6 – revised the list
Aug 2013	3	S. Nkosi	Reviewed clauses:- 2.2.1; Table 4; 3.2.8 a – ii NOTE; 3.2.14; Appendix C; Document number changed to 240-56063756
July 2013	2	S. Nkosi	Final Document for Authorisation Updated all references from “this specification” to “this standard”; Included special requirements and designs that offer environmental friendliness. Reviewed clauses:- 1; 2.1.1; 2.2; 2.2.1; 2.5; 2.7; 3; 3.1.2 Table 1; 3.1.4 a); Table 2; 3.2.1; 3.2.2 a), f), e), g); 3.2.4 b), n), l, t); 3.2.5 b, Table 5; 3.2.6 e), Table 6; Deleted – 3.3 to 3.5 old numbering; 3.2.7 d); 3.2.8 a), b), Deleted – old a) – iii; 3.2.11 f); 3.2.12 a), c), f); 3.2.13 Note, a, b, d, e; 3.2.14 a) to f); 3.2.15 b); 3.2.16 a); 3.2.19 Notes; 3.2.21 b), c); 3.2.22 d), e); 3.2.23 c); 3.2.24.1 a), b) – xx, o), p) – vi – vii; 3.2.24.2; 3.2.24.3; 3.2.24.4, e), b) 3.2.25, a), b); 3.3.1 a); 3.4.2 b); 3.4.3, Note, a); 3.4.4; 3.4.5, d), e); 3.4.6 b), c – i -ii; 3.4.7 b); 3.4.7.2; 3.4.7.2.1 a); 3.5.1 d); 3.5.3.4; 3.5.4; 3.5.5; 3.6.2; 3.8; 6; A.1 a), b), g), o), q); A2 a)
May 2013	1	J. Cebekhulu	Final Document for Publication
Nov 2012	0	J. Cebekhulu	Draft document for Review created from 32-1166

6. Development team

The following people were involved in the development of this as well as previous revisions of this standard. The original document was compiled by Transmission and Distribution switchgear specialists.

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7. Acknowledgements

The Compiler acknowledges the contributions to this revision from Technology, Distribution and Transmission and Quality.

Annex A – Appendix A – Supplier and Eskom responsibilities

The responsibilities of Eskom and the Supplier of the switchgear and associated equipment shall be as defined below.

A.1 Supplier's responsibilities

The Supplier shall be responsible for, but not limited to, the following:

a) upon submission of a tender, the submission of a complete set of technical documents as required by this standard (refer to clause 3.2.23 for documentation requirements), this shall be in paper print, Adobe PDF copy and all the technical schedules A and B shall also be submitted in a copy of the Microsoft Excel format.. The tender shall state clearly all deviations (if any) in the Deviation Schedule and in schedule B (if applicable). Deviations will be evaluated by Eskom and the outcome will be communicated, in writing, to the Tenderer;

   i. The Supplier shall also read the [55] Technical Evaluation Criteria standard 240-46425564 with this document and supply all the information with the technical submission in order for the technical documentation to be evaluated by Eskom. Failing to provide information called by this standard and the [55] Technical Evaluation Criteria standard 240-46425564 shall render the technical submission disqualified for technical evaluation.

b) all testing and recording of results required by this standard as well as the OEM's own protocols using accredited personnel including the use of approved and calibrated test equipment. Type testing shall be carried out in accordance with the relevant IEC product standards. All testing shall be done at accredited local test facilities (SANAS accredited – e.g. SABS) or accredited international testing authorities (e.g. KEMA/CESI/IPH);

c) in the case of evaluation at the factory of circuit-breakers for use on systems with nominal voltages up to and including 765 kV, the erection of a completely functional prototype at the Supplier's own premises under direct supervision of the OEM for a comprehensive evaluation by Eskom before erecting on site. Unless otherwise agreed by Eskom;

d) ensuring equipment is in an acceptable and safe working condition during all phases of transportation from factory to site, storage until the point of official handing over;

e) all necessary arrangements for factory acceptance, transporting and off-loading at the most convenient point (if applicable), as well as for transporting and off-loading at the ultimate destination. Eskom will only accept delivery to the destination specified at the time of placing the order – unless otherwise negotiated. Shafts, bearings and machined surfaces exposed during transport and storage shall be treated with a temporary anti-corrosive coating;

f) provision of OEM accredited installation and pre-commissioning services for all on-site work;

g) the supply of all documentation relevant to the circuit-breaker including routine factory test results. Records shall be available during the pre-commissioning (on-site) testing phase;

h) when required, the supply of a fully complete circuit-breaker assembled, installed, pre-commission (on-site) tested and ready for handover (including, where applicable, controlled switching systems);

i) where necessary (i.e. in the absence of an on-site a.c. power supply), the supply of an a.c. power supply (e.g. generator) for the installation and pre-commissioning of switchgear;

j) the supply of all conductor clamp main terminals on the supply and load side;

k) the supply of all necessary auxiliary equipment, including operating mechanisms, control, monitoring and protective devices, installed in suitable operating mechanism enclosures;

l) the supply of all auxiliary and control wiring and terminations for the circuit-breaker, including inter-pole cabling and cabling to the central control enclosure(s). For single-pole operated circuit-breakers the wiring shall be done in the factory. No additional inter-pole wiring on site is allowed;

m) the supply of all electrical and mechanical interconnections between the elements of the circuit-breaker – made to Eskom's satisfaction;

n) the supply of all fixing bolts, fasteners and adapter plates – excluding the bolts required for fixing support structures to concrete foundations (which are to be supplied by Eskom);

o) where applicable, the first filling of the insulation and/or extinguishing medium to the OEM's rated value;

p) when required, the supply of the steel support structures for the circuit-breaker;

q) when required, testing and recording of results required by this standard as well as the OEM's own protocols using accredited personnel including the use of approved and calibrated tools and test equipment;

r) provision of all training in accordance with 240-56065202 by OEM accredited trainers;

s) any modifications required during the circuit-breaker service life; and

t) any other responsibilities as specified in this document.

A.2 Eskom's responsibilities

Eskom shall be responsible for the following:

a) the supply of the relevant standard(s) or specification(s) and completed schedule A's with the enquiry;

b) the evaluation of all equipment offered and documentation supplied with a tender. This includes the compilation of an evaluation report summarising the outcomes of the evaluation;

c) when required, the assessment and evaluation of the relevant manufacturing facilities;

d) when required, the assessment and evaluation of the relevant transport, installation and pre-commissioning facilities;

e) the approval of all drawings submitted by the Supplier (e.g. general arrangement, nameplate, schematic wiring, etc.);

f) the approval of all other documentation provided by the Supplier (e.g. manuals, training material, inspection and testing plans after installation, etc.);

g) the supply of a heater connection point for long term storage;

h) the provision of concrete foundations for the approved circuit-breaker support structure;

i) the stringing and clamping of main conductors;

j) the supply and installation of the control cabling to the circuit-breaker operating mechanism enclosure;

k) the supply and installation of all control, metering, relaying and annunciation equipment remote from the circuit-breaker;

l) specifying (at the time of placing the order) whether the steel support structure for the circuit-breaker is required to be supplied by the Supplier;

m) if necessary, provide suitable storage facilities where circuit-breakers are to be stored for extended durations prior to installation due to unplanned delays; and

n) the witnessing and approval of the first complete circuit-breaker installation and pre-commissioning.

Annex B – Appendix B – Technical Schedule A & B (Generic)

TECHNICAL SCHEDULES A & B FOR 6,6 kV to 765 kV OUTDOOR CIRCUIT-BREAKERS

SAP: ____________ BKR LT/ DT ___kV ____A ___kA _P ___VDC Creepage (BIL) Spacing

Schedule A: Purchasers specific requirements
Schedule B: Guarantees and technical particulars of equipment offered

1	2	3		4	5
Item	**Clause of 240-56063756**	**Description**		**Schedule A**	**Schedule B**
1		**Item and system description** BKR LT/ DT ___kV ____A ___kA _P ___VDC Creepage (BIL) Spacing			
1.1		• SAP No		____________	xxxxxxxxxx
1.2		• Buyers Guide Drawing		Eskom Drwg Number/ N/A	xxxxxxxxxx
1.3		• Circuit-breaker application		Transformer/Bus/Line/ Cable/Shunt Cap/ Traction/Shunt Reactor/Gen Synchronising on HV busbar (____mm phase spacing)	xxxxxxxxxx
1.4		• Nominal system voltage (U_n)	kV	__________	xxxxxxxxxx
1.5		• System voltage range	pu	0,9 to 1,1	xxxxxxxxxx
1.6		• System earthing (effective/non effective) (*1 - *non-effective when to be used on 88kV and below)*		Effective/ Non-effective	xxxxxxxxxx
		☐			
2		**Ratings**			
2.1		• Rated voltage (U_r)	kV	____________	
2.2		• Number of phases on system		3	
2.3		• Rated short-duration power-frequency withstand voltage (U_d)	kV	____________	
2.4		• Rated peak lightning impulse withstand voltage (U_p)	kV	____________	
2.5		• Rated frequency (f_r)	Hz	50	
2.6		• Rated normal current (I_r) - main circuit	A	____________	
2.7		• Calculated maximum continuous current - main circuit @ 40 ^{0}C ambient	A	xxxxxxxxxx	
2.8		• Calculated maximum continuous current - main circuit @ 45 ^{0}C ambient	A	xxxxxxxxxx	

2.9		• Maximum allowable temperature of main contacts (refer to Table 3 of SANS 62271-1)	°C	xxxxxxxxxx	
2.10		• Measured temperature rise (highest) of main contacts @ rated current (type test)	K	xxxxxxxxxx	
2.11		• Maximum allowable temperature of bolted or equiv connections (refer to Table 3 of SANS 62271-1)	°C	xxxxxxxxxx	
2.12		• Measured temperature rise (highest) of bolted or equiv connections @ rated current (type test)	K	xxxxxxxxxx	
2.13		• Maximum allowable temperature of terminals for the connection to external conductors (refer to Table 3 of SANS 62271-1)	°C	xxxxxxxxxx	
2.14		• Measured temperature rise (highest) of terminals for the connection to external conductors @ rated current (type test)	K	xxxxxxxxxx	
2.15		• Rated short-time withstand current (I_k and I_{ke})	kA	____________	
2.16		• Rated peak withstand current (I_p and I_{pe})	kA	____________	
2.17		• Rated duration of short circuit (t_k)	s	3	
2.18		• Rated d.c. supply voltage of closing and opening devices and of auxiliary and control circuits (U_a)	V	__________	
2.19		• Rated a.c. supply voltage of heaters and other a.c. auxiliary circuits (U_a)	V	230	
2.20		• Rated supply frequency of closing and opening devices and of auxiliary and control circuits	Hz	d.c.	
2.21		• Rated supply frequency of heaters and other a.c. auxiliary circuits	Hz	50	
2.22		• Rated short-circuit breaking current (I_{SC}) of circuit-breaker	kA	____________	
2.23		• Factor by which the 100 % symmetrical and asymmetrical single-phase rated short-circuit breaking current exceeds the three-phase rating	pu	__________	
2.24		• Circuit-breaker class		xxxxxxxxxx	
2.25		• First-pole-to-clear factor (k_{pp}) for circuit-breaker		____________	
2.26		• Standard values of TRV related to the rated short-circuit breaking current (SANS 62271-100)		SANS 62271-100 Table 5	
2.27		• Rated short-circuit making current of circuit-breaker	kA	____________	
2.28		• Rated operating sequence for circuit-breaker		O-0,3s-CO-3m-CO/ O(1 pole)-0,3s-C(1 pole)-O(all poles)-3m-CO(all poles)	
2.29		• Minimum resting time following rated operating sequence	min	xxxxxxxxxx	

2.30		• Characteristics for short-line faults		SANS 62271-100 4.105 for Class S2 circuit-breakers only	
2.31		• Rated out-of-phase making and breaking current for circuit-breakers	kA	xxxxxxxxxx	
2.32		• Classification of circuit-breaker according to its restrike performance (line- and cable-charging breaking current)		Class C2	
2.33		• Rated capacitive switching currents for circuit-breaker - line-charging breaking current	A	__________	
2.34		• Rated capacitive switching currents for circuit-breaker - cable-charging breaking current	A	__________	
2.35		• Classification of circuit-breaker according to its restrike performance (capacitor bank switching)		Class C2	
2.36		• Rated capacitive switching currents for circuit-breaker - single & back-to-back capacitor bank breaking current (I_{sb} & I_{bb})	A	__________	
2.37		• Frequency of the inrush current (f_{bi})	Hz	__________	
2.38		• Rated capacitive switching currents for circuit-breaker - back-to-back capacitor bank inrush making current	kA	__________	
2.39		• Chopping number of the circuit-breaker	λ	xxxxxxxxxx	
2.40		• Rated opening time for circuit-breaker	ms	xxxxxxxxxx	
2.41		• Rated break-time for circuit-breaker (max 60ms for U_n ≤ 132kV; max 50ms for U_n >132kV)	ms	shall not exceed 60 (Un ≤ 132kV) / 50 (Un >132kV)	
2.42		• Rated closing time for circuit-breaker	ms	xxxxxxxxxx	
2.43		• Rated open-close time for circuit-breaker	ms	xxxxxxxxxx	
2.44		• Rated reclosing time for circuit-breaker	ms	xxxxxxxxxx	
2.45		• Rated close-open time for circuit-breaker	ms	xxxxxxxxxx	
2.46		• Rated pre-insertion time for circuit-breaker	ms	7±1	
2.47		• Circuit-breaker mechanical endurance class		Class M2	
2.48		• Number of mechanical operations for circuit-breaker		__________	
2.49		• Classification of circuit-breakers as a function of electrical endurance		__________	
3		**Service conditions**			
3.1		• Location (indoors/outdoors)		Outdoors	
3.2		• Ambient air temperature range	°C	-10 to +40	
3.3		• Solar radiation	W/m²	1100	
3.4		• Altitude (amsl)	m	1800	
3.5		• Class of pollution (SANS 60815-1:2009)		Very heavy ('e')	
3.6		• Average humidity	%	95	
3.7		• Wind speed (velocity)	m/s	34	
3.8		• Condensation and precipitations		Yes	

3.9		• Seismic activity	g	0,3	
4		**General**			
4.1		• Circuit-breaker compliant to SANS 62271-100		Yes	
4.2		• Circuit-breaker design (live-tank / dead-tank)		Dead-tank/ Live-tank	
4.3		• Circuit-breaker manufacturer		xxxxxxxxxx	
4.4		• Circuit-breaker country of origin		xxxxxxxxxx	
4.5		• Circuit-breaker model/type designation		xxxxxxxxxx	
4.6		• Circuit-breaker total mass	kg	xxxxxxxxxx	
4.7		• CTs required		Yes/ N/A	
4.8		□ - CT manufacturer		N/A	
4.9		□ - CT country of origin		N/A	
4.10		• Support structure design		xxxxxxxxxx	
4.11		□ - Steel support structure to be supplied with circuit-breaker	Y/N	No/ Yes	
4.12		□ - Circuit-breaker pole operation		3-pole operated (3P)/ 1-pole operated (1P)	
4.13		□ - Stored energy operation for circuit-breaker mechanism		Yes	
4.14		□ - Energy storage device (*spring-hydraulic shall be considered for DTCB U_r >145kV and LTCB $U_r \geq$ 550kV and 800kV)		Spring/ (as per note*)	
		□ **NOTE:** When a feeder circuit-breaker is in the closed position and the spring has been charged, it shall be able to “TRIP-CLOSE-TRIP” before the spring needs to be recharged		Yes	
4.15		□ - Manual and motorised spring charging		Yes	
4.16		□ - Manual and electric energy release		Yes	
4.17		□ - Mechanical energy stored in charged spring	kJ	xxxxxxxxxx	
4.18		□ - Mechanical device provided to prevent over-charging of the closing spring for manual and motor charging		Yes	
4.19		□ - Safe conditions produced in the case of failure to latch		Yes	
4.20		□ - Circuit-breaker insulation and/or extinguishing medium		SF6/Enviro-friendly	
4.21		□ - Type of interrupter design (puffer, self-blast, etc.)		xxxxxxxxxx	
4.22		□ - Configuration of moving contacts (single, double or triple motion)		xxxxxxxxxx	
4.23		□ - Minimim expected life-span of circuit-breaker	years	> 40	
		□			
5		**Construction requirements**			
		• Design and layout of the circuit-breaker :			
5.1		□ - standardised circuit-breaker elements to maximise interchageability	Y/N	Yes	

5.2		- modular, pre-assembled elements shall be designed to facilitate handling and installation	Y/N	Yes	
5.3		- designed to facilitate ease of construction and maintenance	Y/N	Yes	
5.4		- Filter material housing located to provide easy access during maintenance	Y/N	Yes	
6		**Circuit-breaker operating mechanism enclosure requirements**			
6.1		• Operating mechanisms, local control facilities and all parts requiring lubrication protected by weatherproof enclosures	Y/N	Yes	
6.2		- degree of protection for enclosures containing exposed bearings, auxiliary switches, motors and other electrical devices	IP	IP 55	
6.3		- degree of protection for all open areas in the circuit-breaker common base frame as well as externally mounted indicating devices (where applicable)	IP	IP 2X	
6.4		- degree of protection for all other enclosures	IP	IP 54	
6.5		• Operating mechanism enclosure, handles and fixings material		3CR12 stainless steel/ Painted aluminium	
6.6		• Operating mechanism enclosure corrosion protection in accordance with 5.6 of DSP 34-1658	Y/N	Yes	
6.7		• Operating mechanism enclosures arranged to facilitate easy access from all sides	Y/N	Yes	
6.8		- all fastenings compliant with 240-56063756	Y/N	Yes	
6.9		• Circuit-breaker designed for operation from the front of the operating mechanism enclosure	Y/N	Yes	
6.10		• Access to the operating mechanism controls, terminals strips etc. provided through hinged front access door	Y/N	Yes	
6.11		• Maximum height to top of mechanism allows servicing from ground ($U_n \leq$ 132kV) or viewing indications and reading from ground (U_n >132kV)	Y/N	2000	
6.12		• Front access door secured with a heavy-duty locking mechanism	Y/N	Yes	
6.13		• Padlocking facility shackle diameter	mm	6	
6.14		• Front access door equipped with travel stop	Y/N	Yes	
6.15		• Rigid, corrosion resistant documentation pocket provided on inside of front access door, securely attached no protrusion through door	Y/N	Yes	
6.16		• Facilites provided for securing operating tools on inside of front access door	Y/N	Yes	

6.17		•	Earthing of operating mechanism enclosure in accordance with 240-56063756	mm	Yes	
6.18		•	Provision for bottom/ below entry of all control cabling into operating mechanism enclosure	Y/N	Yes	
6.19		•	Metallic cable racking provided for inter-pole cabling?	Y/N	No	
6.20		•	Upper surfaces of enclosure shaped/sloped to prevent the accumulation of water	Y/N	Yes	
6.21		•	Gasket material offered		Neoprene / Heavy-duty foam-plastic	
6.22		•	Gauze-covered drain hole provided (> 25 mm)	Y/N	Yes	
6.23		•	Enclosure lifting eyes provided		Top	
6.24		•	Enclosure colour		Light grey (G29)	
6.25		•	Mechanical trip facility located inside mechanism enclosure	Y/N	Yes	
7			**Circuit-breaker supporting structure**			
		•	Mechanical loads and parameters relating to the design of the circuit-breaker support structure and foundation			
7.1		☐	- "static" dead weight of the circuit-breaker	N	xxxxxxxxxx	
7.2		☐	- rated "static" terminal force F_{shA} of the circuit-breaker due to connected conductors	N	xxxxxxxxxx	
7.3		☐	- rated "static" terminal force F_{shB} of the circuit-breaker due to connected conductors	N	xxxxxxxxxx	
7.4		☐	- rated "static" terminal force F_{sv} of the circuit-breaker due to connected conductors	N	xxxxxxxxxx	
7.5		☐	- "dynamic" horizontal force exerted during operation on the foundation	N	xxxxxxxxxx	
7.6		☐	- "dynamic" vertical force exerted during operation on the foundation	N	xxxxxxxxxx	
7.7		☐	- "dynamic" moment (torque) exerted during operation about the foundation	Nm	xxxxxxxxxx	
7.8		☐	- "dynamic" horizontal force exerted between circuit-breaker poles (centre phase interrupter chamber) during a rated (terminal fault) short-circuit	N	xxxxxxxxxx	
7.9		☐	- wind force (load) exerted on the circuit-breaker	N	xxxxxxxxxx	
7.10		☐	- maximum torque required for the foundation holding down bolt nuts	Nm	xxxxxxxxxx	
7.11		•	Circuit-breaker steel support structure to be designed by manufacturer	Y/N	Yes/ No	
7.12		•	Circuit-breaker concrete foundation to be designed by manufacturer	Y/N	Yes/ No	
7.13		•	Common base frame supplied with circuit-breaker ($U_n \leq 132$ kV)	Y / N / N/A	Yes/ N/ N/A	

7.14		•	Circuit-breaker designed to interface with the standard Eskom steel support structure	Y/N	Yes/ No	
7.15		•	Circuit-breaker support structure designed to interface with the standard Eskom concrete foundation	Y/N	Yes/ No	
7.16		•	Circuit-breaker steel support structure drawing (240-56063756 Table 5)		Esk Drwg Number/ TBA	
7.17		•	Circuit-breaker concrete foundation drawing (240-56063756 Table 5)		Esk Drwg Number/ TBA	
7.18		•	Surge arrester mounting brackets supplied and fitted (U_n ≤ 33 kV)	Y/N	Yes/ No	
		□				
8			**Corrosion protection and lubrication**			
8.1		•	Corrosion specification		DSP 34-1658	
8.2		•	Corrosivity rating of environment		"high" to "very high"	xxxxxxxxxx
8.3		•	Minimum detailed specification number for exposed metal	DS	DS-11	xxxxxxxxxx
8.4		□	- Equivalent detailed specification number offered for operating mechanism enclosures	DS	xxxxxxxxxx	
8.5		□	- Equivalent detailed specification number offered for all bolts, nuts and washers	DS	xxxxxxxxxx	
8.6		□	- Equivalent detailed specification number offered for all structural steel	DS	xxxxxxxxxx	
8.7		□	- Equivalent detailed specification number offered for all other exposed metal (excluding main terminals)	DS	xxxxxxxxxx	
8.8		•	Details of lubricants provided with tender documentation	Y/N	Yes	
8.9		•	Details of flange arrangements, treatments to prevent flange corrosion provided with tender		Yes	
8.10		•	Material and Corrosion Protection Information Table 6 on the 240-56063756 standard completed	Y/N	Yes	
9			**Circuit-breaker operating mechanism enclosure heaters**			
9.1		•	Heater size offered (≥220kV use 0.54/07529)	Watt	100	
9.2		•	Heater control circuit specification (240-56030489 and Eskom standard wiring drawing)		Eskom Drwg Number and 240-56030489	
9.3		•	Heater maintains dew-point higher than ambient temperature, constantly circulates air to all parts of enclosure	Y/N	Yes	
10			**Terminal requirements**			
10.1		•	HV main terminal type		Flat pad	
10.2		•	Flat pad details:			
10.3		□	- Number of holes and pitch	mm	8 x 50/ 9 x 40	

10.4		- Thickness (min)	mm	20	
10.5		- Material		Aluminium	
10.6		• Main HV terminals shall be in accordance with SANS 62271-301	Y/N	Yes	
10.7		• HV main terminals removable without interfering with operation of circuit-breaker	Y/N	Yes	
10.8		• Details of main HV terminals shown on the GA	Y/N	Yes	
10.9		• Earthing terminals		N/A	
10.10		• Details of earthing terminals shown on the GA	Y/N	Yes	
10.11		- Circuit-breaker earthed to main substation grid through support structure and foundation holding down bolts	Y/N	Yes	
10.12		- Earthing of circuit-breaker via steel support structure and foundation holding down bolts	Y/N	Yes	
10.13		- Additional conductor provided between the circuit-breaker and the support structure	Y/N	Yes/ No	
10.14		- Material (preferably not exposed)	Cu/ Al	Yes/ No	
10.15		- Additional Ø18 mm hole provided at bottom of steel support structure (if part of supply)		N/A	
11		**Safety clearances and personnel safety**			
11.1		• Live parts isolated by means of elevation	Y/N	Yes	
11.2		• Minimum electrical working clearance (240-56063756 Table 6)	mm	__________	
11.3		• Distance from lowest part of any high-voltage insulation above ground	mm	2500	
11.4		• Type of pressure relief devices provided		xxxxxxxxxx	
12		**Insulation requirements**			
		• Hollow insulators			
12.1		- Insulator material		Ceramic DILO fitting/ Silicone rubber composite	
12.2		- Insulator manufacturer		xxxxxxxxxx	
12.3		- Ceramic type insulators in accordance with SANS 62155 and SANS 60815-2	Y/N	Yes	
12.4		- Silicone rubber composite type insulators in accordance with SANS 61462 and SANS 60815-3	Y/N	Yes	
12.5		- Circuit-breaker tested at KIPTS	Y/N	No	
		• Minimum insulation creepage distances (SANS 60815-1)			
12.6		- Minimum external unified specific creepage distance (USCD)	mm/kV	__________	
		• Clearances in air			

12.7		☐ - Phase to phase clearance in air	mm	xxxxxxxxxx	
12.8		☐ - Phase to earth clearance in air	mm	xxxxxxxxxx	
		☐			
13		**Position / status indication**			
		• Circuit-breaker position indication			
13.1		☐ - Position indication to SANS 62271-1	Y/N	Yes	
13.2		☐ - Position indication visible with operating mechanism enclosure front access door closed	Y/N	Yes	
13.3		☐ - Closed position: “I” in white lettering on a red background	Y/N	Yes	
13.4		☐ - Open position: “O” in white lettering on a green background	Y/N	Yes	
13.5		☐ - Lettering (symbol) size (min)	mm	30	
		• Closing spring status indication			
13.6		☐ - Status indicated by "SPRING CHARGED" and "SPRING DISCHARGED"	Y/N	Yes	
13.7		☐ - Lettering size (min)	mm	15	
13.8		• Type of non-resettable circuit-breaker operation counter offered		Mechanical / electrical	
13.9		• Pressure gauge provided (compensated for temperature and responding to insulation and/or extinguishing medium density) - where applicable	Y/N	Yes	
13.10		• Pressure gauge sheltered from the elements - where applicable	Y/N	Yes	
		☐			
14		**Labels**			
		• Operating labels			
14.1		☐ - Instructions for tripping (“TO TRIP”) and closing (“TO CLOSE”) the circuit-breaker	Y/N	Yes	
14.2		☐ - Instructions for charging closing springs (“TO CHARGE SPRING”)	Y/N	Yes	
14.3		• Actuator(s) for local opening and closing of the circuit-breaker labelled in accordance with 240-56063756. NOTE The trip/close actuator colour differ from IEC 60073	Y/N	Yes	
14.4		• Warning labels for manual operation; mechanical trip facility; interval between repeated CO's at testing	Y/N	Yes	
		• Function labels			
14.5		☐ - Function labels provided to identify all LV (secondary) control equipment	Y/N	Yes	
14.6		☐ - Function label text height (min)	mm	5	
14.7		• Labels manufactured to 240-56062515	Y/N	Yes	
		☐			
15		**Requirements for SF_6 gas (where applicable)** NOTE The Supplier shall provide details of other environmental friendly insulation and/or extinguishing			

		medium if applicable			
15.1		• SF_6 in accordance with IEC 60376	Y/N	Yes	
15.2		• The maximum SF_6 gas leakage rate (NB: provide details if other enviro-friendly insulation and/or extinguishing medium)	%	0,5 / year	
		• SF_6 gas purity			
15.3		- SF_6 content	%	>98	
15.4		- Dew point at rated filling pressure (max) (at +20°C)	°C & µL/L	>-10	
		• SF_6 gas-filled circuit-breaker filling and pressure monitoring			
15.5		- central gas/filling evacuation point connection provided		DILO DN8/ DILO DN20	
15.6		- height of gas filling/evacuation point above ground (max)	mm	2400	
15.7		- gas filling point and the gas pressure gauge separated	Y/N	Yes	
15.8		- dial type gauge responding to Density and indicating pressure compensated for temperature provided	Y/N	Yes	
15.9		- Density monitoring device (density switch) contact requirements		Eskom Drwg Number	
15.10		- Density monitoring device suitable for outdoor operation	Y/N	Yes	
15.11		- method/system used to prevent corrosion of moving parts and contacts		xxxxxxxxxx	
15.12		- Density monitoring device shielded against direct sunshine	Y/N	Yes	
15.13		- non-return valves fitted on all DN8/DN20 fittings and pipe work to allow removal of poles and/or density monitoring device while maintaining system pressure	Y/N	Yes	
15.14		- details of arrangement offered supplied with tender documentation	Y/N	Yes	
15.15		- pipe work material		Cu	
15.16		- separate/common filling/evacuating and density monitoring point per pole provided		Separate	
15.17		- type of electrical connections to the density-monitoring device		xxxxxxxxxx	
15.18		- cabling protected using compression glands/grommets	Y/N	Yes	
15.19		- details of all pressure devices provided with tender documentation	Y/N	Yes	
15.20		- Density monitoring device electrical interlocks and alarm requirements		Eskom Drwg Number and 240-56030489	
15.21		• Management of SF_6 gas in accordance with NRS 087	Y/N	Yes	
16		**Current Transformers**			

16.1		• Type of CT design		N/A/ Ring-type	
16.2		• CT specification		N/A/ CT Standard/ Specific per sub	
16.3		• Number of cores		N/A/ CT Standard/ Specific per sub	
16.4		• CT specification (drawing number)		Eskom Drwg Number	
16.5		• Rated short-time withstand current - magnitude	kA	N/A	
		□ Rated short-time withstand current - duration	s	N/A	
16.6		• Position relative to the circuit-breaker		N/A/ both sides (per side 1P, 1BZ, 1M)	
16.7		• Terminal numbering and wiring interface (drawing number)		N/A	
		• Protection current transformers:			
16.8		□ a) cores		N/A/ CT Standard/ Specific per sub	
16.9		□ b) class		N/A/ CT Standard/ Specific per sub	
16.10		□ c) ratios	A	N/A/ CT Standard/ Specific per sub	
		• Bus-zone current transformers:			
16.11		□ a) cores		N/A/ CT Standard/ Specific per sub	
16.12		□ b) class		N/A/ CT Standard/ Specific per sub	
16.13		□ c) ratios	A	N/A/ CT Standard/ Specific per sub	
		• Measurement current transformers:			
16.14		□ a) cores		N/A/ CT Standard/ Specific per sub	
16.15		□ b) class		N/A/ CT Standard/ Specific per sub	
16.16		□ c) burden	VA	N/A/ CT Standard/ Specific per sub	
16.17		□ d) ratios	A	N/A/ CT Standard/ Specific per sub	
16.18		• Details of the calculated magnetising curves provided on a log-scale	Y/N	Yes	
16.19		• Details of protection against mechanical damage and fixing method provided	Y/N	Yes	
16.20		• Ring-type CTs interchangeable without dismantling the bushing, this method provided with tender documentation		N/A	
		□			
17		**Switching surge control (where applicable)**			
17.1		• Pre-insertion closing resistor if offered (provide Close, Open and Pre-insetion times)		Closing, 7±1	
17.2		• Pre-insertion closing resistor resistance	Ω	ca 300 - 350	

17.3		• Electronic controller offered for switching of cap banks, reactor banks and transformers (Provide Manufacturer & Type, IEC 61850 protocol compliancy)	Y/N	Yes	
17.4		• Metal oxide surge arresters offered		xxxxxxxxxx	
		☐			

18		**Grading capacitors (where applicable)**			
18.1		• Grading capacitors if offered (provide insulation material e.g. oil/paper) (Provide Manufacturer & Type)		xxxxxxxxxx	
18.2		• Grading capacitor capacitance	pF	xxxxxxxxxx	
18.3		• Details of how to verify condition of grading capacitors during the life of the circuit-breaker provided with the tender documentation	Y/N	Yes (where applicable)	
		☐			
19		**Extreme asymmetrical short-circuit interrupting capability (where applicable)**			
19.1		• Circuit-breaker required to interrupt short-circuit currents with a higher degree of asymmetry than required by SANS 62271-100	Y/N	xxxxxxxxxx	
19.2		• Proof of higher asymmetrical interrupting capability provided with tender documentation	Y/N	Yes (where applicable)	
		☐			
20		**Requirements for simultaneity of poles during single closing and single opening operations**			
20.1		• Contact synchronism retained within rated values during the expected maintenance interval of circuit-breaker	Y/N	Yes	
20.2		☐ - time interval between contact touch for all poles of the circuit-breaker	ms	< 5	
20.3		☐ - time interval between contact touch for interrupters in the same pole	ms	< 3.3	
20.4		☐ - time interval between contact touch for individual closing resistors - where applicable	ms	< 10	
20.5		☐ - time interval between contact touch for individual closing resistors in the same pole (series connected) - where applicable	ms	< 6,6	
20.6		☐ - time interval between contact separation for all poles of the circuit-breaker	ms	< 2.5	
20.7		☐ - time interval between contact separation for interrupters in the same pole	ms	< 1	
		☐			
21		**Controlled switching**			

21.1		• All information and details provided with the tender documentation (Controller is IEC61850 protocol compliant)	Y/N	Yes	
22		**Pole discordance (PD) or phase discrepancy**			
22.1		• All information and details provided with the tender documentation	Y/N	Yes	

23		**Auxiliary and control circuits**			
23.1		• Auxiliary and control circuit requirements (≥220kV use 0.54/07529 (Live-tank CB's) & 0.54/8557 (Dead-tank CB's))		Eskom Drwg Number and 240-56030489	
		• Auxiliary power supplies:			
23.2		- Provision		On site by Eskom	
23.3		- Peak power requirement (max)	VA	xxxxxxxxxx	
23.4		- Standby power requirements	VA	xxxxxxxxxx	
		• Circuit-breaker spring-charging motor control circuit (per mechanism):			
23.5		- d.c. supply voltage range of operation	%	85 to 110	
23.6		- d.c. current (peak starting)	A	< 30	
23.7		- d.c. current (max continuous)	A	< 10	
23.8		- total time taken to charge spring	s	< 10	
23.9		- method offered for protection against continual motor running (over-run)		xxxxxxxxxx	
23.10		- automatic charging of closing spring		Yes	
23.11		- number of spare contacts of SLS provided (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))		Eskom Drwg Number	
		• Circuit-breaker closing control circuit (per mechanism):			
23.12		- d.c. supply voltage range of operation	%	85 to 110	
23.13		- d.c. power (peak)	W	≤ 500	
23.14		- number of close coils required		1	
23.15		- close coil current	A	xxxxxxxxxx	
23.16		- close coil resitance @ 20^{0}C	Ω	xxxxxxxxxx	
		• Circuit-breaker tripping control circuit (per mechanism):			
23.17		- d.c. supply voltage range of operation	%	70 to 110	
23.18		- d.c. power (peak)	W	≤ 500	
23.19		- number of trip coils required		2	
23.20		- physically and electrically separate trip control circuits		Yes	
23.21		- trip circuit supervision		Yes	
23.22		- trip coils rated to carry 20mA d.c. continuously		Yes	
23.23		- trip coil current	A	xxxxxxxxxx	
23.24		- trip coil resitance @ 20^{0}C	Ω	xxxxxxxxxx	
23.25		• Circuit-breaker equipped with anti-pumping circuitry		Yes	
23.26		• d.c. isolation switch provided		Yes	
23.27		• Circuit-breaker control circuit interlocks specification		Eskom Drwg Number and 240-56030489	
23.28		• Circuit-breaker alarm circuits wiring specification (≥220kV use 0.54/07529)		Eskom Drwg Number and 240-56030489	
		• Auxiliary contacts provided (spare for Eskom			

			use):			
		□	Duty rating			
23.29		□	- a.c. and d.c. supply current	A	10	
23.30		□	- N/O and N/C contact reference positions (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))		Circuit-breaker opened, spring discharged, gas low, relay coils de-energised	
		□	Low insulation and/or extinguishing medium alarm			
23.31		□	- N/O		0	
23.32		□	- N/C		2	
		□	Low insulation and/or extinguishing medium block contacts			
23.33		□	- N/O		0	
23.34		□	- N/C		2	
		□	Spare circuit-breaker auxiliary switch contacts (per mechanism) (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))			
23.35		□	- N/O		4	
23.36		□	- N/C		4	
		□	Spare circuit-breaker spring limit switch contacts (per mechanism) (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))			
23.37		□	- N/O		3	
23.38		□	- N/C		3	
		•	Terminal blocks and terminal strips:			
23.39		□	- Number of spare terminals provided		≥ 6	
23.40		□	- Terminal blocks to DSP 34-253, screw clamp, spring-loaded insertion type (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))		Yes	
23.41		□	- Terminal block width offered (above 132kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))	mm	≥ 8	
23.42		□	- Make of terminal block offered (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))		xxxxxxxxxx	
23.43		•	Lugs (insulated hook blade type)		Crimped	
23.44		•	Earth sliding link types/equivalents (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))		Weidmuller TVP SAKA 10	
23.45		•	Trunking provided on both sides of each terminal strip		Yes	
23.46		•	'Fine-tooth' trunking tooth width	mm	6,1	
23.47		•	Trunking size	mm	60 x 60	
		•	Wiring size:			
23.48		□	- CT and motor control circuit wires	mm^2	2,5	
23.49		□	- Control and other auxiliary wires	mm^2	1,5	
23.50		□	- Minimum number of strands		7	
		•	Wiring colour:			

23.51		☐ - CT wires		red/white/blue/black	
23.52		☐ - Earth wires		green/yellow	
23.53		☐ - All other wires		grey	
23.54		• Wiring identification		Ferruling	
23.55		• Terminal strips numbered and designated as per drawing (≥220kV use 0.54/07529)		Eskom Drwg Number	
		• LV MCBs:			
23.56		☐ - MCBs to SANS 60947-2 and IEC 60898		Yes	
23.57		☐ - Make and type offered		xxxxxxxxxx	
23.58		☐ - I_{CU}	A	xxxxxxxxxx	
23.59		☐ - I_{CS}	A	xxxxxxxxxx	
23.60		☐ - Utilisation category (SANS 60947-2)		'A'	
23.61		☐ - Max service voltage	V	xxxxxxxxxx	
23.62		☐ - d.c. MCB rated voltage	V	≥ 250	
23.63		☐ - Pollution degree (SANS 60947-2)		≥ 3	
23.64		☐ - Suitable for isolation (SANS 60947-2)		Yes	
23.65		☐ - Protection curve (SANS 60947-2 / IEC 60898)		'C'	
23.66		☐ - Location		Mechanism enclosure	
23.67		• Circuit-breaker auxiliary and control circuit wiring interface (drawing number) (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))		Eskom Drwg Number	
23.68		• Bottom entry removable brass/aluminium LV gland plates provided (minimum area 200 x 100 mm; thickness 3mm)	Y/N	Yes	
23.69		• Terminal strips shall be arranged in a vertical orientation (with minimum 150mm distance to gland plate)	Y/N	Yes	
23.70		• Earthing point inside mechanism enclosure provided, allows 10 spare secondary control cable cores	Y/N	Yes	
		☐			
24		**Nameplates**			
		• Nameplates provided for the following:			
24.1		☐ - circuit-breaker (SANS 62271-100)	Y/N	Yes	
24.2		☐ - circuit-breaker operating mechanism (SANS 62271-100)	Y/N	Yes	
24.2		☐ - CT (NRS 029)	Y/N	N/A	
24.3		• Method used to attach nameplates (riveted or screwed on)		xxxxxxxxxx	
24.4		• Nameplate material offered (engraved aluminium or stainless steel)		xxxxxxxxxx	
24.5		• Duplicate nameplates provided for CTs on inside of operating mechanism enclosure front access door	Y/N	N/A	
		☐			

25	**Tools and spares**			
	• Tools to be supplied with circuit-breaker (minimum requirements):			
25.1	☐ - full set of operating tools (Has the list on separate sheet been provided?)	Sets	1 set per circuit-breaker	
25.2	☐ - tools fitted on inside of the front access door	Y/N	Yes	
25.3	• Standard tools available for minor maintenance (Has the list on separate sheet been provided?)	Y/N	Yes	
25.4	• Specialised tools available for major maintenance purposes (Has the list on separate sheet been provided?)	Y/N	Yes	
25.5	• Spares available for maintenance (Has the list on separate sheet been provided?)	Y/N	Yes	
25.6	☐ Written letter, in case of design obsolescence has been provided?	Y/N	Yes	
26	**Documentation** **Note: All tender documentation to be provided in electronic format.** • Documentation to be supplied with tender:			
26.1	☐ - GA drawing (provide drawing number on separate sheet provided)	Sets	1	
26.2	☐ - Drawing of all insulators used in the circuit-breaker (provide drawing number on separate sheet provided)	Sets	1	
26.3	☐ - Generic layout of nameplates (provide drawing number on separate sheet provided)	Sets	1	
26.4	☐ - Generic auxiliary and control circuit schematic wiring diagram (provide drawing number on separate sheet provided)	Sets	1	
26.5	☐ - GA drawing of the operating mechanism enclosure	Sets	1	
26.6	☐ - list of spare parts with prices for each circuit-breaker offered (provide list on separate sheet provided)	Sets	1	
26.7	☐ - list of all operating tools for each circuit-breaker offered (Has the list on separate sheet been provided?)	Sets	1	
26.8	☐ - list of all standard minor maintenance tools for each circuit-breaker offered (Has the list on separate sheet been provided?)	Sets	1	
26.9	☐ - list of all specialised major maintenance tools for each circuit-breaker offered (Has the list on separate sheet been provided?)	Sets	1	

26.10		□ - full list as well as copies of type test certificates and reports (Has the report numbers on separate sheet been provided?)	Sets	1	
26.11		□ - generic routine test certificates for each circuit-breaker	Sets	1	
26.12		□ - transport, storage, installation, operating and maintenance manuals	Sets	1	
26.13		□ - training material	Sets	1	
26.14		□ - generic quality inspection and test plan (QITP)	Sets	1	
26.15		□ - all other relevant additional information requested	Sets	1	
		• Documentation to be supplied with each circuit-breaker:			
26.16		□ - Schematic wiring diagram for circuit-breaker	Sets	1	
26.17		□ - Complete set of routine test certificates for circuit-breaker	Sets	1	
26.18		□ - Commissioning and hand-over test sheet	Sets	1	
26.19		□ - Transport, storage, installation, operating and maintenance manuals	Sets	1	
26.20		• Submission of documentation requested upon awarding of contract	Y/N	Yes	
26.21		• Units used in Republic of South Africa		In tender/offer	
26.22		• Project reference list, service to Eskom		In tender/offer	
		□			
27		**Packaging requirements**			
27.1		• Each individual circuit-breaker unit packed	Y/N	Yes	
27.2		• Containers (e.g. wooden crates) suitable for transport and storage over long periods (for up to 18 months) (NB: preservation requirements in QM-58)	Y/N	Yes	
27.3		• Durable waterproof packaging designed to prevent damage to components during transportation and storage on site	Y/N	Yes	
27.4		• Suitable ventilation provided to minimise condensation	Y/N	Yes	
27.5		• Packaging able to withstand impact loadings of at least 18 kN	Y/N	Yes	
27.6		• Each crate clearly and sequentially marked	Y/N	Yes	
27.7		• Each container/crate clearly marked with a durable label using an indelible font with all specified information in 240-56063756	Y/N	Yes	
27.8		• Exposed shafts, bearings and machined surfaces treated with a temporary anti-corrosive coating	Y/N	Yes	
27.9		• Loose components or components that are subject to damage from exposure to dust or water packed in hermetically sealed plastic bags	Y/N	Yes	
27.10		• All components clearly marked	Y/N	Yes	

27.11		• Fork-lift lifting points provided on the packaging - where applicable	Y/N	Yes	
27.12		• External temporary 230 V a.c. connection point for the heater circuit provided	Y/N	Yes	
27.13		• Non-resettable impact recorder/detector provided	Y/N	Yes	
27.14		• Circuit-breaker transported with a positive gas pressure of maximum 150 kPa - where applicable	Y/N	Yes	
27.15		• Copy of the BOM shall be provided with the delivery note	Y/N	Yes	
		□			
28		**Miscellaneous**			
		• General			
28.1		• Test equipment used for pre-commissioning in accordance with 240-56063756	Y/N	Yes	
28.2		• Written commitment to provide Inspection and maintenance DVD has been provided with tender docs	Y/N	Yes	
28.3		• Required period for spares availability	Years	25 years after discontinuation of switchgear	
28.4		□ Availability of trip coils, close coils, spring charging motors, density monitoring devices, contactors & relays	Hours	12	
28.5		• Specification sheets, speed calculation points, travel curve values shall be provided at contract awarding	Y/N	Yes	
29		**Training Requirements**			
29.1		• Training offered in accordance with 240-56065202	Y/N	Yes	

SIGNATURES

Supplier	Name (Print)	Sign	Date
Factory	Name (Print)	Sign	Date
Eskom	Name (Print)	Sign	Date

Annex C – Appendix C - TECHNICAL SCHEDULES A & B for PIUs in accordance with EST 240-64685228

Requirements per specific IED

Schedule A: Purchasers specific requirements
Schedule B: Guarantees and technical particulars of equipment offered

3	**Requirements (per specific IED)**	Unit	Schedule A	Schedule B
-	IED Type		Switchgear PIU	
3.2	**Hardware and Firmware**			
3.2.1	**Manufacturer type designation**			
a	Model number		Specify	
b	Hardware version		Specify	
c	Firmware version		Specify	
3.4	**Input energising current (CT inputs)**			
3.4.1	Number of three phase CT inputs		N/A	
3.4.2	Number of three phase CT inputs with Neutral input		N/A	
3.4.3	Number of single phase/neutral CT inputs		N/A	
3.4.4	Number of Sensitive Earth Fault CT inputs		N/A	
3.5	**Input energising voltage (VT inputs)**			
3.5.1	Number of three phase VT inputs		N/A	
3.5.2	Number of single phase VT inputs		N/A	
3.6	**DC Auxiliary energising voltage**			
3.6.1	Nominal DC voltage (ordering option per application)	V	110 or 220	
3.7	**DC Binary inputs**			
3.7.1	Number of binary inputs (Nominal voltage)		Specify	
3.7.2	Number of binary inputs (48V)		N/A	
3.7.3	Number of binary inputs (24V)		N/A	
3.8	**Binary Outputs (output contacts)**			
3.8.1	Number of high-break output contacts		Specify	
3.8.2	Number of standard output contacts		Specify	
3.9	**Analogue transducer inputs and outputs**			
3.9.1	Number of analogue transducer inputs		N/A	
3.9.2	Number of analogue transducer outputs		N/A	
3.10	**Indications**			
3.10.1	Number of LED indications		Specify	
3.11	**Display**			
3.12	**Push buttons**			
3.12.1	Number of integrated push buttons		Specify	
3.16	**Communication ports and protocols**			
3.16.2	Number of fibre optic Ethernet ports (rear)		Specify	
3.16.3	Number of copper Ethernet ports (rear)		N/A	
3.17	**Event recording and oscillography**			
3.17.1	Oscillographic recorder No. analogue channels		N/A	

3.17.2	Oscillographic recorder No. digital channels		N/A	

TECHNICAL SCHEDULES A & B FOR SWITCHGEAR PIUs IN ACCORDANCE WITH EST 240-64685228

Requirements per IED product family

Schedule A: Purchasers specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

3	**Requirements (per IED family)**	Unit	Schedule A	Schedule B
-	Manufacturer product family/series name		Specify	
3.1	**Environmental conditions**			
	Requirements as per specification		Noted	
3.2	**Hardware and Firmware**			
	Requirements as per specification		Noted	
3.2.11	IEDs shall not employ any method of forced cooling.		Comply	
3.2.13	Support of IEC 61850 Logical Node LPHD as per [37] 240-42066934. Attributes serial number, model name/number and location shall be supported.		Comply	
3.2.14	Provision of a self supervision function as per specification		Comply	
3.3	**Global ratings**			
3.3.1	Nominal frequency	Hz	N/A	
3.3.1	Required operating range	Hz	N/A	
3.4	**Input energising current (CT inputs)**			
3.4.1a	Nominal current: Phase, Earth Fault	A	N/A	
3.4.1b	Nominal current: Sensitive Earth Fault (where applicable)	A	N/A	
3.4.2	Saturation current (linear) rating	I_{Nom}	N/A	
3.4.3a	Continuous overload	A	N/A	
3.4.3b	Short time overload: 1 second	A	N/A	
3.4.4	Burden per phase at I_{Nom}	VA	N/A	
3.4.5	Details provided on hardware and software filtering		N/A	
3.5	**Input energising voltage (VT inputs)**			
3.5.1a	Nominal voltage (phase-to-phase)	V	N/A	
3.5.1b	Nominal voltage (phase-to-neutral)	V	N/A	
3.5.2a	Continuous overload	V_{Nom}	N/A	
3.5.2b	Short time overload: 3 second	V_{Nom}	N/A	
3.5.3	Burden per phase at V_{Nom}	VA	N/A	
3.5.4	Details provided on hardware and software filtering		N/A	
3.6	**DC Auxiliary energising voltage**			
3.6.1	Nominal DC voltage (as per circuit-breaker ordering option)	V_{DC}	110 or 220	
3.6.2	Operating range	V_{Nom}	0.8 to 1.2	
3.6.3	Quescent burden	W	≤ 50	

3.6.100	Additional burden per energised opto input	W	Specify	
3.6.101	Additional burden per energised output contact	W	Specify	
3.6.102	Power up time	s	Specify	
3.7	**DC Binary inputs**			
3.7.1	Nominal voltage (V_{Nom})	V_{DC}	As per (3.5a)	
3.7.2	Nominal voltage (V_{Nom}) - special inputs (where applicable)	V_{DC}	N/A	
3.7.3	Requirements as per specification		Noted	
3.7.4a	Pick-up threshold range	V_{Nom}	0.70 to 0.80	
3.7.4b	Reset threshold range	V_{Nom}	0.60 to 0.70	
3.7.5	Pick-up time with AC/contact bounce rejection	ms	< 10	
3.8	**Output contacts**			
3.8.1(a)	**High-break contacts**			
i	Make and carry for 200ms at 250 Vdc	A	30	
ii	Carry for 1s at 250 Vdc	A	10	
iii	Carry continuously at 250 Vdc	A	5	
iv	Break (inductive L/R = 40ms) at 250V dc	A	10	
v	Duty cycle		3 ops in 3 sec	
vi	Durability: operations under load		> 10 000	
vii	Operate time	ms	Specify	
3.8.1(b)	**Standard contacts**			
i	Make and carry for 200ms at 250 Vdc	A	30	
ii	Carry for 1s at 250 Vdc	A	10	
iii	Carry continuously at 250 Vdc	A	5	
iv	Break (inductive L/R = 40ms) at 250V dc	A	0.2	
v	Durability: operations under load		> 10 000	
vi	Operate time	ms	Specify	

TECHNICAL SCHEDULES A & B FOR SWITCHGEAR PIUs IN ACCORDANCE WITH EST 240-64685228

Requirements per IED product family (continued)

Schedule A: Purchasers specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

3.9	**Analogue transducer inputs and outputs**			
3.9.2	Signal type		N/A	
3.9.3	Maximum output current	I_{Nom}	N/A	
3.9.4	Maximum load on outputs	Ohm	N/A	
3.9.5	Response time to 0 - 100% step change		N/A	
3.9.6	Maximum full scale error	%	N/A	
3.10	**Indications**			
3.10.2	Indications provided by		LED, LCD text	
3.10.3	Colours supported		Tricolour: R,Gr,Amber	
3.10.4	Indications visible by default (without manual intervention)		Comply	
3.10.5	Alarm reset types supported:			

a	Follow		Yes	
b	Latching, manual reset		N/A	
c	Latching, manual/auto reset		N/A	
3.10.6	Resettable via external HMI and via the IED front panel		N/A	
3.10.7	Lamp test function as per specification		N/A	
3.11	**Display**			
3.11.1	On-board back-lit display provided		Specify	
3.11.2	Display life as per IED design life		Yes (where provided)	
3.11.3	Is a screen saver feature required/provided to achieve design life?		Specify	
3.11.4	Default display of analogues as per specification		N/A	
3.11.5	Display of multiple sets of analogue data (as required)		N/A	
3.11.6a	Mimic provided		N/A	
3.11.6b	Can mimic be hidden		N/A	
3.12	**Push buttons**			
	Requirements as per specification		N/A	
3.12.5	Actuating principles		N/A	
3.12.6	Guards provided, or double action operation		N/A	
3.12.7	Identification of circuit-breaker controls		N/A	
3.13	**Programmable logic**			
3.13.1	Support for logical gates: AND, OR, NOT, timers, flip-flops, counters		N/A	
3.13.2	Flip-flop and counter states are stored in non-volatile memory		N/A	
3.13.3	Virtual outputs (internal variables) are provided		N/A	
3.14	**Setting groups**			
3.14.1	Number of settings groups		N/A	
3.14.2	Settings groups activated by MMS and via binary input		N/A	
3.15	**Security**			
3.15.2	Levels of role based access supported		≥ 3	
3.15.3	Password settable via rear Ethernet port		Yes	
3.15.4	Password length	Char	≥ 16	
3.15.5	Support for numeric, alpha and special characters		Yes	
3.15.6	Support detection and reporting of changes as per specification		Yes	
3.16	**Communication ports and protocols**			
3.16.1	**Communication ports**			
1	Front port			
a	Port type		Ethernet, USB, RS 232	
b	Protocol		Specify	
2	Rear ports			
a	Fibre optic communication type		100BaseFX (1300nm)	

b	Fibre optic cable type		50/125µm or 62.5/125µm MM	
c	Fibre optic connectors		LC (pref) or ST	
d	Optical budget	dB	Specify	
3	One multi-session or two separate ports provided		Yes	
4	Independently settable IP addresses for each port		Yes	
3.16.2	**Communication protocol**			
1	IEC 61850 supported as standard.		Yes	
3a	Protocol for remote engineering access		Specify	
3a	Remote Access protocol conforms to 240-64038621		Yes	

TECHNICAL SCHEDULES A & B FOR SWITCHGEAR PIUs IN ACCORDANCE WITH EST 240-64685228

Requirements per IED product family (continued)

Schedule A: Purchasers specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

3.17	**Real time clock and Time synchronisation**			
	Requirements as per specification		Noted	
3.17.1	Real time clock provided, suitable for 30 year IED operation		Yes	
3.17.2	Time drift per day (unsynchronised)	s	<2	
3.17.5	Clock back-up energy storage device			
a	Type (e.g. battery, capacitor)		Specify	
b	If battery, minimum lifespan	yrs	10	
c	If battery, replaceable without soldering		Yes	
3.17.7	Time synchronisation provided by		SNTP or PTP	
3.17.8	SNTP guaranteed accuracy	ms	< 10	
3.17.10	Support for local time offsetting from UTC		Yes	
3.18	**Event recorder and Oscillography**			
	Requirements as per specification		N/A	
3.18.2	Event recorder storage capacity	events	N/A	
3.18.5	Oscillography analogue signal sampling rate	kHz	N/A	
3.18.6	Oscillography digital signal sampling rate	kHz	N/A	
3.18.7	Settable oscillography recording length	s	N/A	
3.18.8	Total oscillogrpahy recording time stored	s	N/A	
3.18.10	Oscillography recorded analogue values		N/A	
3.18.11	COMTRADE file format supported		N/A	
3.18.12	Recordings time stamped, non-voltatile storage		N/A	
3.19	**Software**			
3.19.1	**Software package**			
	Requirements as per specification		Noted	
-	Software name		Specify	
-	Software version number		Specify	

3	Software backwards compatible with Eskom's installed base?		Yes	
4	Corporate software licence provided		Yes	
5	Software costs (if any) to be recovered via IED sales		Noted	
6	Eskom may copy and distribute software for Eskom use		Yes	
11	Software compatibility with Microsoft Windows		XP and 7	
12	Software requires PC administrator rights to operate		No	
3.19.2	**Software functions**			
1	All listed functions supported		Yes	
3.19.3	**Setting file data exchange**			
2	Bi-directional exchange of settings with Microsoft Excel.		Yes	
4	Open source setting file format for exchange		ASCII; *.xml; *.xls; *.csv; *.xrio; *.mdb	
6	All application-specific changes via device settings		Yes	
7	All settings and configurations uploadable to front and rear ports		Yes	
3.19.4	**Event recording and oscillography data exchange**			
1	Protocols supported		MMS file services (pref), HTTPS, FTP	
3.20	**IED simulation models**			
3.20.1a	Models available		Yes	
3.20.1b	Model format (pref: DigSilent PowerFactory)		Specify	
3.21	**Documentation**			
	Requirements as per specification		Noted	
3.21.2	Manuals reflect specific model numbers and firmware offered		Yes	
3.21.3	Manuals available in English		Yes	
3.21.6	Manuals available in searchable *.pdf format		Yes	
3.21.8	Microsoft Excel settings sheet provided		Yes	
3.21.10	Settings guideline provided		Yes	
3.22	**Design life & in-service experience**			
3.22.1	IED design life	yrs	> 20	
3.22.2	Operating record and in service history provided		Yes	
3.22.3	Details of improvements made in last 3 years provided		Yes	
3.22.4c	IED in-service experience as of tender closing	eq.yrs	> 50	

TECHNICAL SCHEDULES A & B FOR SWITCHGEAR PIUs IN ACCORDANCE WITH EST 240-64685228

Requirements per IED product family (concluded)

Schedule A: Purchasers specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

3.23	**Marking, labelling and packaging**			

	Requirements as per specification		Noted	
3.23.2	LED/push button labels slide behind clear screen		Yes	
3.24	**Spares**			
3.25	**Repairs**			
3.25.1	Repair turn around time		Specify	

TECHNICAL SCHEDULES A & B FOR SWITCHGEAR PIUs IN ACCORDANCE WITH EST 240-64685228

Type Tests per IED product family

Schedule A: Purchasers specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

4.1	**General**				**Schedule A**	**Schedule B**
4.1.4	Type testing laboratory				Specify	
4.1.4	SANS/ILAC accreditation of laboratory				Specify	
4.2	**Type Tests (per IED product family)**					
	Test	**Standard**	**Ports***	**Compliance criteria**		
-	Manufacturer product family/series name				Specify	
4.2.1	**Product Safety**					
1(a)	Dielectric withstand	IEC 60255-5	-	2kV r.m.s. 50Hz for 1 minute between all terminals to case earth, 1kV across contacts.	Comply	
1(b)	Insulation resistance	IEC 60255-5	-	Insulation resistance greater than 20MΩ when measured at 500Vd.c.	Comply	
1(c)	Electrical impulse (1.2/50µs)	IEC 60255-5	-	5kV 1.2/50µs waveform, 0.5J	Comply	
2	Enclosure protection	SANS 60529	ENC	Protected against ingress of dust particles, dripping water.	IP41 (front panel)	
				Protected against access to hazardous parts with the back of a hand.	IP1X (rear)	
4.2.2	**Environmental specifications**					
1	Cold	IEC 60068-2-1	-	16 hours at -25°C (LCD screen operative)	-25°C Test Ad	
2	Dry Heat	IEC 60068-2-2	-	16 hours tolerance at +55°C/+70°C (control room / outdoor application)	+55°C / +70°C Test Bd	
3	Cyclic Temperature and Humidity	IEC 60068-2-30	-	25°C and 95% relative humidity/ 55°C and 95% relative humidity, 12 + 12 hour cycle	+55°C Test Db	

4	Vibration	IEC 60255-21-1	-	Response: 1g, 10 - 150Hz, 1 sweep, energised. Contacts should not close for longer than 2ms.	Class 2 Response	
			-	Endurance: 1g 10 – 150Hz, 20 sweeps, un-energised. Contacts should not close for longer than 2ms.	Class 1 Endurance	
5	Shock	IEC 60255-21-2	-	Response: 5g, 11ms, 3 pulses in each direction, energised	Class 1 Response	
			-	Withstand: 15g, 11ms, 3 pulses in each direction, un-energised	Class 1 Withstand	
6	Bump	IEC 60255-21-2	-	10g, 16ms, 1000 pulses un-energised.	Class 1	
7	Seismic	IEC 60255-21-3	-	Test method A (single axis sine sweep test) 1 – 35Hz, 1 sweep.	Class 1	

TECHNICAL SCHEDULES A & B FOR SWITCHGEAR PIUs IN ACCORDANCE WITH EST 240-64685228

Type Tests per IED product family (concluded)

4.2.3	**Immunity Specifications**					
Note: Refer to IEC 60255-26 for an overview of electromagnetic compatibility requirements.						
1(a) - (c)	Voltage dips, interruption, gradial start-up/shut-down	IEC 60255-11	PS	50ms interruption has no effect on operation No maloperation for 5s interruption. No maloperation for decaying DC over 60s, rising over 60s.	Comply	
1(d)	AC ripple	IEC60255-11	PS	Device shall function correctly with 12% 100Hz ac signal superimposed on the d.c. supply.	Comply	
4.2.3	**Immunity Specifications (Continued)**					
2	Power frequency magnetic field	SANS 61000-4-8	ENC	100A/m continuous, 1000A/m 1-3s, 50Hz	Class 5	
3	1MHz oscillatory waves	IEC60255-22-1 or SANS 61000-4-18	PS, IO	2.5kV CM, 1kV DM, 2s total test duration, 6 – 10 bursts at 400Hz repetition.	Class 3	
			COM	1kV CM, 0kV DM, 2s total test duration, 6 – 10 bursts at 400Hz repetition.		

4	Electrostatic Discharge	IEC 60255-22-2 or SANS 61000-4-2	ENC	6kV Contact Discharge, 8kV Air Discharge	Class 3	
5	Radiated Radio Frequency field	IEC 60255-22-3 or	ENC	10V/m unmod r.m.s., 80% AM (1kHz), 80MHz – 1GHz, 1.4 – 2.7 GHz	-	
		SANS 61000-4-3			Class 3	
6	Fast Transient	IEC 60255-22-4	PS, IO, E	2kV, 5kHz	Class B	
			COM	1kV, 5kHz		
7	Surge	IEC 60255-22-5 or		1,2/50µs (8/20µs) voltage (current) surge:	-	
			PS, IO	0,5; 1; 2 kV line to earth, 0,5; 1 kV line to line		
			COM	0,5; 1 kV line to earth		
		SANS 61000-4-5	PS, IO	2kV	Class 3	
8	Induced Radio Frequency field	IEC 60255-22-6 or	PS, COM, IO, E	10Vrms, 150kHz – 80MHz	-	
		SANS 61000-4-6			Class 3	
9	Power Frequency immunity	IEC 60255-22-7	IO	AC voltages applied to D.C. inputs: 150V r.m.s. DM, 300V r.m.s. CM	Class A	
4.2.4	**Emission Specifications**					
Note: Refer to IEC 60255-26 for an overview of electromagnetic compatibility requirements.						
1	Conducted emission	IEC 60255-25	PS	0,15 – 0,5 MHz: 79dB(µV) quasi peak, 66dB(µV) ave.	-	
				0,5 – 30 MHz: 73dB(µV) quasi peak, 60dB(µV) ave.		
2	Radiated emission	IEC 60255-25	ENC	30 – 230 MHz: 40dB(µV) quasi peak at 10m	-	
				230 – 1000 MHz: 47dB(µV) quasi peak at 10m		

* Immunity and Emission tests are applicable to specific "ports" of the Equipment Under Test:-

COM: (Rear) communication ports; E: Earth terminal; ENC: Device enclosure; IO: Inputs/Outputs; PS: Power Supply

CM = Common Mode, DM = Differential Mode.

Annex D – Maintenance Analysis

Below is the table with the FMECA required details that shall be completed and submitted with the tender documentation by the supplier. This shall have the headings of each column as shown below.

The supplier shall provide the details of the maintenance analysis (Table 1A: FMECA sheet) to indicate the reasoning as to the identified maintenance activities and logistics requirements. Note that a criticality assessment may have to be included for each Functional Importance, Health, Usage or Environment row that is included in Table: Maintenance Requirements Definition, if the Consequence or Probability is dependent on these. The supplier shall complete the shaded areas.

The supplier shall also complete the shaded areas of the maintenance requirements definition (Table 1B). The maintenance requirements are defined based on the activities identified from the FMECA and RCM (if included) and taking criteria, associated with the actual functional location, into consideration. This results in several possible maintenance requirement permutations, one of which will be selected by the maintenance function for any item of plant, and from which a consolidated maintenance plan can then be developed.

Table D.1: FMECA Worksheet

<table>
<tr><th colspan="9">FMEA</th><th colspan="33">Criticality (Risk) Assessment</th><th>Outcome</th></tr>
<tr><th rowspan="3">Ref</th><th rowspan="3">Function / item</th><th rowspan="3">Failure mode</th><th rowspan="3">Failure mechanism / cause</th><th colspan="3">Failure effects</th><th rowspan="3">Detection method</th><th rowspan="3">Compensating provisions</th><th rowspan="2">Usage, Environment and Health</th><th colspan="4">High / Harsh / Good</th><th colspan="4">Low / Harsh / Good</th><th colspan="4">High / Mild / Good</th><th colspan="4">Low / Mild / Good</th><th colspan="4">High / Harsh / Poor</th><th colspan="4">Low / Harsh / Poor</th><th colspan="4">High / Mild / Poor</th><th colspan="4">Low / Mild / Poor</th><th rowspan="3">Maintenance Determination / Recommendation</th></tr>
<tr><th rowspan="2">Local</th><th rowspan="2">Next Higher</th><th rowspan="2">End</th><th rowspan="2">Critical</th><th rowspan="2">Significant</th><th rowspan="2">Economic</th><th rowspan="2">Run to failure</th><th rowspan="2">Critical</th><th rowspan="2">Significant</th><th rowspan="2">Economic</th><th rowspan="2">Run to failure</th><th rowspan="2">Critical</th><th rowspan="2">Significant</th><th rowspan="2">Economic</th><th rowspan="2">Run to failure</th><th rowspan="2">Critical</th><th rowspan="2">Significant</th><th rowspan="2">Economic</th><th rowspan="2">Run to failure</th><th rowspan="2">Critical</th><th rowspan="2">Significant</th><th rowspan="2">Economic</th><th rowspan="2">Run to failure</th><th rowspan="2">Critical</th><th rowspan="2">Significant</th><th rowspan="2">Economic</th><th rowspan="2">Run to failure</th><th rowspan="2">Critical</th><th rowspan="2">Significant</th><th rowspan="2">Economic</th><th rowspan="2">Run to failure</th><th rowspan="2">Critical</th><th rowspan="2">Significant</th><th rowspan="2">Economic</th><th rowspan="2">Run to failure</th></tr>
<tr><th>Functional Importance</th></tr>
<tr><td rowspan="3">1.1</td><td rowspan="3">Pressure sensor, number XYZ</td><td rowspan="3">No output</td><td rowspan="3">Mechanical or electrical damage</td><td rowspan="3">No pressure input to analogue-to-digital converter</td><td rowspan="3">Control system inhibits start-up sequence</td><td rowspan="3">No effect</td><td rowspan="3">Control system start-up test function</td><td rowspan="3">Visual alarm on operator console/ redundant sensor</td><td>Probability[1]</td><td colspan="4">D</td><td colspan="4">C</td><td colspan="4">D</td><td colspan="4">B</td><td colspan="4">C</td><td colspan="4">B</td><td colspan="4">C</td><td colspan="4">A</td><td>None</td></tr>
<tr><td>Consequence[2]</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="2"></td></tr>
<tr><td>Risk[3]</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">1.2</td><td rowspan="3">Pressure sensor, number XYZ</td><td rowspan="3">Out of range output</td><td rowspan="3">Electrical damage</td><td rowspan="3">Out of range pressure input to analogue-to-digital</td><td rowspan="3">Control system initiates shutdown sequence</td><td rowspan="3">Over-pressure of vessel possible</td><td rowspan="3">Control system continuous test function</td><td rowspan="3">Visual and audible alarm on operator console</td><td>Probability[1]</td><td colspan="4">E</td><td colspan="4">E</td><td colspan="4">E</td><td colspan="4">E</td><td colspan="4">E</td><td colspan="4">E</td><td colspan="4">E</td><td colspan="4">E</td><td></td></tr>
<tr><td>Consequence[2]</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="2"></td></tr>
<tr><td>Risk[3]</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">1.3</td><td rowspan="3">Pressure sensor, number XYZ</td><td rowspan="3">Inaccurate output</td><td rowspan="3">Electrical damage</td><td rowspan="3">Inaccurate pressure input to analogue-to-digital converter</td><td rowspan="3">Incorrect control of pressure system</td><td rowspan="3">Over or under-pressure of vessel possible</td><td rowspan="3">None</td><td rowspan="3">None</td><td>Probability[1]</td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td><td></td></tr>
<tr><td>Consequence[2]</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="2"></td></tr>
<tr><td>Risk[3]</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Table D.2: Maintenance Requirements Definition

Equipment Class:	Breaker
Equipment Sub Class:	SF6
Equipment Sub Class Family:	ABC

		Options	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Trigger Modifiers	Functional Importance	Critical																									X	X	X	X	X	X	X	X
		Significant																	X	X	X	X	X	X	X	X								
		Economic									X	X	X	X	X	X	X	X																
		Run to fail	X	X	X	X	X	X	X	X																								
	Usage / Duty Cycle	High			X	X			X	X			X	X			X	X			X	X			X	X			X	X			X	X
		Low	X	X			X	X			X	X			X	X			X	X			X	X			X	X			X	X		
	Environment	Harsh		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X
		Mild	X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X	
	Health	Very Good / Good	X	X	X	X					X	X	X	X					X	X	X	X					X	X	X	X				
		Fair / Poor / Very Poor					X	X	X	X					X	X	X	X					X	X	X	X					X	X	X	X

Key	
1M	One monthly
6M	Once every six months
1Y	Once every year
2Y	Once every two years
3Y	Once every three years
4Y	Once every four years

Maintenance Tasks	FMECA Ref No	Trigger [1] (Time and/or Condition)	Outage Y/N	Manual Y/N	Maintenance Activities
Condition Monitoring					
Inspection or Test Task 1...n					
Preventive Maintenance based on Time					
Maintenance Task 1...n					
Preventive Maintenance based on Condition					
Maintenance Task 1...n					
Corrective Maintenance:					
Maintenance Task 1...n					
Statutory Maintenance					
Maintenance Task 1...n					

SECTION 5: PARTICULARS & GUARRANTEES

PART 2.1A: 132kV CIRCUIT BREAKERS

SPECIFICATION NO:

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
1	**Class circuit breaker**		Outdoor	
2	**Number of poles**		3	
3	Manufacturer			
3.1	Type number			
3.2	Model			
4	Insulating and breaking medium		SF6 GAS	
5	**Voltage ratings**			
5.1	Impulse withstand voltage at sea level (BIL)	kV	650 peak	
5.2	Impulse withstand voltage at Pretoria altitude	kV	550 peak	
5.3	Impulse withstand voltage at sea level for SF6 breakers at :			
5.3.1	nominal working SF6 gas	kV		
5.3.2	minimum working SF6 gas	kV		
5.3.3	maximum working SF6 gas	kV		
5.4	Switching surge withstand voltage at sea level for SF6 breakers at:			
5.4.1	nominal working SF6 gas	kV		
5.4.2	minimum working SF6 gas	kV		
5.4.3	maximum working SF6 gas	kV		
5.5	One minute wet power frequency withstand voltage at :			
5.5.1	nominal working SF6 gas	kV		
5.5.2	minimum working SF6 gas	kV		
5.5.3	maximum working SF6 gas	kV		
5.6	Rated transient recovery voltage	kV peak		
5.7	First pole to clear factor			
5.8	Rated characteristic for short line faults :			
5.8.1	Rated peak factor			
5.8.2	Rate of rise of recovery voltage	kV/ mic. s		

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
6	**Electrical clearance**			
6.1	Minimum distance between live part and earth (Flashover distance)	mm	1200	
6.2	Total creepage distance across breaking chamber	mm	min 3 600	
6.3	Total creepage distance to earth	mm	min 1 450	
7	**Current ratings**			
7.1	3 second symmetrical breaking current	kA	31,5	
7.2	3 second asymmetrical breaking current	kA	36	
7.3	Maximum symmetrical short circuit-breaking current	kA		
7.4	Continuous current rating	A	2000	
7.5	Maximum three second current	kA		
7.6	Maximum rated making current at 145 kV	kA	79	
7.7	Rated breaking current under out of phase conditions	kA		
7.8	Rated line charging breaking	A	50	
7.9	Rated cable charging breaking current	A	50	
8	**Contacts**			
8.1	Main contact type			
8.2	Main contact material :			
8.2.1	Fixed			
8.2.2	Moving			
8.2.3	Insulated			
9	**Timing**			
9.1	Total circuit-breaker opening time from energisation of trip coil to final contact position	ms		
9.2	Circuit-breaker opening time from first contact break to final contact	ms		
9.3	Total circuit-breaker closing time energisation of closing coil	ms		
9.4	Minimum dead time for autoreclosing duties	ms	300	
9.5	Operating sequence		0-0,3 sec-CO	
			3 min-CO	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
10	**Auxiliary contacts**			
10.1	Spare auxiliary switch contacts to be provided additional to those normally needed for control and			
10.2	Can these contacts be adjusted :			
10.2.1	between NO and NC		Yes	
10.2.2	timing relative to breaker		Yes	
10.3	Rating of auxiliary contacts		240 AC, 5 A	
			110 DC 10 A	
11	**MECHANISM DETAILS**			
11.1	Mechanism(s) per 3 phase breaker		1	
11.2	Type of mechanism offered		Motor wound spring or Hydraulic	
11.3	Are the three poles mechanically linked?			
12	**ELECTRICAL CONTROL**			
12.1	DC control for closing and triping	V	110 (80% -	
12.2	No of closing coils		1	
12.3	No of tripping coils		2	
12.4	Maximum power rating of each coil at nominal voltage :			
12.4.1	closing	W		
12.4.2	tripping	W		
13	**Spring operated Mechanisms**			
13.1	Manual charging		Yes	
13.2	Motor recharging		Yes	
13.3	Rated power of individual charging motor	W		
13.4	Rated voltage of charging motor	V	110 DC	
13.5	Maximum motor starting current	A		
13.6	Duration of maximum starting	ms		
13.7	Duration of normal charging cycle - after :			
13.7.1	Close operation	s		
13.7.2	To recharge fully discharged	s		
13.8	Mechanism heaters			
13.9	Are heaters provided			
13.1	Heater auxiliary supply		240 V, 50 Hz	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
14	**GENERAL PHYSICAL DETAILS**			
14.1	Pole spacing		2 000 mm	
14.2	Height of upper electrical connection above ground		4 100 mm	
14.3	Height of lower electrical connection above ground			
14.4	Height of structure for above connection heights			
14.5	Dimensions of electrical connector			
14.6	Material of electrical connector			
14.7	Total mass of complete circuit-breaker (excluding structure)	kg		
14.8	Construction of mechanism		Weatherproof	
14.9	Dynamic forces when operating :			
14.9.1	- up	N		
14.9.2	- down	N		
15	**MAINTENANCE**			
15.1	Number of interruptions before inspection of contacts at :			
15.1.1	Full fault interrupting capacity		min 10	
15.1.2	Rated current			
15.1.3	No load			
15.2	Number of interruptions before replacement of contacts at :			
15.2.1	Full fault interrupting capacity		min 10	
15.2.2	Rated current			
15.2.3	No load			
15.3	Accumulated breaking current before inspection of contacts :	(kA)ý		
15.4	Period of operation after which inspection of contacts is required	years		
15.5	Details of contact replacement procedure (please attach a separate description or manual)			
15.6	Volume of SF6 gas required for one complete CB	m3		
15.7	Number of technical manuals		One per CB	

SECTION 5: PARTICULARS & GUARRANTEES

PART 2.1B: 275kV CIRCUIT BREAKERS

SPECIFICATION NO:

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
1	**Class circuit breaker**		Outdoor	
2	**Number of poles**		1	
3	Manufacturer			
3.1	Type number			
3.2	Model			
4	Insulating and breaking medium		SF6 GAS	
5.3	Impulse withstand voltage at sea level for SF6 breakers at :			
5.3.1	nominal working SF6 gas	kV		
5.3.2	minimum working SF6 gas	kV		
5.3.3	maximum working SF6 gas	kV		
5.4.1	nominal working SF6 gas	kV		
5.4.2	minimum working SF6 gas	kV		
5.4.3	maximum working SF6 gas	kV		
5.5	One minute wet power frequency withstand voltage at :			
5.5.1	nominal working SF6 gas	kV		
5.5.2	minimum working SF6 gas	kV		
5.5.3	maximum working SF6 gas	kV		
5.6	Rated transient recovery voltage	kV peak		
5.7	First pole to clear factor		1.3	
5.8	Rated characteristic for short line faults :			
5.8.1	Rated peak factor			
5.8.2	Rate of rise of recovery voltage	kV/ mic. s		
6	**Electrical clearance**			
6.1	Minimum distance between live part and earth (Flashover distance)	mm		
6.2	Total creepage distance across breaking chamber	mm		
6.3	Total creepage distance to earth	mm		
7	**Current and voltage ratings**			

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
7.1	**Current ratings**			
7.1.1	Rated short-circuit breaking current	kA	40	
7.1.2	Rated short-time (3 sec) withstand current	kA	50	
7.1.3	Rated peak withstand current	kA	100	
7.1.4	Continuous current rating	A	3150	
7.2	**Rated insulation levels**			
7.2.1	Rated Voltage (r.m.s)	kV	300	
7.2.2	Rated lightining impulse withstand voltage	kV	1050	
7.2.3	Rated short-duration Power-frequency withstand voltage	kV	395	
7.2.4	Rated switching impulse withstand voltage	kV	850	
8	**Contacts**			
8.1	Main contact type			
8.2	Main contact material :			
8.2.1	Fixed			
8.2.2	Moving			
8.2.3	Insulated			
9	**Timing**			
9.1	Total circuit-breaker opening time from energisation of trip coil to final contact position	ms		
9.2	Circuit-breaker opening time from first contact break to final contact	ms		
9.3	Total circuit-breaker closing time energisation of closing coil	ms		
9.4	Minimum dead time for autoreclosing duties	ms	300	
9.5	Operating sequence		0-0,3 sec-CO	
			3 min-CO	
10	**Auxiliary contacts**			
10.1	Spare auxiliary switch contacts to be provided additional to those normally needed for control and			
10.2	Can these contacts be adjusted :			
10.2.1	between NO and NC		Yes	
10.2.2	timing relative to breaker		Yes	
10.3	Rating of auxiliary contacts		230 AC, 5 A	
			110 DC 10 A	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
11	**MECHANISM DETAILS**			
11.1	Mechanism(s) per 3 phase breaker		1	
11.2	Type of mechanism offered		Motor wound spring or Hydraulic	
11.3	Are the three poles mechanically linked?			
12	**ELECTRICAL CONTROL**			
12.1	DC control for closing and triping	V	110 (80% -	
12.2	No of closing coils		1	
12.3	No of tripping coils		2	
12.4	Maximum power rating of each coil at nominal voltage :			
12.4.1	closing	W		
12.4.2	tripping	W		
13	**Spring operated Mechanisms**			
13.1	Manual charging		Yes	
13.2	Motor recharging		Yes	
13.3	Rated power of individual charging motor	W		
13.4	Rated voltage of charging motor	V	110 DC	
13.5	Maximum motor starting current	A		
13.6	Duration of maximum starting	ms		
13.7	Duration of normal charging cycle - after :			
13.7.1	Close operation	s		
13.7.2	To recharge fully discharged	s		
13.8	Mechanism heaters			
13.9	Are heaters provided			
13.1	Heater auxiliary supply		230 V, 50 Hz	
14	**GENERAL PHYSICAL DETAILS**			
14.1	Pole spacing			
14.2	Height of upper electrical connection above ground			
14.3	Height of lower electrical connection above ground			
14.4	Height of structure for above connection heights			
14.5	Dimensions of electrical connector			

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
14.6	Material of electrical connector			
14.7	Total mass of complete circuit-breaker (excluding structure)	kg		
14.8	Construction of mechanism		Weatherproof	
14.9	Dynamic forces when operating :			
14.9.1	- up	N		
14.9.2	- down	N		
15	**MAINTENANCE**			
15.1	Number of interruptions before inspection of contacts at :			
15.1.1	Full fault interrupting capacity		min 10	
15.1.2	Rated current			
15.1.3	No load			
15.2	Number of interruptions before replacement of contacts at :			
15.2.1	Full fault interrupting capacity		min 10	
15.2.2	Rated current			
15.2.3	No load			
15.3	Accumulated breaking current before inspection of contacts :	(kA)ý		
15.4	Period of operation after which inspection of contacts is required	years		
15.5	Details of contact replacement procedure (please attach a separate description or manual)			
15.6	Volume of SF6 gas required for one complete CB	m3		
15.7	Number of technical manuals		One per CB	

	Standard	Technology

Title: **HIGH VOLTAGE OUTDOOR DISCONNECTORS AND EARTHING SWITCHES STANDARD**

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Date: 10/12/2015

PCM Reference: **<xxxxxx>**

SCOT Study Committee Number/Name: **<Number or name>**

Content

Figures

Tables

1. Introduction

This standard covers Eskom's specific and standard requirements for outdoor alternating current disconnectors and earthing switches from 11 kV up to and including 765 kV system voltage levels. The "equipment" hereinafter mentioned refers to disconnectors (isolators) as well as earthing switches forming combined units with disconnectors (isolators) or separately mounted earthing switches as applicable. The terminology "disconnectors" and "earthing switches" is mainly used in this standard.

The equipment specified herein will be used on the Eskom's Transmission and Distribution's 50 Hz AC high voltage system for purposes of safety isolation, safety earthing and circuit selection.

This standard is based on SANS 62271-102: Alternating current disconnectors and earthing switches.

2. Supporting clauses

2.1 Scope

2.1.1 Purpose

This standard covers Eskom's technical requirements for high-voltage outdoor disconnectors and earthing switches for voltages above 1 000V. It provides the specific and standardised requirements. This standard covers preferred ratings; construction and testing requirements; and application, loading, installation, operation, and maintenance guidelines for all high-voltage outdoor air switches rated in excess of 1000 V. This includes such switch types as disconnectors and earthing switches for manual or power operation. The specification addresses design, manufacture, testing, supply, delivery, erection, pre-commission testing, operation and maintenance training of outdoor type disconnectors, earthing switches and associated equipment specified herein. The disconnectors and earthing switches shall comply with SANS 62271-102 and the additional and special requirements mentioned in this standard.

The purpose of this standard is to provide a basic standard for air insulated disconnector and earthing switches.

A set of technical schedules A and B accompanies this standard, which are as per Annex A (Generic). Additional and special requirements are also included in schedule A.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

NOTE: When issuing an enquiry based on this standard, it should be stated in the enquiry that the editions of the normative references that are current at the date of issue of the enquiry shall apply, unless otherwise agreed with Eskom. However in special cases, the responsible engineer may rule that the editions of one or more normative references applicable at the effective date of the Eskom specification shall apply

2.2.1 Normative

[1] SANS 62271–102, Alternating current disconnectors and earthing switches.

[2] SANS 62271–1, Common clauses for high-voltage switchgear and control gear standards.

[3] SANS 60529, Degrees of protection provided by enclosures (IP code).

[4] SANS 60137, Insulated bushings for alternating voltages above 1 000 V.

[5] SANS 60265-1, High-voltage switches – Part 1: Switches for rated voltages above 1 kV and less than 52 kV.

[6] SANS 62271-104, High-voltage switches – Part 2: High-voltage switches for rated voltages of 52 kV and above.

[7] SANS 60273, Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1 000 V

[8] SANS 60168, Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1 000 V

[9] SANS 60815, Selection and dimensioning of high-voltage insulators intended for use in polluted conditions Part 1: Definitions, information and general Principles

[10] SANS 60815, Selection and dimensioning of high-voltage insulators intended for use in polluted conditions Part 2: Ceramic and glass insulators for ac systems

[11] SANS 62262, Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)

[12] SANS 62271-301, Dimensional standardisation of high-voltage terminals

[13] Occupational Health and Safety Act (OHS Act) No. 85 of 1993 – Construction and Electrical Machinery Regulations.

[14] SANS 121 (ISO 1461) Hot-dip galvanised coatings on fabricated iron and steel articles – Specifications and test methods.

[15] SANS 1019, Standard voltages, currents and insulation levels for electricity supply.

[16] SANS 1091, National colour standard.

[17] ESP 32-846: Operating Regulations for High Voltage Systems (ORHVS)

[18] QM-58, Supplier contract quality requirements specification

[19] TPC41-141: Commissioning of new substation plant documentation and check sheets.

[20] 240-75655504, Corrosion protection specification for new indoor and outdoor Distribution equipment manufactured from steel.

[21] 240-56065202, Switchgear training requirements from original equipment manufacturers.

[22] 240-56062328: Rev 0 KIPTS natural ageing and pollution performance test procedure for outdoor insulator products Section 0 – General Requirements

[23] 240-56062330: Rev 0 KIPTS natural ageing and pollution performance test procedure for outdoor insulator products Section 4 – Particular requirements for Switch Disconnectors

[24] Technical Bulletin: 06TB-027: CAP’s Requirements for KIPTS Test reports

[25] 240-89286480, Proposed HV linked isolator (three pole) auxiliary switch (secondary) contact arrangements

[26] D-DT 5200: Substation standard drawing-foundations and structural supports

[27] D-DT 6000: Buyers Guide - substation

[28] 0.54/07129: Outdoor application earth switch 220, 275, 400 & 765kV standard terminal numbering

[29] 0.54/07858: Outdoor application isolator 220, 275, 400kV & 765 kV standard terminal numbering

[30] 0.54/07859: Outdoor application isolator 132kV and below standard terminal numbering

[31] 0.54/07860: Outdoor application earth switch 22- 132kV standard terminal numbering

[32] 0.54/07861: Outdoor application isolator pantograph 220, 275, 400 & 765kV standard terminal numbering

[33] 0.54/3987: 400kV three phase bus bar isolator support (5,5m phase centres)

[34] 0.54/3558: 400kV three phase bus bar earthing switch support tubular substation

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

For the purposes of this standard and clause 3 of SANS 62271-1, the following terms, definitions and abbreviations are applicable:

Definition	Description
Disconnector	A mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements. A disconnector is capable of opening and closing a circuit when either negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the poles of the disconnector occurs. It is also capable of carrying currents under normal circuit conditions and carrying for a specified time currents under abnormal conditions such as those of short circuit.
Disconnector terminology	It is equivalently used in this standard for isolators, links, pantograph, semi pantograph and knee type designs.
Earthing switch	A mechanical switching device for earthing parts of a circuit, capable of withstanding for a specified time currents under abnormal conditions such as those of short circuit, but not required to carry current under normal conditions of the circuit.
In-line arrangement	The individual phases are in parallel with the busbar and in line with each other, with the disconnector in the closed position.
The definitions given in SANS 62271-100 and the following shall apply:	
Breakdown maintenance	Unplanned (or unscheduled) maintenance work required to repair a fault and thus restore the switchgear and control gear to an acceptable condition after a failure.
Major maintenance (overhaul)	Work performed with the objective of repairing or replacing parts which are found to be out of tolerance by inspection, test, examination, or as required by manufacturer's maintenance manual, in order to restore the component and/or the switchgear and control gear to an acceptable condition (within tolerance). **NOTES** 1) This is the definition of “overhaul” given in 3.1.11 of SANS 62271-1. 2) Major maintenance involves the execution of specialised maintenance where specialised knowledge and skills are required and is also sometimes referred to as specialised maintenance.

Definition	Description
Minor maintenance	The execution of scheduled or preventive maintenance work in accordance with the manufacturer's maintenance manual and requiring the switchgear and control gear to be taken out of service (i.e. in a down state). **NOTES** 1) Observations resulting from minor maintenance can lead to the decision to carry out an overhaul. 2) Scheduled maintenance is defined in 3.1.7 of SANS 62271-1. 3) Minor maintenance may be time-based and/or condition-based. 4) Minor maintenance may also include *switchgear* examination (refer to 3.1.10 of SANS 62271-1) with diagnostic tests (refer to 3.1.9 of SANS 62271-1). 5) Minor maintenance may also be referred to as 2nd line maintenance.
Routine inspection	Visual investigation of the principal features of the switchgear and control gear in service without dismantling. **NOTES** 1) This inspection is generally directed toward pressures and/or levels of fluids, tightness, position of relays, pollution of insulating parts, but actions such as lubricating, cleaning, washing, etc. which can be carried out with the switchgear and control gear in service are also included. 2) Observations resulting from inspection can lead to the decision to carry out an overhaul. 3) As indicated in note 1 above, routine inspection may include scheduled maintenance activities in accordance with the manufacturer's maintenance manual. 4) Routine inspection may also be referred to as 1st line maintenance. 5) This is the definition of "inspection" given in 3.1.8 of SANS 62271-1.
Specialised tools	Purposely designed tools that are necessary to carry out maintenance on a disconnector and/or earthing switch. Typical examples of such tools are jigs for contact assembly and/or contact pressure, mechanical bearing assembly and disassembly, etc.
Working clearance	Straight line distance (clearance) from the closest live part at service voltage to ground level required to safely conduct work.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
Disconnector class M1	Disconnector having an extended mechanical endurance of 2 000 operating cycles
Disconnector class M2	Disconnector having an extended mechanical endurance of 10 000 operating cycles
OEM	Original Equipment Manufacturer
ORHVS	Operating Regulations for High Voltage Systems

Abbreviation	Description
PVC	Poly Vinyl Chloride
RIV	Radio Influence Voltage
SPS class	Site Pollution Severity class

2.5 Roles and responsibilities

PDE HV Plant Engineering shall ensure that the approved standard is in place for use by Eskom.

The detailed list of Supplier and Eskom responsibilities are covered under Clause 3.46.2 and 3 47.

2.6 Process for monitoring

Not applicable.

2.7 Related/supporting documents

Technical schedules A & B.

3. Service Conditions

The normal service conditions for outdoor switchgear and control gear specified in SANS 62271-1 shall apply. The following additional specific requirements shall be taken into account:

a) Ambient temperatures ranging from -10 ^{o}C to +45 ^{o}C. Sudden and drastic temperature changes are encountered with the resulting condensation of water vapour that can take place within housings, mechanism boxes and hollow components.

b) Solar radiation intensity up to a level of 1100 W/m^2 as well as significant ultra-violet (UV) radiation intensity.

c) The altitude does not exceed 1800 m. De-rating effects due to lower air density in terms of dielectric withstand, Radio Influence Voltage (RIV) behaviour and continuous current handling capability up to an altitude of 1 800 m above sea level.

d) Airborne pollution in the form of dust, smoke, corrosive gases and saline content due to location in areas of industrial activity, close proximity to the sea and so on.

- The class of corrosion characterizing the site severity will be specified in Schedule A in accordance and the details required under clause 3.20.3 shall be supplied with tender documentation.

e) Mechanical forces due to wind and overhead conductor loadings up to a maximum continuous value of 1500 N in any direction imposed on the main terminals.

f) Wind pressure: not exceeding 700 Pa (equivalent to 34 m/s)

g) Unusual service conditions, example, abnormal vibration, shocks, earthquakes, or tilting and or seismic activity up to 0, 3 g.

4. Ratings

All required ratings are specified in schedule A. The ratings stated in Schedule B shall be the actual values determined by type testing, not merely the values specified in schedule A.

4.1 Rated Voltage (U_r)

The rated maximum voltage of a switch is the highest root-mean-square (rms) line-to-line voltage of rated power frequency for which the switch is designed to operate.

The rated voltage of the disconnectors shall be in accordance with the values given in section 1. The rated voltage will be specified in schedule A. The rated voltage offered shall be stated in schedule B.

Note: The nominal system voltages in Eskom's are 11 kV, 22 kV, 33 kV, 66 kV, 88kV, 132 kV, 220 kV, 275 kV, 400 kV and 765 kV. For 88kV system, the 132kV disconnectors and earthing switches are used.

4.2 Rated Insulation Level

The rated insulation levels of the disconnectors shall be in accordance with the values given in Table 1 and shall be stated in schedule B.

Table 1: Rated insulation levels for rated voltages

Rated voltage for equipment U_r [kV] r.m.s.	Nominal system Voltage Un [kV] r.m.s.	Rated short-duration power frequencies withstand voltage Ud [kV] r.m.s.		Rated lightning impulse withstand peak voltage Up [kV]		Rated switching impulse withstand peak voltage U_s [kV]		
		Common value	Across the isolating distance	Common value	Across the isolating distance	Phase-to-earth and across open switching device	Between phases	Across isolating distance
12	11	28	32	75	85	N/A	N/A	N/A
24	22	50	60	125	145	N/A	N/A	N/A
36	33	70	80	170	195	N/A	N/A	N/A
52	44	95	110	250	290	N/A	N/A	N/A
72,5	66	140	160	325	375	N/A	N/A	N/A
100	88	185	210	450	520	N/A	N/A	N/A
145	132	230 275	265 315	550 650	630 750	N/A	N/A	N/A
245	220	360 395	415 460	815 950	950 1 050	N/A	N/A	N/A
300 362	275	395 450	435 520	950 1050 1050 1175	950+(170) 1050+(170) 1 050(+205) 1 175(+205)	750 850 850 950	1 125 1 275 1275 1 425	700 + (245) 800(+295)
420	400	520	610	1 425	1425+(240)	1 050	1 575	900 +(345)
550	400	620	800	1550	1550 (+315)	1050	1175	900 (+450)
800	765	960	1 150	2 100	2100+(455)	1 425	2 420	1175 +(650)

The information in this Table is extracted from SANS 1019 and SANS 62271-1 with correction applied for Eskom requirements. These values represent Eskom's minimum requirements.

4.3 Rated Frequency

The rated power frequency is the fundamental steady-state supply voltage frequency at which the switch is designed to operate. The rated frequency of disconnectors and earthing switches shall be 50 Hz.

4.4 Rated Normal Current and Temperature Rise

The rated continuous current is the maximum current the switch shall be required to carry continuously under usual service conditions without exceeding specified temperature limits.

The specific rated normal current of disconnectors shall be 1600 A; 2500 A; 3150 A and 4000 A and clause 4.4 of and SANS 62271-1 is applicable.

The rated normal current shall be specified in schedule A. The tenderer shall state the rated normal current offered in schedule B. The associated temperature and temperature rise limits shall be in accordance with the and SANS 62271-1.

Table 2: Rated values of normal current (I_r), short-time withstand current (I_k) and peak withstand current (I_p)

Rated Voltage (U_r) [kV]	Rated normal current (I_r) [A]					Rated short- time withstand current (I_k) [kA]	Rated peak withstand current (I_p) [kA]
	1600	**2000**	**2500**	**3150**	**4000**		
12	x	x	x	-	-	20 /25	50 / 63
24	x	-	x	-	-	20 / 25 / 31.5	50 / 63 / 80
36	x	x	x	-	-	20 / 25 / 31.5	50 / 63 / 80
52	x	x	x	-	-	20 / 25 / 31.5	50 / 63 / 80
72,5	x	x	x	x	-	20 / 25 / 31.5	50 / 63 / 80
100	x	-	x	-	-	20 / 25/40	50 / 63/100
145	x	x	x	x	-	20 / 25 / 40	50 / 63 / 100
245	-	-	x	x	-	40 / 50	100 / 125
300	-	-	-	x	-	50	125
420	-	-	-	x	x	50 / 63	125 / 160
550	-	-	-	x	x	50 / 63	125 / 160
800	-	-	-	x	x	50	125

4.5 Rated Short Time Withstand Current (I_k)

The rated short-time withstand current shall be as sub clause 4.5 of SANS 62271-1 with the following addition, for Eskom requirements refer to Table 2. If an earthing switch is combined with a disconnector as a single unit, the rated short-time withstand current of the earthing switch shall, unless otherwise specified, be at least equal to that assigned to the disconnector.

The rated short-time current shall be stated in schedule A. The tenderer shall state the rated short-time current offered in schedule B and time period.

4.6 Rated Peak Withstand Current (I_p)

Sub clause 4.6 of SANS 62271-1 is applicable with the following addition, for Eskom requirements refer to Table 2.

If an earthing switch is combined with a disconnector as a single unit, the rated peak withstand current of the earthing switch shall, unless otherwise specified, be at least equal to that assigned to the disconnector.

The rated peak withstand current shall be stated in schedule A. The tenderer shall state the rated peak withstand current offered in schedule B.

4.7 Rated Duration of Short-circuit (t_k)

The rated duration of short-circuit shall be 3 seconds and sub-clause 4.6 of SANS 62271-1 is applicable with the following addition:

If an earthing switch is combined with a disconnector as a single unit, the rated duration of the short-time withstand current of the earthing switch shall, unless otherwise specified, be at least equal to that assigned to the disconnector.

4.8 Rated Supply Voltage of Closing and Opening Devices and of Auxiliary and Control Circuits (U_a)

Sub clause 4.8 of SANS 62271-1 is applicable; limit is covered in schedule A.

4.9 Rated Supply Frequency of Closing and Opening Devices and of Auxiliary Circuits

Sub clause 4.9 of SANS 62271-1 is applicable.

4.10 Ice Breaking Capability

The rated ice breaking capability shall be stated in schedule B.

Notwithstanding the fact that the operating environment is not conducive to severe icing conditions, mechanical strength reserves and safety factors of the equipment shall be satisfactorily demonstrated by having successfully passed an ice-breaking test according to SANS 62271-102 Clause 6.103 for a Class 10 category.

4.11 Rated Short-circuit Making Current

Earthing switches to which a rated short-circuit making current has been assigned shall be capable of making at any applied voltage, up to and including that corresponding to their rated voltage, any current up to and including their rated short-circuit making current.

If an earthing switch has a rated short-circuit making current, this shall be equal to the rated peak withstand current.

The rated short-circuit making current shall be stated in schedule A. The tenderer shall state the rated short-circuit making current offered in schedule B.

4.12 Rated Contact zone

The rated values of contact zone shall be obtained from the manufacturer. This refers also to a tolerable angular displacement of the fixed contact. For proper function of the disconnector or earthing switch, the user shall ensure that the fixed contact stays within these limits by considering the service conditions when specifying the substation design and the cantilever strength of insulators

4.13 Rated Mechanical Terminal Load

The rated mechanical terminal load shall be stated by the manufacturer in accordance with SANS 62271-102. This shall be stated in schedule B.

Disconnectors and earthing switches shall be able to close and open while subjected to their rated static mechanical terminal loads.

The maximum static mechanical terminal load to which the terminal of a disconnector or earthing switch is allowed to be subjected under the most disadvantageous conditions is the rated static mechanical terminal load of this disconnector.

Recommended rated static mechanical terminal loads are given in table 3 of SANS 62271-102 and are intended to be used as a guide.

Rated Values of the Bus-transfer Current Switching Capability of Disconnectors

This sub clause is applicable to disconnectors rated 52 kV and above. The tenderer shall state the rated value of bus transfer current switching capability in schedule B.

The value of the rated bus-transfer current for both air-insulated and gas-insulated disconnectors shall be 80 % of the rated normal current. It will normally not exceed 1 600 A, irrespective of the rated normal current of the disconnector.

NOTE: A maximum rated bus-transfer current of 1 600 A was chosen as being typically the highest current which can be switched even though the rated normal current of the disconnector may be substantially greater. It is common practice to select disconnectors based on the short-time current ratings as well as the rated normal current. The maximum continuous current carried by the disconnector, therefore, may be considerably less than the rated normal current. Rated bus-transfer currents greater than 80 % of the rated normal current or greater than 1 600 A may be assigned by the manufacturer.

4.14 Rated Values of the Induced Current Switching Capability of Earthing Switches

This sub clause is applicable to disconnectors rated 52 kV and above. The tenderer shall state the rated value of the induced current switching capability in schedule B.

4.15 Rated Values of Mechanical Endurance for Disconnectors

A disconnector shall be able to perform the following number of operations taking into account the programme of maintenance specified by the manufacturer. Eskom shall specify the required mechanical endurance class of the disconnector in schedule A.

The tenderer shall state the mechanical endurance class of the disconnector in schedule B.

Table 3: Classification of disconnectors for mechanical endurance

Class	Type of disconnector	Number of operating cycles
M1	Disconnector intended for use with a circuit breaker of equal class (extended mechanical endurance)	2 000
M2	Disconnector intended for use with a circuit breaker of equal class (extended mechanical endurance)	10 000

4.16 Rated Values of Electrical Endurance for Earthing Switches

Earthing switches have three classes of electrical endurance:

a) earthing switches with no making capability = class E0;

b) earthing switches with short-circuit making capability = class E1 (these earthing switches have the making capability of two making operations);

c) earthing switches with a short-circuit making capability of five making operations = class E2;

d) Eskom shall specify the required electrical endurance class of the disconnector in schedule A.

e) The tenderer shall state the electrical endurance class of the disconnector in schedule B.

5. Design and Construction

5.1 Requirements

5.1.1 Design, Component and Material Changes

NOTE: For the duration of the contract and also applicable to once off orders, no changes shall be made to the equipment as well as the officially approved drawings. If such changes are unavoidable, agreement to such changes require written approval by the Commodity Manager (refer to QM-58 specification)

In the event of changes to the equipment, the change(s), together with the reasons for wishing to make the change, shall be forwarded to the Commodity Manager. All concessions shall be approved by Eskom.

In the case that changes are required, a modification instruction with pictures, drawings and measurements shall be provided.

Suitable training and parts shall be supplied to Eskom within 30 days of any modification required for all disconnectors and earthing switches supplied to Eskom.

a) The handling of all defects shall be referred to the commercial rules of the contract.

b) Life expectancy of the equipment shall be to the type tested values of the design, mechanical and electrical endurances but is expected to be not less than 40 years when operating at least twice per day.

5.1.2 Type of Disconnector

The type of disconnector, e.g. conventional or pantograph shall be as specified in schedule A. The tenderer shall state the type of disconnector in schedule B.

Note: Only the exact type of disconnector specified will be acceptable. No alternatives will be considered.

Type of Operation for the Disconnector

a) Hand operated mechanism shall be for voltages up to 132 kV with the option of motor operated for 66 kV up to 132 kV.

b) For voltages 220 kV and above shall only be motor operated. The type of operation as well as the number of operating mechanisms per disconnector shall be as specified in schedule A. The tenderer shall state the disconnector type of operation in schedule B.

c) For voltages above 132 kV, only double action low friction entry current path disconnector shall be acceptable.

d) For 132 kV and below voltages, the low friction entry is preferred but also proven direct free entry designs shall be considered.

e) All disconnectors shall have type tested and proven dead centre or over-locking method.

5.1.3 Adjustment Facilities and Stability of Settings

a) At points where stable and fine adjustment is necessary to achieve correct functional behaviour this must be possible in a step-less manner. Typically preferred examples are right/left handed threaded components, slotted flanges and/or levers or other methods which makes it possible to achieve this function reliably during the life expectancy of the disconnector.

Note: Use of round section U-bolt clamps and other similar methods for fine adjustment purposes is considered as not meeting this “step-less” requirement and is therefore not acceptable and is considered sufficient reason to reject a bid on technical grounds.

b) Adjustment facilities shall be fixed by an approved method such as locknuts and shall not require drilling and pinning.

c) Adjustment facilities and their fixings shall be designed for the life expectancy of the equipment.

5.2 Earthing Switches

5.2.1 Type of Earthing Switch

The number and type of earthing switch namely in-built or separate free standing shall be as specified in schedule A. The tenderer shall state the type of offered earthing switch in schedule B.

Note: An in-built earthing switch means an earthing switch fitted to a disconnector using portions of the disconnector for its construction.

5.2.2 Type of Operation

The type of operation for earthing switches shall be specified in schedule A. unless otherwise specified; three-pole ganged manual operation is standard. The tenderer shall state the type of offered earthing switch operation in schedule B. From rated voltages at and above 220kV, only double-action motion of the earthing switch blade shall be acceptable.

5.2.3 Special Requirements for Earthing Switches

Flexible copper connections between movable parts of an earthing switch and its frame shall have a cross section of at least 50 mm².

This minimum value of the cross-sectional area of copper connections is given to ensure mechanical strength and resistance to corrosion.

Where the flexible connection is used to carry the short-circuit current, it shall be designed accordingly. If another material is used, a suitable equivalent of cross-section shall be provided.

5.2.4 Corrosion Protection and Lubrication

All disconnectors and earthing switches shall be designed to the same level of corrosion resistance and the design shall be suitable for the most onerous corrosive environment.

Note: Service experience has shown that corrosion has a major influence on the performance of the equipment. Corrosion of components in the main current path and the mechanical drive system is a common cause of failure. Since it is a major exercise to gain access to such components and the resultant maintenance work often compromises reliability of the substation and the interconnected network, long-term resistance against corrosion is the foremost requirement of the equipment.

a) All exposed metal shall be protected against corrosion in accordance with DSP 34-1658 for outdoor “high” to “very high” ” ‘C4’ and ‘C5’ (i.e. coastal) corrosively rating environments.

b) The minimum detailed specification (“DS”) for all exposed metal in accordance with DSP 34-1658 shall be “DS-11” (3CR12), ‘DS-18 (Stainless steel) and ‘DS-13” (Hot-dip galvanised).

NOTE: Plastic or fibre-reinforced plastic materials for operating mechanism enclosures, or other applications where exposure to the elements is involved shall be not accepted.

The corrosion protection system (i.e. the equivalent detailed specification “DS” number in accordance with DSP 34-1658) offered by the manufacturer for the following components shall be stated in schedule B.

Corrosion protection details shall be provided with the tender documentation (refer to point d) hereunder:

- enclosures;
- nuts, bolts, studs and washers;
- bearing assemblies and linkages;
- structural steel (i.e. common base frame, support structure legs (if applicable), etc.); and
- other exposed metal (excluding main terminals).

c) The supplier is required to identify the lubricants used and to submit details with the tender documentation (refer to 5.9.5 of tests carried out to prove suitability for the application. If possible, a list of equivalent lubricants from South African sources shall be provided. All liquids or chemicals shall be supplied with Material Safety Data Sheets (MSDS).

d) Material and Corrosion Protection Information

The supplier shall provide with the tender documentation the information on each supplied equipment type specified below:

Table 4: Material and Corrosion Protection Information

Eskom specified requirements	To be completed by supplier	Completed Example
Item or part Description		Support bracket
Drawing number		DEMO1
Material type		EN8
Material grade		(BS 970 080M40)
Type of corrosion protection		HD galvanising
Minimum thickness of protective coating		85 micro
Verification tests carried out on coating **e.g. Thickness with thickness gauge**		6 measurements along profile
Expected life of coating (Industry/marine)		Marine = 5 years Industry = 8 years
Maintenance frequency of protection coating		Repair installation damage on commissioning and thereafter once a year
Maintenance type of protection coating		Patch repair with Zinc-fix
Bi-metallic corrosion prevention		Coat both sides
Crevice corrosion prevention		Seal with crevice with Zinc-fix
Item or part weight in Kilogram		7kg
Field experience		Equipment used at coast in USA
Remarks/General comments		Debris, scratches and indentation have been removed prior to galvanising.

- Steelwork Requirements for Support Structures (if part of the supply)
  - i. Steel shall be in accordance with SANS 1431
  - ii. Steel shall be Grade 350W
  - iii. Steel shall be hot-dip galvanised in accordance with SANS 121
  - iv. Steel members shall be marked/stamped and clearly legible.
  - v. Welding shall conform to the requirements of SANS 10044.
  - vi. Welds shall be seal welded.
  - vii. Steelwork shall be fabricated, erected and levelled to a tolerance of ±1.5mm.
  - viii. Bolts and nuts shall be in accordance with SANS 1700:5.
  - ix. Bolts and nuts shall be Grade 8.8.

x. Bolts, nuts and washers shall be hot-dip galvanised in accordance with SANS 121.

xi. Holes shall have diameter of 18mm for M16 bolts.

xii. All works shall comply with the requirements of SANS 1200

5.3 Operating Mechanisms

5.3.1 Manually Operated Mechanism

a) Eskom shall specify the required type of mechanism operation in schedule A. The tenderer shall state the type of offered mechanism in schedule B. The operating force of 750 N as per clause A.6.105.1.2 of SANS 62271-102 shall apply.

b) Manually operated mechanisms shall be evaluated and approved by Eskom. The process shall be assisted by means of samples, drawings and descriptive literature. The tenderer shall provide all these requirements at the tendering stage.

c) Mechanism considered “acceptable” shall have the following design features:-

A robust steel handle of not less than 40 mm or greater than 55 mm outside diameter;

- The operation of swing type handles takes place in the horizontal plane.
- The operation of crank type handles takes place in a vertical plane.
- The height for the operating handle is between 1000 mm and 1200 mm above ground level.
- The length of a swing type handle is between 750 mm and 1200 mm.
- The output shaft is galvanically connected to the substation earth mat via the support structure by means of a multi-stranded insulated flexible copper conductor of at least 65 mm^2 cross-sectional areas.
- There is adequate physical clearance to prevent injury to operating personnel.
- There are padlocking facilities provided in both the “open” and “closed” positions.
- There are padlocking facilities suitable for an Eskom standard padlock with an 8 mm shank.
- The open and closed positions are positively identified at the mechanism with labels “ON” and “OFF” respectively.
- A reduction gear box type mechanism shall require a maximum revolution of fifty (50) turns for a full operating cycle.
- The direction in which to achieve open and close is clearly indicated.
- There is a fixed door-stop provided on all hinged doors. The facility shall be robust enough to withstand the force of wind in accordance with sub-clause 3f).
- The operating mechanism enclosure, handles and fixings shall be manufactured from 3CR12 stainless steel with corrosion protection in accordance with section 5.2.3, unless otherwise approved by Eskom.

5.3.2 Motor Operated Mechanism

a) Eskom shall specify the required type of mechanism operation in schedule A. The tenderer shall state the type of offered mechanism in schedule B. Clause A.6.105.1.1 of SANS 62271-102 shall apply.

NOTE: Switchgear shall be required to operate at one of two dc. control voltage reliably i.e. the closing and opening devices, operating mechanism motors and motor contactor coils to be supplied with the switchgear are required to be suitable for operation at either 110 V dc. or 220 V dc. as specified in schedule A.

b) A readily available dc. supply voltage "conversion kit" may be required by Eskom from the Supplier in order to convert the disconnector operating mechanism from 110 V to 220 V dc or vice versa.

c) Motors shall be designed, rated and tested to the relevant IEC requirements and for the operating voltage specified in Schedule A.

Note: The use of resistors to reduce the supply voltage to motors is not acceptable. The method used to achieve immunity to spurious operation due to induced surges in the control cables is subject to approval by Eskom. The tenderer shall provide all details with tender documentation.

d) Motor operated mechanisms shall be evaluated and approved by Eskom. The process shall be assisted by means of samples, drawings and factory visits. The tenderer shall provide all these requirements at the tendering stage.

e) Mechanism considered “acceptable” shall have the following design features:-

- The output torque and operational characteristics are optimally matched to the driven equipment.
- The speed of operation and end of motion drive characteristics takes place with no “bounce-back” action.
- In the case of overloading and attendant risk of mechanical damage, supplies to the motor circuit and control contactor circuits of all poles is immediately interrupted and alarm signalling provided for this condition.
- Resetting of overload devices results in a neutral condition and it is possible to reverse the drive from the original direction it was travelling when the overload occurred.
- A manual operation facility is provided by means of a device such as a crank handle with clear indication of direction to operate towards both open and closed conditions.
- The main access to the mechanism interior is provided with a padlocking facility to accept an Eskom standard padlock with an 8 mm shank
- For electrical and mechanical interlocks refer to clause 3.27.
- There is a three-position switch labelled “local-off-remote” as well as two separate push buttons, one labelled “ON” to close the main contacts and the other one labelled “OFF” to open the main contacts.
- It shall be practicable to measure the motor operational current by means of a “clip-on” type ammeter.
- There is ample accessibility to key components such as motors and auxiliary switches without the necessity of having to remove wiring to other components inside the mechanism box.
- The output shaft is galvanically connected to the substation earth mat via the support structure by means of a multi-stranded insulated flexible copper conductor of at least 65 mm^2 cross-sectional areas.
- It is required to mechanically disconnect and reconnect the drive for purposes of functional testing of the drive and controls whilst the main contacts are fully open and without affecting the final adjustment of the equipment.
- The open and closed positions are positively identified with labels “ON” and “OFF” respectively.
- Open type motors and gears shall not represent a hazard when local operation is in progress.
- There is a fixed door-stop provided on all hinged doors. The facility shall be robust enough to withstand the force of wind in accordance with sub-clause 3f).

- The operating mechanism enclosure, handles and fixings shall be manufactured from 3CR12 stainless steel with corrosion protection in accordance with clause 5.2.3, unless otherwise approved by Eskom.
    - o No moisture ingress into auxiliary switches.
    - o Moisture heaters.
    - o IP 55 classification.
    - o Misalignment of auxiliary switches shall not be possible.

Where lubrication is necessary no dismantling of gearboxes or gear trains shall be necessary. Motor bearings shall be of the sealed type.

5.4 Enclosures

5.4.1 General Design

Enclosures shall be designed for facilitating access to the innards as well as preventing unauthorised access to controls in the case of motor operating mechanisms.

The design of the enclosure shall be such that access to the control circuitry can be obtained when the operating handle is either locked in the open/closed position.

5.4.2 Degrees of Protection

All enclosures shall comply with IEC Publication 60529 classification IP55.

Upper surfaces of enclosures shall be shaped or sloped to prevent accumulation of water.

There are no nesting places for insects such as wasps or bees nor allows the accumulation of water and/or debris and complies with IEC Publication 60529 classification IP55.

5.4.3 Sealing

a) Where components require sealing from the environmental elements the effectiveness of sealing shall be maintained for the normal service life of the equipment. This includes prevention of moisture accumulation inside sealed off areas. Besides the mechanism enclosure this also refers to enclosed type current transfer contacts, output shafts, bearing housings, fixing bolts and control cubicles.

b) The method of sealing of doors and other items such as output shafts shall be subject to approval by Eskom. What Eskom considers acceptable are the following features on the design offered:-

- No seals are exposed directly to the environmental elements.
- Seals on doors and removable panels are of extruded EPDM rubber or heavy duty foamed polyurethane.
- Natural rubber or felt seals are not acceptable.

c) Anti-condensation Heaters

- To prevent internal condensation, motor drive mechanisms shall be provided with suitably rated permanently connected electric heaters.
- The heater power shall be matched to the internal volume of the enclosure and shall not cause damage to internal components.
- The heaters shall be located at the bottom of the enclosure and in conjunction with suitably located vents shall circulate dry air constantly to all parts of the enclosure.
- The heaters shall be mounted separately from the secondary terminal strip.

- The heater elements shall be shrouded and leads to the heater elements insulated by means of silicon rubber or ceramic beads not PVC.
- The electrical supply for heaters is 230 Volts ac.
- It shall be possible to isolate the heater by means of an approved isolating device.
- The heater control circuits shall comply with the requirements of Eskom secondary wiring interface standard drawings, 0.54/07129; 0.54/07858; 0.54/07860 and 0.54/07858, or a drawing stated in schedule A.

5.5 Working Clearances and Personnel Safety

a) The disconnector and earthing switch shall be installed in a manner that ensures safety to authorised personnel.

b) Live parts shall be isolated by means of elevation.

NOTE: The use of protective fences to prevent contact with live parts is not acceptable**.**

c) The electrical working clearance from ground to live parts at system voltage as required by statutory requirements contained in the Occupational Health and Safety Act No. 85 of 1993 shall be complied with. Working clearances are given in Table 5.

Table 5: Minimum electrical working clearances

System voltage [kV]	***Working clearance [mm]***	
	Vertical	***Horizontal***
22	2 800	1 400
33	2 900	1 500
66	3 200	1 800
132	3 700	2 300
220	4 300	2 900
275	4 800	2 400
400	5 700	4 000
765	10 200	8 900

d) The distance from the lowest part of any high-voltage (i.e. > 1000 V) insulation above ground shall not be less than 2 500 mm.

e) Moving parts shall not pose any hazard to personnel or adjacent equipment. There shall be no shock hazards present to operating persons.

f) For integral type earthing switches fitted to a disconnector where electrical clearance to live parts is reduced temporarily during operation it is a requirement that compliance with Annex D of SANS 62271-102 is demonstrated by means of suitable high voltage tests. Satisfactory proof of such tests in the form of type test certification shall be submitted with the tender documentation.

5.6 Nameplates

a) Every disconnector and earthing switch shall be provided with a rating plate mounted on an earthed vertical flat surface so that a normally sighted person standing at ground level can easily read the details.

b) The nameplates and their fixings shall be weather and corrosion proof and shall be stated in schedule B.

c) Nameplates shall be either engraved aluminium or stainless steel and are subject to approval by Eskom. The nameplates shall be securely fastened to the equipment in a reliable manner. The nameplate material offered shall be stated in schedule B.

d) Ratings of the equipment using the symbols according to sub-clause 5.10 of and SANS 62271-102 shall be indicated on the nameplate and in addition to the manufacturer's name and equipment type designation shall display at least the following information:

- Rated voltage, rated normal current and short time current values, duration *
- Rated switching impulse withstand ($\mathbf{U_s}$) for voltages above 132 kV
- Rated lightning impulse withstand voltage ($\mathbf{U_p}$)
- Rated power-frequency withstand voltage ($\mathbf{U_d}$)
- Mechanical endurance class
- Serial number
- Year of manufacture
- Standard to which equipment complies e.g. SANS 62271-102
- Eskom order Number and contract number.
- Eskom stock (SAP) number.
- Rated supply voltage of auxiliary circuits
- Main contact resistance (terminal to terminal)

Note: * Actual true type test values to which the equipment has been certified shall be displayed.

In instances where motor and manual operated drives are supplied, a separate rating plate shall be provided giving details of the drive itself. This rating plate shall be a separate rating plate to the above and mounted outside the drive itself. In addition to the manufacturer's name and type designation it shall display the following information:-

- Rated control voltage ($\mathbf{U_a}$) and current;
- Serial number
- Year of manufacture
- Mechanical endurance class
- AC supply voltage

5.7 Operating Labels

Where a support structure is required, the support structure shall make provision for the attachment of operating labels. The position and orientation of the labels shall be such that they are visible from the ground level.

Where applicable, all labels shall be manufactured in accordance with 240-56062515 and shall be attached using inherently corrosion-resistant rivets or self-tapping screws. No stick-on labels, double sided tape or glue is accepted, unless otherwise approved by Eskom.

5.8 Mechanical Features

5.8.1 Base Frames

a) Base frames of equipment shall be fixed to the support structure in such a manner as to avoid distortion or excessive deflection when in operation.

b) Base frames shall not permit bird nesting. The accessibility of birds into mechanical parts of the disconnector will be assessed by Eskom and be modified at no cost if required.

5.8.2 Bearings

a) Base bearings and bearings requiring protection from the elements shall be of the sealed type.

b) Bearing housings shall not permit internal condensation and accumulation of moisture.

c) Bearings shall be appropriate for the application i.e. high thrust and cantilever loads. Due cognisance must be taken of vibrations set up in service which can influence performance of such bearings.

d) Bearings shall be of a standard commercially available type and available from various manufacturers and local agencies.

5.8.3 Bushes

a) The information about the type of bushes used and method of lubrication shall be provided with tender documents.

b) Where bushes are provided requiring periodic lubrication, standard type grease nipples shall be provided.

c) Bushes claimed to require no periodic lubrication must have a proven track record.

5.8.4 Gears

a) Any gearing arrangements used on the operating mechanism shall be adequately covered and protected against environmental elements.

b) Any interlocking arrangements that are enclosed shall be protected to a rating of IP2X.

5.8.5 Linkages

a) Inter-phase linkages and other motion transfer arrangements shall transmit the operating forces in an efficient and stress-free manner.

b) Self-aligning features shall be provided at the ends of linkages to accommodate changes in direction during linkage movement and if adjustable must also be lockable.

c) The adjustment facility to adjust the angle of the operation of the current path as well as travel of the operation of the current path shall be provided.

d) Linkage rod ends shall be self-lubricated and shall be in continuous galvanic contact with the earthed portions of the equipment to prevent development of induced voltages.

e) When the pole centres exceed 3 000 mm inter-phase linkages shall operate in tension only to avoid buckling. A concession in this respect requires ample evidence in the form of successfully performing the ice-breaking test on a fully representative gang-operated three pole unit. This shall be class 10 in accordance with SANS 62271-102 clause 6.103.

5.8.6 Main Terminals

a) The main terminals shall be in accordance with SANS 62271-301. For all Eskom system voltages, the main terminals shall be aluminium flat pad with 4 x 50 mm, 8 x 50 mm and 9 x 40 mm pitch having a minimum thickness of 20 mm. The diameter of the holes shall be 14 mm (M12). The pad thickness, hole diameter and pitch shall be specified in schedule A.

b) At 11 kV to 66 kV four (4 x 50 mm) holes pad shall be acceptable. At 132 kV only four (4 x 50 mm) and eight (8 x 50 mm) holes pads are acceptable. Above 132 kV only eight (8 x 50 mm) and nine (9 x 40 mm) holes shall be acceptable.

c) Temperature rise and short-time current type tests for the equipment shall be carried out with the same type of terminal as will be supplied.

5.8.7 Earthing Switch Terminal

For earthing switches an earthing switch terminal per pole shall be provided, suitable for a copper flat type conductor strap (50mm x 3mm) and shall be of sufficient size that the current density does not exceed 50 A/mm^2 based on the short time current rating of the earthing switch. Fixed contacts shall not open from setting if the moving contact is not aligned, contact must always make in the closed position.

For the stand alone earthing switches, the following main terminals shall be provided:

a) an 8 hole (2 x 4 hole pattern) aluminium flat pad with a 50 mm pitch (distance between holes) and having a minimum thickness of 20 mm for all voltages of 66kV and above. The diameter of the holes shall be 14 mm;

b) Dimensional details of the main terminals shall be shown on the earth switch general arrangement drawing.

5.8.8 Current Paths

a) Current paths shall be designed for a minimum maintenance interval of twelve (12) years.

b) For conventional disconnectors, current path assemblies shall consist of the top mechanism having a minimum sub component, (preferably one solid piece current path with replaceable contacts).

c) Simple contact pressure arrangement with a simple a contact tension setting technique, and minimum moving parts shall be preferred which must self-align.

d) Pantograph type disconnectors shall have current path designs which eliminate the need for major overhauling, other than at the main contact zone.

e) Copper contacts shall be tinned on the bolted side and silver plated on the contact side.

f) Bird nesting shall not interfere with the functionality of the disconnector.

5.8.9 Post Insulators

a) Post insulators shall comply with the requirements of SANS 60273 and SANS 60815.

b) The type of post insulator material shall be porcelain or composite. The type of insulator material offered and manufacturer shall be stated in schedule B.

c) Disconnectors for use in systems of nominal voltage up to and including 132 kV shall be tested at Eskom's KIPTS pollution test site in accordance with 240-56062330. Refer to sub-clause q) below for information on Eskom's technical acceptance. Only for items in which it is requested, KIPTS certificates must be supplied for Medium (M), Heavy (H) and Very Heavy (VH) pollution cycles. The KIPTS test facility limitation is currently (as at 2014) up to 132kV. Therefore the test requirement is split according to nominal system voltage level as follows:

- $\mathbf{U_n}$ ≤ 132kV: For insulators for applications up to nominal system voltages of 132kV (i.e. lightning Impulse withstand up to and including 550kV), the Eskom KIPTS "Natural aging and pollution performance test" is to be conducted in place of the IEC 60507 artificial pollution test. The test shall be according to Eskom procedures 240-56062328 and 240-56030420. The test commencement date and test duration shall be as defined in 240-56030420.

d) Post insulators from the same supplier and type shall be supplied per item of equipment.

e) Mixing of post insulator makes and type per item of equipment is not permitted.

f) Details of the post insulator such as manufacturer, type designation, creepage dimensions and shed profile shall be submitted at the tendering stage.

g) The standard colour for post insulators shall be dark brown, if porcelain.

h) There shall be exact interchangeability between post insulators irrespective of the supplied creepage distance.

5.9 Operation Interlocks between Disconnector and Earthing Switch

5.9.1 Facilities shall be provided to mechanically Interlock the Respective Drives so that:

a) The in-built earthing switch can only be closed when the disconnector is fully open

b) The disconnector can only be closed when the in-built earthing switch is fully open.

5.9.2 Electrical Interlocks:

a) Remote operation is blocked when the main access door is open, and this must be shown on the wiring schematic.

b) Electrical supply to the motor is isolated when the manual operating handle is inserted.

c) The earth switch shall also be electrically interlocked with the disconnector (when fitted with integral earth switches).

5.9.3 Indicating Devices

A mechanical indicating device shall be provided at each mechanism to indicate the open or closed position.

5.9.3.1 The following symbols shall be used:

a) Device *closed* “ON” in white lettering on a red background

b) Device *open* “OFF” in white lettering on a green background

c) Lettering size shall be at least 20 mm.

5.9.4 Electro-Magnetic Compatibility (EMC)

Requirements concerning EMC of the equipment shall be according to Clause 5.18 of SANS 62271-102.

5.9.5 Lubricants such as Greases and Similar Compounds

a) The performance of lubricants such as greases and similar compounds shall be proven as adequate for the intended purpose and application and shall not degrade during the application period.

b) The supplier is required at the tendering stage to list the lubricants and or compounds used and to submit details in the form of tests carried out to prove suitability for the intended purpose, including that of providing a barrier against atmospheric influence and/or corrosion inhibition.

c) The sources of these lubricants and compounds (including Southern African sources), shall be provided. All liquids or chemicals shall be supplied with Material Safety Data Sheets (MSDS).

5.10 Inspection and Maintenance

5.10.1 General

The effectiveness of maintenance depends mainly on the way instructions are prepared by the OEM and implemented by Eskom. The supplier shall supply maintenance information in the form of maintenance manuals, field service bulletins and Digital Video Disk (DVD) material covering the following aspects:

Extent and frequency of maintenance for this purpose, the following factors shall be considered:

a) Switching operations (accumulated switching amperage);

b) Total number of operations;

c) Environmental conditions; and

d) Measurement and diagnostic tests for condition monitoring.

5.10.2 Inspection

With the tender documentation (refer to sub-clause 13.2.1m), the supplier shall submit the quality control plans to Eskom, indicating all inspection hold points. Eskom may add the necessary inspection hold and/or witness points for Eskom or its appointed representative. The supplier shall make due allowance for these activities in the manufacturing programme and, to avoid delays, shall give sufficient, agreed upon, advanced notice of the date of inspection. Eskom will not accept late delivery on the basis of inspection delays.

NOTE: Where applicable, the minimum required notification period for overseas travel from South Africa is 8 weeks.

5.10.3 Scope of Work to be performed:

It shall include but not be limited to the following:

a) Recommended place for the maintenance work (indoor, outdoor, in factory, on-site, etc.);

b) Procedures for inspection and maintenance, diagnostic tests, examination overhaul;

c) Reference to drawings;

d) Reference to part numbers or standard kit of parts;

e) Tools required, including special equipment or tools;

f) Precautions to be observed (e.g. cleanliness);

g) Lubrication procedures; and

h) Cleaning materials.

5.10.4 Graphical Information:

a) Detailed drawings and sketches of the disconnector components, with clear identification (part number and description) of assemblies, sub-assemblies and essential components.

b) Expanded detail drawings, which indicate the relative position of components in assemblies and sub-assemblies, are expected as a preferred illustration method. Graphs and similar means of portraying important information shall also be included.

c) Specified operational values:

- Values and tolerances pertaining to which, when exceeded, make corrective action necessary, for example:
  - Operating times and contact velocities;
  - Resistance of the main current carrying circuits;
  - Torque settings for fasteners; and
  - Important dimensions.

d) Specifications for materials:

- This includes warnings of known non-compatibility of materials.
  - Fluid; and
  - Cleaning and degreasing agents.

e) Tools, lifting and access equipment:

- A list of standard and specialised tools shall be provided with description of their application and associated part number.

f) Tests after the maintenance work:

All tests shall be clearly described and shall include the parameters to be observed.

5.10.5 Maintenance DVD

a) It is anticipated that maintenance intervals for the disconnector will be very long, e.g. several years. Consequently, it is essential that the instruction manual be supplemented and supported by a maintenance orientated video recording. The video recording shall be converted into a suitable DVD format. A written commitment from the supplier regarding the submission of the DVD shall be provided with the tender documentation. The actual DVD shall be supplied upon awarding of the contract following approval of the maintenance manual by Eskom. Copies of the DVD shall be issued to the contract manager and relevant technical specialists.

b) The DVD shall provide a record of the maintenance requirements and procedures for the equipment supplied. The DVD and related instruction and maintenance manuals shall be detailed enough to enable a trained maintenance crew to perform all inspections and maintenance required on the equipment. It is anticipated that the instruction manuals will list what maintenance is required, while the DVD will show how such maintenance is achieved.

c) The DVD shall cover routine 1st line (inspection), 2nd line maintenance and specialised (intrusive) overhauling of all equipment requiring such work, as well as some trouble-shooting techniques and tips. It shall explain the normal operation of the equipment in sufficient detail for the maintenance crew to be able to differentiate between normal and abnormal equipment performance. The DVD shall concentrate on equipment maintenance and shall not include any unnecessary sales or publicity material. Since the topics to be covered are extensive and complex, it may be considered an advantage to present the results in definite sections, covering the various aspects or portions of the equipment.

d) These sections may be on separate DVDs or if consolidated into a single DVD, there shall be adequate indexing to permit quick access to the desired section. For each piece of equipment requiring maintenance, the DVD shall show:

- The tools, equipment and materials required to perform the maintenance, especially any special tools;
- The tests required prior to maintenance operations to record the status of the equipment and/or to indicate the areas requiring maintenance/re-adjustment;
- The dismantling steps, including any marking of positions required prior to disassembly, any discharging of pressure and/or stored energy;
- The dismantling, removal, replacement and re-assembly of any sub-components requiring scheduled maintenance/replacement;
- The re-assembly, realignment and re-installation of all components, including any lubrication of moving parts;
- The testing of the re-assembled equipment, including acceptable values and tolerances of the measured/tested parameters; and
- Some trouble-shooting methods if the required tolerances are not achieved.

e) The trouble-shooting portion of the DVD shall record the normal/expected values of equipment performance, plus techniques and tips to analyse the cause of any abnormalities, and how to correct them.

5.11 Condition monitoring of disconnectors

The supplier is encouraged to develop practical and innovative methods to improve the reliability and maintainability of the disconnector installation. This may include on-line condition monitoring and/or integrated diagnostic devices achieving the following functions:

- Accumulated interruption amperage values (per pole);
- Contact wear (per pole); and
- Continuous monitoring, recording and alarm signalling of the mechanical operating characteristics of the disconnector.

The on-line condition monitoring and/or integrated diagnostic device shall be IEC61850 protocol compliant.

Required routine checks and maintenance actions of a minor and major nature required in order to ensure correct operation of the equipment.

Preventative maintenance plans and schedules shall be displayed in the form of tables, charts and flow diagrams.

a) For the operator level a basic inspection checklist shall be provided detailing minor inspection requirements.

5.12 Dismantling and Replacement of Major Parts

Precise details for dismantling and replacement of major parts shall be provided.

5.13 List of Tools

a) If there is a requirement for special tools this shall be detailed here. Included shall be the lifting equipment and slings necessary for installation and disassembly.

b) A full list of operating tools shall be provided with the tender documentation. If additional sets of operating tools are required, this shall be specified in schedule A.

c) All operating tools shall be fitted on the inside of the mechanism enclosure.

5.14 Training

Refer to the training specification which is 240-56065202: Switchgear training requirements from original equipment manufacturers.

5.15 Drawings

5.15.1 Outline and General Arrangement

The minimum information shall include (also refer to sub-clause 13.2.1c):

a) Leading dimensions, i.e., phase to phase spacing, minimum phase to phase clearance, distance to main-terminals, electrical clearance (distance to nearest live portion above ground), distance above ground to top of operating mechanism, dimensions of mechanism, overall height, width and depth.

b) Base frame mounting details and holding down bolts to interface with the steel support and civil foundation. Unless it is specified in schedule A that the steel support structure and/or concrete foundation is to be designed by the manufacturer, the disconnector and earthing switch shall be designed to interface with the standard Eskom steel support structure in accordance with the drawings specified in Table 6 below:-

Table 6: Eskom standard drawings for outdoor disconnectors and earthing switches steel support structures which are in line with Eskom civil foundations

System voltage [kV]	Spacing [mm]	Steel support structure drawing number
22	1 000	0.54/505 ; D-DT 5205
33	1 200	0.54/493 ; D-DT 5204
44	1 800	0.54/490

System voltage [kV]	Spacing [mm]	Steel support structure drawing number
66	2 000	0.54/2235 ; D-DT 5203
88	2 400	D-DT 17501 sheet 2 of 2,
	2850	0.54/7500 – In-line, no earthing switch
	2400	0.54/7483 – L/ H earthing switch
	2400	0.54/7485 – R/ H earthing switch
	2400	0.54/7484 – Double earthing switches
	2400	0.54/4196 – Transverse/ In-line
132	2400	D-DT 5202 sheet 2k
	3000	0.54/7486 – No earthing switch; D-DT 5202 sheet 2A
	3000	0.54/7487 – Double earthing switches, Motor
	3000	0.54/7488 – Double earthing switches
220 and 275	4300	0.54/7489 – isolator (2440 mm high)
		0.54/7490 – isolator (2330 mm high)
		0.54/7491 – isolator (2450 mm high)
		0.54/7492 – pantograph 3600 mm high
		0.54/7493 – pantograph (9500mm high)
400	5500	0.54/3983 – isolator
	6500	0.54/3293 – isolator
	7010	0.54/4432 – isolator
		0.54/3558 – earth switch
		0.54/7494 – pantograph (3300mm high)
		0.54/7495 – pantograph (3450mm high)
765	11 000	To be as per schedule A
	14 000	To be as per schedule A

5.15.2 Phase spacing:

a) For 132kV: all disconnectors and earthing switches should be offered with phase centres of 2400mm, 3000mm and 3600mm.

b) For 220kV and 275kV: all disconnectors and earthing switches should be offered with phase centres of 4300mm and 6700mm. The 4300mm dimension is standard for tubular bus bar designs. Pantographs shall not be offered with the phase spacing dimensions as the poles shall not be interlinked through drive rods.

c) For 400kV: all disconnectors, pantographs and earthing switches should be offered with phase centres of 5500mm, 6500mm and 7010mm. The 5500mm dimension is standard for tubular bus bar designs.

d) For 765kV: all disconnectors, pantographs and earthing switches should be offered with phase centres of 11 000mm and 14 000mm.

e) Details of main terminals and earthing switch terminals;

f) Maximum permissible loading on main terminals (with directions) expressed in Newtons;

g) Mass of equipment in kilograms, which shall include the mass and description of the heaviest component. If necessary operating forces produced between the poles.

h) Any special trenches or support steelwork required between phases;

i) Where applicable, a dimensioned outline and general arrangement drawing including foundation details of the supporting structures offered, if not included in the above.

j) Forces - operating forces and directions for all operations (dynamic and static.)

k) The centre of gravity

l) Title to include nominal voltage, normal current rating and short-circuit withstand current and duration in the title blocks of the drawings.

m) Details of post insulators [material type, classification, dimensions, creepage distance, withstand voltages (power frequency, switching and lightning), mechanical strength, shed profile, top and bottom PCDs].

5.15.3 Drawings

Drawings showing the generic layout of all the nameplates or rating plates (disconnectors and operating mechanisms, as per clause 13.2 shall have manufacturer's drawing number and revision number; Provision shall be made on each sheet for an Eskom-allocated drawing number as well as for the Eskom contract number – for population after awarding of the contract;

5.15.4 Schematic wiring diagram with the manufacturer's drawing number and revision number

Provision shall be made on each sheet for an Eskom-allocated drawing number as well as for the Eskom contract number – for population after awarding of the contract;

a) Contacts shall be shown with the main contacts in the open position, contactors in the de-energised condition, refer to clause 12.6 of this standard.

b) The status of these items shall be clearly described in the diagram. Diagrams shall show the relative timing of main and auxiliary contacts and tolerances in timing between the auxiliary contacts in accordance with the Eskom drawing D-DT 5045.

c) Drawings shall be labelled in English.

5.16 Inspection and Tests

5.16.1 General

Manufacture, factory inspection, shipping, off-loading, storage on site, erection and site tests shall be as per document QM-58.

5.16.2 Test Reports

Single copies of type-test reports and a typical routine test report shall be submitted to Eskom at the tendering stage for approval.

Routine test reports approved by Eskom shall be submitted with despatch of each equipment item from the Contractors works and included in all manuals. Test reports shall be in English.

5.16.3 Requirements in respect of the isolating distance of disconnectors

For reasons of safety, disconnectors shall be designed in such a way that no dangerous leakage currents can pass from the terminals of one side to any of the terminals of the other side of the disconnector.

This safety requirement is met when any leakage current is led away to earth by a reliable earth

Connection or when the insulation involved is effectively protected against pollution in service.

NOTE it is usual that the isolating gap of a disconnector is longer than the phase-to-ground insulating distance since SANS 62271-1 specifies higher withstand test levels across the isolating distance than for the phase-to-ground insulation.

Where a long creepage distance is required, the phase-to-ground insulation distance should become longer than the isolating gap. For such cases, to maintain low probability of disruptive discharge across the isolating gap, the use of protective devices such as surge arresters or rod gaps may be necessary and shall be approved in writing by Eskom prior to acceptance.

5.16.4 Mechanical Strength

Disconnectors and earthing switches having a rated static mechanical terminal load when installed according to the manufacturer's instructions shall be able to withstand their rated static and dynamic mechanical terminal load without impairing their reliability or current carrying capacity.

Operation of Disconnectors and Earthing Switches – Position of the Movable Contact System and its Indicating and Signalling Devices

5.16.5 Securing of Position

Disconnectors and earthing switches, including their operating mechanisms, shall be designed in such a way that they cannot come out of their open or closed position by gravity, wind pressure, vibrations, reasonable shocks or accidental touching of the connecting rods of their operating system.

Disconnectors and earthing switches shall permit temporary mechanical locking in both the open and closed position for safety purposes (for example maintenance).

5.16.6 Additional Requirements for Power-operated Mechanisms

Motor operated mechanisms shall also be provided with a manual operating facility. Connecting a hand-operating device (for instance a hand crank) to the power-operated mechanism shall ensure safe interruption of the control energy to the power-operated mechanism.

5.16.7 Indication and Signalling of Position

Indication and signalling of the closed and open position shall not take place unless the movable contacts have reached their closed or open position, respectively, and the first paragraph of 5.16.5 is fulfilled.

a) Indication of Position

It shall be possible to know the operating position of the disconnector or earthing switch. For the open position this requirement is met if one of the following conditions is fulfilled:

The isolating distance or gap is visible;

The position of each movable contact ensuring the isolating distance or gap is indicated by:

b) A reliable visual position indicating device.

The kinematic chain between the movable contacts and the position indicating device shall be designed with sufficient mechanical strength to meet the requirements of the specified tests. The position indicating kinematic chain shall be a continuous mechanical connection to ensure a positively driven operation. The position indicating device may be marked directly on a mechanical part of the power kinematic chain by suitable means. The strain-limiting device, if any, shall not be part of the position indicating kinematic chain.

Where all poles of a disconnector or earthing switch are mechanically coupled so as to be operable as a single unit, it is permissible to use a common position indicating device.

c) Electrical Position Signalling by Auxiliary Contacts

A common signal for all poles of a disconnector or earthing switch shall be given only if all poles of the disconnector or earthing switch have a position in accordance with sub-clause 5.16.7.

Where all poles of a disconnector or earthing switch are mechanically coupled so as to be operable as a single unit, it is permissible to use a common position indicating device.

5.16.8 Maximum Force Required for Manual Operation

The values given below also apply to maintenance and operation of normally motor-operated disconnectors and earthing switches.

NOTE these values include ice-breaking, if applicable.

The operating height above servicing level should be agreed between manufacturer and user.

5.16.9 Operation requiring more than one Revolution

The force needed to operate a disconnector or earthing switch requiring more than one revolution (hand crank for example) shall not be higher than 60 N with a possible peak of 120 N during a maximum of 10 % of the total required revolutions.

5.16.10 Operation Requiring up to one Revolution

The force needed to operate a disconnector or earthing switch requiring up to one revolution (swing lever for example) should not exceed 250 N (refer to sub-clause 5.6.3 of SANS 62271-1). A peak value of 450 N is accepted during a rotation of 15° maximum.

5.16.11 Dimensional Tolerances

For the mounting dimensions and the dimensions of high-voltage connections as well as the earthing connections of disconnectors and earthing switches, the tolerances given in ISO 2768-1 shall apply for linear and angular dimensions.

6. Tests

6.1 Type Testing

a) Equipment shall be type tested in accordance with the requirements of SANS 62271-102. The following type tests shall be carried out:

b) Dielectric tests (refer to clause 6.2 of SANS 62271-102);

  1) Power frequency withstand voltage tests

  2) Lightning impulse dry withstand voltage tests

  3) Switching impulse voltage tests of switches rated 300 kV and above

c) Radio interference (RIV) test (refer to clause 6.3 of SANS 62271-102);

d) Measurement of the resistance of circuits (refer to clause 6.4 of SANS 62271-102);

e) Temperature rise tests (refer to clause 6.5 of SANS 62271-102);

f) Verification of the protection (refer to clause 6.6 of SANS 62271-102);

g) Electromagnetic compatibility tests (EMC) (refer to clause 6.9 of SANS 62271-102);

h) Test to prove the short-circuit making performance of earthing switches (refer to clause 6.101 of SANS 62271-102);

i) Operating and mechanical endurance tests (refer to clause 6.102 of SANS 62271-102);

j) Operating under severe ice conditions (refer to clause 6.103 of SANS 62271-102). The class of ice coating shall be class 10 in accordance with SANS 62271-102;

k) Operation at temperature limits (refer to clause 6.104 of SANS 62271-102);

l) Test to verify the proper functioning of the position indicating device (refer to clause 6.105 of SANS 62271- 102);

m) Bus-transfer current switching tests (refer to clause 6.106 of SANS 62271-102);

n) Induced current switching tests (refer to clause 6.107 of SANS 62271-102);

o) Bus-charging switching tests (refer to clause 6.108 of SANS 62271-102);

p) The manufacturer shall perform a complete set of type tests for each disconnector design offered. The type test certificates and reports shall be submitted for review during the tender or product evaluation stage. Type test reports shall be specified according to SANS IEC 62271-102. All type tests done on IEC 60129 shall not be accepted. All the testing shall be carried out with the disconnector wholly assembled.

q) The disconnector of voltages 132kV and below shall have been type tested in accordance with the KIPTS natural ageing and pollution performance test procedure for outdoor insulator products, Section 0 and Section 4 – Particular requirements for other insulator products (34-224 & 34-216). The products which have KIPTS certification will be technically preferred suppliers if all other tender returnables are successful, see Technical Bulletin 06TB-027.

r) The manufacturer shall be fully responsible for performing or having performed all the required tests as specified. Suppliers shall confirm the manufacturer’s capabilities in this regard when submitting tenders. Any limitations shall be clearly stated. The manufacturer and or supplier shall be responsible for all the costs related to testing.

s) The manufacturer shall perform a complete set of type tests for each design as well as routine tests on each unit. The type test certificates and reports shall be submitted for review during the tender or product evaluation stage.

NOTE: If, in the opinion of Eskom, repeat or new type test are necessary, the cost of these tests will be taken into account in the evaluation of tenders. In such a case, Eskom may request the supplier to submit details of the cost of carrying out each applicable type test.

6.2 Witnessing of Tests

a) Eskom reserves the right to be present at any of the tests specified. The supplier shall specify the sequence of tests required in each particular case and whether witnessing of tests is required, and after completion of all preliminary tests, shall then give Eskom not less than fourteen days’ notice of the firm date when the witnessing of the tests shall be ready. For overseas suppliers the minimum required notice is 8 weeks.

NOTE where applicable, the minimum required notification period for overseas travel from South Africa is 8 weeks.

b) Eskom shall be notified as soon as possible but within 48 hours of all the test failures and corrective actions. This shall take the form of a brief report that shall, upon request, be supported by a more detailed report. It is desirable that Eskom is notified of test failures to allow in situ inspection if desired.

6.3 Test Certificates and Test Reports

a) Type test certificates together with each complete test report shall be supplied only in the English language in electronic format with the tender documents.

b) Copies of the routine test certificate and reports shall be supplied with the tender documentation in electronic format. The test certificates shall indicate the tests performed and results, type designation of the equipment tested, etc. and shall make provision for approval by an Eskom authorised representative.

c) One hard copy of the routine test certificate and or report shall be supplied with the disconnector and stored in the documentation pocket inside the mechanism enclosure. In addition to the hard copy, the routine test certificates and or report shall be made available in electronic format and submitted to Eskom.

d) All test records shall be supplied for each disconnector offered and the record must be in an MS Windows based software e.g. MS Excel and in English language.

6.4 Grouping of Tests

Sub clause 6.1.1 of and SANS 62271-1 is applicable with the following mandatory type tests where applicable:

a) Mandatory Type Tests:

Tests to prove satisfactory operation and mechanical endurance (clause 6.102) (M);

b) Optional Type Tests:

- Tests to prove the short-circuit making performance of earthing switches (clause 6.101);
- Tests to prove satisfactory operation under severe ice conditions (clause 6.103);
- Tests to prove satisfactory operation at temperature limits (clause 6.104)
- Test to verify the proper function of position indicating device (clause 6.105 annex A;
- Tests to prove the bus-transfer current switching capability of disconnectors (clause 6.106 and annex B);
- Tests to prove the induced current switching capability of earthing switches (clause 6.107 and annex C);
- Tests to prove the bus-charging current switching ability of disconnectors used in metal enclosed switchgear (clause 6.108 and annex F);

6.5 Information to be included in the Type Test Reports

a) The following details concerning insulators used during the type tests are of particular importance and shall be given in the relevant test reports:

- Rated cantilever strength;
- Rated torsion strength of support insulators (and operating insulators, where applicable);
- Height and number of elements
- Creepage distance and shed-profile.
- Forces on the insulators during all stages of operation and direction of forces.

b) In the case of dielectric tests, information shall be included regarding the smallest gap at which the indicating or signalling device can signal the position OPEN. The minimum size of the gap and the height above ground used for the test shall be stated. Also the distance of the lowest part of insulation to ground shall be given.

7. Manufacturing, Transport, Storage, Installation, Pre-commissioning and After Sales Technical Support

7.1 Manufacturing

a) The manufacturing, transport, storage, installation and pre-commissioning of disconnectors, as well as their operation and maintenance in service, shall be carried out in accordance with the instructions given by the OEM.

b) The supplier shall provide instructions for the transport, storage, installation; operation and maintenance of the equipment according to the requirements set out by the OEM.

c) Eskom will only accept delivery to the destination specified and the supplier shall make all necessary arrangements for acceptance, transportation and off-loading at the most convenient point, as well as for offloading at the ultimate destination (point of installation) and storage.

7.2 Inspection of manufacturing facilities and disconnectors

a) Eskom reserves the right to inspect and evaluate all manufacturing facilities relating to the disconnector offered.

b) Eskom reserves the right to inspect any ordered disconnector before shipment, or at any stage of manufacture. This inspection will entail a thorough check to ensure complete compliance with this standard, switchgear schedules and the approved manufacturer's drawings.

c) With the tender documentation, the supplier shall submit the quality control plans to Eskom, indicating all inspection hold points. Eskom may add the necessary inspection hold and/or witness points for Eskom or its appointed representative. The supplier shall make due allowance for these activities in the manufacturing programme and, to avoid delays, shall give sufficient, agreed upon, advanced notice of the date of inspection. Eskom will not accept late delivery on the basis of inspection delays.

NOTE: where applicable, the minimum required notification period for overseas travel from South Africa is 8 weeks.

d) Any deviations in the disconnector design shall be pointed out in accordance with the tendered deviation schedule and the type test certificates provided for the specific unit design. No clearance will be given where there is no satisfactory evidence of the relevant type test certificates, where such tests are required.

e) Clearance shall be obtained before dispatching the equipment. This clearance shall be confirmed on the routine test certificates. No clearance shall be given where there are any outstanding defects resulting from Factory Acceptance Testing (FAT) or from this inspection.

7.3 Conditions during Transportation, Storage and Installation

a) Conditions can be expected to be onerous during transport, storage and installation. Adequate precautionary measures shall be provided for the protection of sensitive components such as insulating parts and operating mechanisms during transport, storage and installation.

b) Vibrations and impacts during transport shall also be applied. Refer to clause 10f) for the requirements for non-resettable impact recorders.

c) The equipment shall be designed, manufactured and packaged appropriately to contend with the conditions arising during shipping and handling (including corrosion of exposed parts). The supplier shall demonstrate this either by testing or through previous satisfactory experience.

d) Shipping test: this test shall cover all the conditions to be encountered during transportation from factory to the designated site, including loading/off-loading from one mode of transport to another;

e) Vibration test: this test may be used to supplement actual shipping tests to check for unexpected shortcomings in the equipment and packaging; and

f) Weather-proof test: this test may demonstrate the adequacy of the packaging to prevent ingress of moisture and water from weather or sea conditions.

g) If the design of the equipment is mature, and the equipment has previously been shipped successfully from OEM premises to the offloading point under similar conditions, the above tests may be waived at Eskom's discretion.

7.4 Transportation, Off-loading and Storage

a) The supplier shall be responsible for the transportation and off-loading from OEM premises to offloading of the equipment on site. Off-loading includes transportation from the point of off-loading the equipment after transportation to the point of installation.

b) The supplier shall provide his own means of off-loading at the point of installation. Non resettable impact gauges should be applied and set to a level below the level where the impact will cause damage.

7.5 Storage

a) If any equipment requires maintenance or attention during storage, this shall be clearly stated in the contract and Eskom's attention shall be drawn to this fact. This information shall be submitted with the tender documentation as well as with orders upon awarding of a contract. Crates supplied for transport shall be suitable for site storage for a period up to 6 months in the case where installation outages are delayed.

b) At the time of off-loading at an Eskom facility, the supplier has the responsibility to ensure that the necessary steps are taken by Eskom to ensure satisfactory storage.

c) Where heaters need to be energised, a clearly marked and accessible electrical connection point (refer to 10f) point 16) shall be provided to enable Eskom to supply power to the heaters.

d) Storage for a period of up to 6 months in the case when installation outages are delayed.

e) The supplier shall implement proper storage and handling (de-stuffing) procedures. A copy of the storage and handling procedures shall be made available to Eskom for acceptance. This shall indicate the maximum recommended period of storage, as well as recommended actions to be taken if a longer storage period is required.

7.6 Installation

a) The supplier shall be responsible for the installation and pre-commissioning of the equipment when required by Eskom. This includes the supply of all installation tools, lifting tackle and test equipment.

b) The supplier shall be responsible for ensuring the training and accreditation of persons employed for the installation and pre-commissioning of switchgear.

NOTE: Eskom will normally provide the support structures (unless otherwise specified) under a separate contract/order.

c) Installation includes mounting and securing the equipment and its support structure onto the concrete support foundation, levelling of the disconnector, where applicable.

d) For each type of supplied disconnector, the installation instructions provided by the supplier according to the OEM's instructions shall at least include the items listed below:

- Unpacking, inspection and lifting instructions: all information required for unpacking and lifting safely shall be given, including details of any special lifting and positioning devices that are necessary;
- Assembly: when the disconnector is not fully assembled for transport, all transport units shall be clearly marked. Drawings showing the assembly of these parts shall be provided with the switchgear;
- Mounting: instructions for mounting the base frame, poles, operating device(s) and auxiliary equipment shall include sufficient details to enable site preparation to be completed. These instructions shall also indicate:

    i. The total mass of the equipment; and

    ii. The mass of the heaviest part of the apparatus to be lifted separately if it exceeds 100 kg

    iii. The length of thread protrusion on each bolt shall be minimum of 3 threads past the nut;

    iv. Qualification of personnel: all personnel employed by the supplier who is involved in the installation and pre-commissioning of the disconnector shall be trained and accredited by the OEM. Proof of this accreditation shall be included in the quality control plan and shall be submitted to Eskom for approval prior to installation and pre-commissioning of equipment by the individuals concerned; and

e) Final installation inspection and testing: instructions shall be provided for inspection and testing after the switchgear and control gear has been installed and all the interfacing connections have been completed.

These instructions shall include the following:

- Procedures for carrying out any adjustment that may be necessary to achieve correct operation;
- Recommendations for any relevant measurements that should be made and recorded to help with future maintenance decisions; and
- Instructions for final inspection and testing.

f) During the performance of the work at the substation site, the supplier shall comply with all the relevant statutes, regulations, bylaws and codes, as well as all the safety and quality requirements pertaining to the work. The supplier shall provide all apparatus including safeguards and personal protective equipment (PPE), including a Fall Arrest System (FAS), necessary for the performance of the work.

g) Installation tools / equipment and debris shall be removed from site when installation is completed.

h) Power supplies for installation purposes can be made available on the construction site.

7.7 On-site work requirement

7.7.1 Supplier responsibilities

The supplier shall be responsible for ensuring the training and certifying of persons employed for the installation and pre-commissioning of switchgear.

NOTE: The first unit to be erected under the contract shall be witnessed and written approval given by Eskom in order to ensure that the both the equipment and work carried out is satisfactory and to establish the necessary standards for subsequent erection work. As part of this exercise the final alignment after main conductor attachment is to be included.

7.7.2 Requirements

Erection of the equipment shall include:-

a) Off-loading and supply of all equipment required for installation and inspection.

b) On completion of the erection works removal from site of all surplus equipment.

c) Site testing (pre-commissioning tests) of the installed equipment as specified in sub-clause 13.2.2 of this standard.

7.7.3 Competency of Erection Staff

a) All persons appointed to supervise or act on the Contractor’s behalf with respect to site erection work shall be fully competent in the erection as well as assembly of the equipment - and be approved in writing by Eskom.

b) The Contractor shall possess and maintain a competency file containing pertinent details of all persons used to supervise and perform site erection work.

Training and accreditation of all staff entrusted with on-site erection plus obtaining approval in writing by Eskom shall be the responsibility of the Contractor

7.7.4 Pre-commissioning

a) Each disconnector shall be tested after installation in accordance with clause 9 to assure proper installation and that no damage occurred during transportation. The pre-commissioning tests shall be witnessed by an appointed Eskom representative/official. To facilitate the testing, adequate D.C. power supplies, test equipment and suitably qualified and accredited personnel shall be provided by the supplier.

b) A disconnector pre-commissioning test report shall be submitted to Eskom, comprising the following parts:

- After the measurements at the substation site, a hand-written pre-commissioning test report shall be handed over to the appointed Eskom representative/official;
- Within three weeks after the pre-commissioning tests, the supplier shall submit an official report to Eskom (two hardcopies); and
- An electronic copy of the official report shall be provided on a CD for each individual disconnector. All the measured values shall be clearly stated in the report as well as the following:
- Test/measuring equipment information/data:
  - i. Make and type of instruments;
  - ii. Serial numbers of instruments;
  - iii. Methods of triggering operating pulse;
  - iv. Measuring methods;
  - v. Calibration certificates of the measuring instruments used, from an accredited laboratory, e.g. SANAS;
  - vi. The disconnector data:
  - vii. Make and type;
  - viii. Serial numbers of poles and mechanisms;
  - ix. Rated voltage, normal current and short-circuit breaking current;
  - x. The name of the substation and section;
  - xi. Disconnector identification and application;
  - xii. Date of commissioning; and
  - xiii. Date and time of testing/measuring
    - o Clear copies of the complete printouts of the mechanical characteristics and main contact resistance measurements shall be attached to the official report. The names of all parties concerned shall be clearly stated in the report. If the measured values differ from the values as they were measured at the manufacturer's works, an interpretation shall be given and, if Eskom deems it necessary, the deviation shall be corrected by the supplier. If the disconnector is found to be faulty during the tests, a fault report shall be completed in addition to the pre-commissioning test report.
    - o After the final inspection, the final commissioning of the plant is performed and the hand-over documents shall be provided to Eskom by the supplier.

7.7.5 On-site pre-commissioning testing

The following tests/inspections shall be done on completion of erection and prior to handing over of the equipment:

a) Motor current measurement (if applicable)

b) Current path resistance measurement (i.e. terminal to terminal and each joint).

c) Contact travel, end position and alignment (including bus transfer devices, where applicable).

d) Complete operational check, including auxiliary switch function. (5 open and 5 close operations).

e) Disconnector closing and opening time (motor driven types only).

f) Operating force measurement for manual type drives

g) Operating forces measurements of motor drives (in electrical and mechanical units).

The above shall be recorded on a test record sheet and signed off by the Contractor's representative.

The results of pre-commissioning tests after installation on site shall be documented, signed off and a copy of the results included with the switchgear documentation for hand-over as part of the quality process. All tests shall be witnessed by Eskom.

7.7.6 After Sales Technical Support

The supplier shall provide locally based technical support on a full time bases for the duration of the contract.

8. Safety, Health and Environment and Quality

These shall be in accordance with Eskom SHEQ requirements.

9. Final Installation and Inspection

a) Provision shall be made during the erection phase for inspection and testing which should be made after the equipment has been installed and all connections have been completed. No equipment is to be handed over unless Eskom's representative is satisfied as indicated on the handing over certificate.

b) Care shall be taken to ensure that spares are protectively packed to enable satisfactory long-term storage.

c) Small spares such as contact fingers, springs, bearings etc. will be stored indoors, but bulky items such as spare insulators, current paths, etc., etc. will be stored outdoors.

10. Packaging and preservation requirements

a) Each disconnector shall be "unit-packed". In other words, the components making up a complete disconnector shall be delivered to site in one or more packing containers which shall contain only the component for one complete individual disconnector.

NOTE: Bolts and nuts shall not be stored in plastic bags, but in laminated wooden crates or boxes.

b) All disconnector components shall be packed in containers (e.g. wooden crates) that are suitable for transport and storage over long periods (for up to 18 months) outdoors. Refer to QM-58 on how to handle preservation.

c) Packaging shall prevent damage to the disconnector components during transportation and storage on site and shall be such that suitable ventilation is allowed in order to minimise condensation.

d) The packaging shall be able to withstand impact loadings of at least 18 kN. The mechanical strength of the packaging shall not be dependent on the strength of the top cover, i.e. it shall be possible to remove and subsequently replace the top cover without losing any mechanical strength of the packaging.

e) Where more than one crate is used per disconnector, each crate shall be clearly and sequentially marked in order to identify each crate as belonging to a specific disconnector (e.g. "CRATE 1 of 3", "CRATE 2 of 3", etc.).

f) Each container/crate shall be clearly marked with a durable label using an indelible font at least 30 mm high indicating the following information:

- Eskom order number;
- Eskom SAP number;
- Disconnector description (including the rated voltage, normal current, rated short-time withstand current, auxiliary D.C. control voltage; specific creepage; "1P" or "3P");
- Manufacturer's name (i.e. make of disconnector)
- Manufacturer's disconnector product designation/code (i.e. type of disconnector);
- Manufacturer's serial number(s);
- Contents of the crate (i.e. a parts list);
- The crate number (e.g. "CRATE 1 of 2", "CRATE 2 of 2");
- The crate overall dimensions (in mm); and
- Total mass of each crate (e.g. "TOTAL MASS: 1000 KG");
- Pictograms / symbols showing correct storage and stacking instructions for crates;
- Exposed shafts, bearings and machined surfaces shall be treated with a temporary anti-corrosive coating.
- Loose components or components that are subject to damage from exposure to dust or water shall be packed in hermetically sealed plastic bags;
- All components shall be clearly marked. Components that are physically impossible to mark shall be individually packed and the packaging shall be marked.
- Fork-lift lifting points shall be provided on the packaging, where applicable. These points shall be braced as though it were a lifting pallet (for mechanical support during lifting activities).
- A readily accessible (i.e. without the need to remove / disturb the external packaging) external temporary supply 230 V ac connection point for the heater circuit during storage shall be provided and wired to the Eskom side of the terminal strip in the factory. This shall consist of an electrical cord wired to a screw type connection block for the connection of the temporary ac supply used during storage. Heater connections shall be designed in such a manner so as not to cause a hazardous situation when energised. No internal wiring should be modified to remove the temporary supply leads. The connection point shall be labelled "230 V AC HEATER CONNECTION: CONNECT IF STORED > 2 DAYS" or similar.
- A non-resettable impact recorder or detector shall be provided and located in such a position so as to record/detect the acceleration of the disconnector body and not the packaging, the setting shall be the lowest impact which can be endured before damage is caused.

- A copy of the installation instructions with lifting instruction and photos or pictures are included and the Bill of Materials (BOM) shall be provided with the delivery note for each accessory supplied in order to allow the recipient to confirm that all items on the BOM have been delivered, and for record purposes.

11. Spares

11.1 General

a) Spare parts to be identified by means of a unique part number to facilitate ordering.

b) Spares will normally be purchased at the same time that orders are placed for disconnectors. The supplier shall provide a list of the minimum recommended spares in the current path and the mechanism.

NOTE: Delivery to any of the specified destinations should remain valid for the duration of the contract period.

11.2 Availability of Spares

a) The supplier (who represents the OEM), shall be responsible for ensuring the continued availability of spare parts required for maintenance for a period of not less than 25 years from the date of discontinuation of the switchgear and control gear.

b) Spares required under emergency breakdown conditions shall be readily available with a maximum lead time of 48 hours from date of purchase order. The supplier shall state the lead time offered in schedule B. This excludes spares required for scheduled maintenance.

c) Large spares such as complete current paths and motor drives shall be packed in separate cases, clearly labelled and consigned to Eskom. Such large spare items shall be provided with a metal label bearing the appropriate identification.

d) A parts list shall be provided with each consignment of spares, clearly identifying each item by description, identification number and quantity supplied. The contract number shall appear on the cases containing spares.

e) The supplier shall undertake to supply to Eskom all the necessary replacement parts for the disconnector throughout its expected service life. If the manufacture of the specific make and type of disconnector (or any of its replacement parts) is discontinued, Eskom shall be advised in writing.

f) Written advice (relating to discontinuation) shall also be provided for parts of the equipment that the supplier obtains from a third party (sub-supplier). In this situation, the supplier shall supply the following information to Eskom:

- All design data;
- All material characteristics and parameters;
- All testing information (parameters, equipment, methods, criteria, etc.);
- All manufacturing information; and
- All relevant working drawings and information.

g) This information shall be supplied to Eskom in a legible and acceptable format in English when notice of discontinuation of the disconnector or any of its replacement parts is given. In this case, Eskom will be able to make alternative arrangements to obtain the necessary replacement parts. Another option is to pool spare parts: the supplier shall state spares availability philosophy with the tender documentation.

11.3 Identification of Spares

a) Spares shall be identified by a unique number and cross-referenced in the instruction manual. Large spares such as poles and operating shafts shall be packed in separate cases, clearly labelled and consigned to Eskom. Such large spare items shall be provided with a metal label bearing the appropriate identification.

b) A parts list shall be provided with each consignment of spares, clearly identifying each item by description, identification number and quantity supplied. The contract number shall appear on the packaging containing spares.

11.4 Packaging, preservation and storage of spares

Refer to QM-58 on how to handle preservation. Care shall be taken to ensure that spares are protectively packed for satisfactory long-term storage. Maintenance spares will usually be stored indoors.

12. Control Cables and Gland Plates

a) Control cables terminated inside enclosures shall enter at the bottom of the enclosure.

b) Cables shall be of the PVC covered steel wire armoured multiple core type fitted with armour grip type glands.

c) Gland plates shall be removable, undrilled and made of brass or corrosion resistant aluminium alloy. Steel gland plates are not acceptable.

d) Suitable gasket to be fitted between the mechanism box and the gland plate.

12.1 A Dimension of the Gland Plate shall be:-

a) Minimum available area of the gland plate shall be at least 75 mm x 75 mm for manual operated disconnectors of 66kV and below voltages. For all other disconnectors, the minimum usable area shall be 100 mm x 150 mm.

b) Minimum thickness at least 2 mm (for brass) or 4 mm (for aluminium).

c) Where applicable, metallic cable racking used to mechanically protect and/or support disconnector cabling (e.g. inter-pole cabling) shall be manufactured using galvanized steel, unless otherwise approved by Eskom.

NOTES:

1) The use of aluminium cable racking is considered to present a theft risk and will not be accepted.

2) Where Eskom support structure legs are provided, no provision is made for securing or mounting inter-pole cable racking on the legs – requiring the (armoured) inter-pole cabling to be buried in the ground in accordance with 240-56030489, unless otherwise approved by Eskom.

12.2 Secondary Terminals

a) Auxiliary switches, internal wiring and other equipment requiring connection to external apparatus shall be wired to terminal strips in the disconnector mechanism box. These must be approved in writing by Eskom.

b) Each terminal strip shall be provided with not less than 4 spare terminals.

c) The arrangement of the terminal strips (vertical orientation) in the equipment shall facilitate the entry of the incoming control cables in the bottom-entry configuration.

d) Secondary terminals to which Eskom's control cables will be terminated shall comply with Distribution Specification 34-253, for rated voltage below 220 kV. For 220 kV and above voltage, Eskom shall specify.

e) The terminal blocks shall be of the screw clamp, spring loaded insertion type.

f) The terminal width of 10mm is the preferred option.

g) The terminal blocks shall be capable of accepting back-to-back insulated hook blade lugs without damaging or deforming the lug.

h) All electrical circuits for external connection shall be terminated at a secondary terminal strip.

i) The secondary terminal strips shall be arranged vertically or horizontally within the enclosure.

j) For horizontally arranged secondary terminals, the lowest part of the terminal strip shall be at least 150 mm above the gland plate.

k) For vertically arranged secondary terminals this value may be less than 150 mm above the gland plate provided sufficient clearance to the sides of the enclosure is provided for arranging and terminating the incoming cable cores, and wiring bundle and working clearance.

l) The secondary terminals shall be of the DIN rail-mounted spring-loaded type. An Eskom approved type of terminal shall be supplied. The sample of it shall be submitted at tendering stage for Eskom approval.

m) At least 4 spare terminals shall be provided.

12.3 Secondary Wiring

a) All wiring shall be carried out in multi-stranded copper conductor. A minimum equivalent area of 2, 5 mm^2 for motor circuits and 1.5 mm^2 for other circuits which is insulated to withstand a routine test voltage of 2 kV for 60 s shall be provided.

b) Each individual wire must be terminated with lugs suitable for the secondary terminal block or component terminal used. Bare wire ends are not acceptable.

c) Wiring shall be clearly identified by an approved means such as ferruling at both ends or laser etching of the insulation.

d) Thermal impression of the insulation or adhesive labels as a means of wiring identification is not acceptable.

e) Wiring to components mounted on swing frames shall be arranged to twist at and along the hinge point.

f) The internal wiring interface of the operating mechanism enclosure shall be standardised in accordance with the Eskom interface standard drawings, 0.54/07129; 0.54/07858; 0.54/07860 and 0.54/07858, or otherwise on a drawing stated in schedule A.

All workmanship with regards to the above shall be subject to Eskom approval.

12.4 Control Elements

a) All control elements such as contactors, thermal overload relays, push buttons and limit switches shall be in accordance with the relevant IEC standards.

b) All control elements shall be regular stock items available from standard product lines.

c) The control elements shall be readily interchangeable with an equivalent item from alternative suppliers. All Mounting of control elements on access doors is not acceptable practice.

d) All control elements must be labelled with their locations inside the drive.

e) The location of the label shall be on the backing plate where the relays are fixed in order to retain the labelling should the relay be changed during its life time.

12.5 Auxiliary Switches

a) Auxiliary switches shall be of an approved type. Approval shall be determined at the tendering stage by means of a sample provided for evaluation by Eskom.

b) Auxiliary switches shall be rated according the values specified in schedule A. The tenderer shall state the rating of the auxiliary switch in schedule B.

c) Auxiliary switches shall be driven positively and the linkage system employed shall ensure correct action throughout the operation.

d) The number and type of auxiliary contacts required for each mechanism shall be as specified in schedule A. The tenderer shall state the number and type of auxiliary contact in schedule B.

e) Auxiliary switch contacts shall be galvanically independent.

f) All spare auxiliary switch contacts shall be wired to the secondary terminal strip.

g) Auxiliary switch contacts shall be protected against ingress of dust particles to the degree of protection IP55.

h) Auxiliary switches shall faithfully reproduce the main contact position and achieve the relative timing parameters required.

i) The auxiliary switch shall be a truly maintenance free device for the life of the equipment.

j) The timing of the designated auxiliary contact types shall be according to the figure below:

k) Switches shall always stay aligned and shall not bend if main contacts become stiff to operate.

l) Auxiliary switches shall not be placed directly under shaft seals where water can enter.

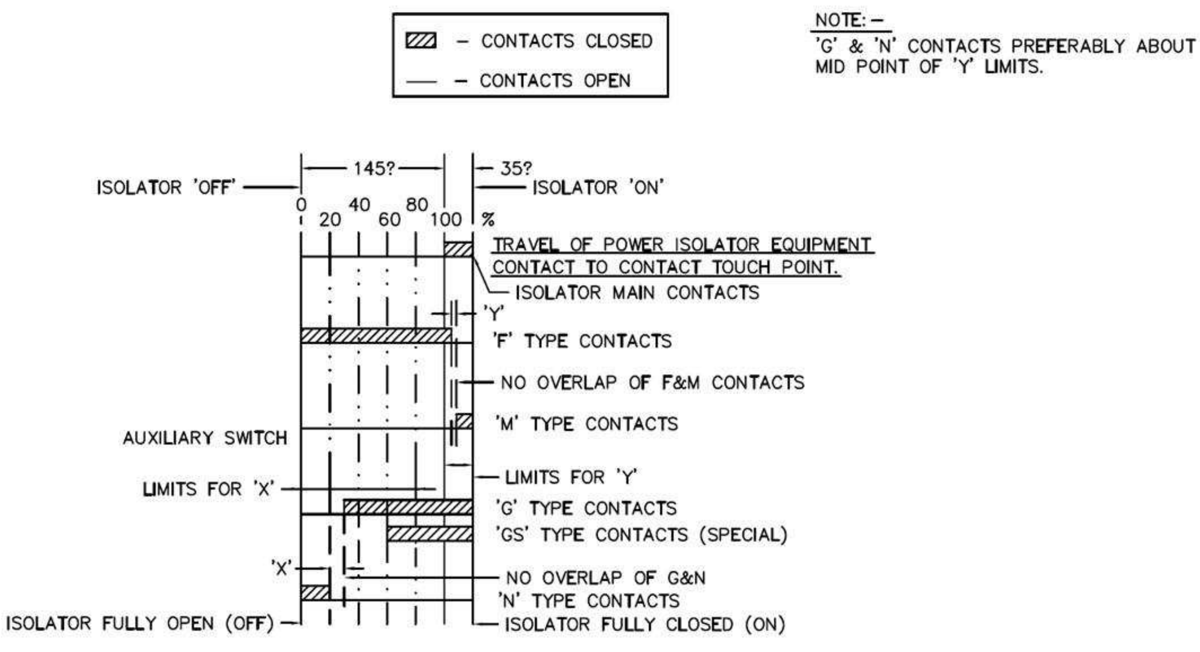

Figure 1: Auxiliary switch contacts timing diagram

12.6 Convention / Practice

The convention has been adopted that auxiliary contacts, limit switches, relay contacts etc. are in the normal condition when:

a) Disconnector and/or earthing switch main contacts are open;

b) Relay coils are de-energised.

The schematic wiring diagram submitted to Eskom for design purposes and final approval shall reflect this convention which is in accordance with Eskom drawing D-DT 5045.

13. Documentation

13.1 Responsibilities

The responsibilities of both Eskom and the supplier for the disconnectors, earthing switches and associated equipment shall be enumerated as below.

13.2 Supplier's Responsibilities

13.2.1 Supplier's Responsibility at Tendering Stage:

The Supplier shall be responsible for the following:

a) At the tendering stage provide a complete set of technical documentation and completed technical schedule B for each disconnector size. The technical schedule B shall not be left blank. Where numerical values (e.g. rated values, dimensions, etc.) or specific information is required, the actual value/information offered shall be stated. In such cases, use of the words "COMPLY", "TBA", NOTED etc. is not acceptable;

b) In the case of evaluation at the factory of disconnector for use on systems with nominal voltages up to and including 765 kV, the erection of a completely functional prototype at the supplier's own premises under direct supervision of the OEM for a comprehensive evaluation by Eskom before erecting on site. Unless otherwise agreed by Eskom;

c) A full set of general arrangement (GA) drawings (also refer to clause 5.15) showing the following minimum information:

- manufacturer's drawing number and revision number; Provision shall be made on each sheet for an Eskom-allocated drawing number as well as for the Eskom contract number – for population after awarding of the contract;
- critical dimensions such as overall dimensions, structure dimensions, phase to phase spacing, phase to phase and phase to earth air clearances, working clearance, height of lowest part of insulation above ground, height of top of mechanism enclosure above ground, mechanism enclosure dimensions, overall height, width and depth of disconnector, etc.;
- details of post insulators [material type, classification, dimensions, creepage distance, withstand voltages (power frequency, switching and lightning), mechanical strength, shed profile, top and bottom PCDs];
- properly annotated drawing with a complete list of major components (bill of materials);
- details of main terminals including dimensions of the fixing holes, terminal hole spacing, plate thickness and maximum permissible loading on main terminals (with directions) expressed in Newton (N);
- details of the main earthing terminal and mechanism enclosure earthing terminal;
- mass of complete disconnector or earthing switch in kilograms (kg), which shall include the mass and description of heaviest component, total mass of disconnector ready for service;

- any special trenches or steelwork required between phases;
- for disconnectors used in systems with nominal voltages above 400 kV, the support structure dimensioned outline and general arrangement and holding down bolts details;
- for disconnectors used in systems with nominal voltages above 400 kV, the support structure earthing terminal;
- for disconnectors used in systems with nominal voltages above 400 kV, the support structure label mounting holes;
- mounting and fastening arrangement for the disconnectors support structure onto the foundation including the minimum required length of foundation holding down bolts as well as the relative position of levelling nuts, spacers, washers, etc. in relation to the base plate;
- maximum torque required for the foundation holding down bolt nuts used to secure the support structure base plate (Nm);
- dynamic horizontal force (N) exerted during operation on the foundation – vector showing location, magnitude and direction;
- dynamic vertical force (N) exerted during operation on the foundation – vector showing location, magnitude and direction;
- dynamic moment (Nm) exerted during operation about the foundation – showing location, magnitude and direction;
- relative location of disconnector poles, base-frame and operating mechanism enclosure(s);
- location of all enclosure doors and handles;
- location and annotation of control facilities;
- location and layout of LV control cable gland plates; and
- location of nameplate on disconnector;
- details about the bus transfer device;
- layout of terminal strips;

d) for all external insulation (i.e. post-insulators), detailed drawings showing the shed profile dimensions including shed and insulation body/core diameters, shed spacing, creepage distance and dry arcing distances, etc. This shall have manufacturer's drawing number and revision number. Provision shall be made on each sheet for an Eskom-allocated drawing number as well as for the Eskom contract number – for population after awarding of the contract;

- a general arrangement drawing of the operating mechanism enclosure. This shall have manufacturer's drawing number and revision number. Provision shall be made on each sheet for an Eskom-allocated drawing number as well as for the Eskom contract number – for population after awarding of the contract;

e) full list of spares required for maintenance (refer to clause 11);

f) full list of operating tools

g) detailed list of standard tools required for 2nd line maintenance

h) full list as well as copies of type test certificates and reports as specified in the specification;

i) generic routine test certificates for the disconnectors;

j) transport, storage, installation, operating and maintenance manuals (refer to clause 7);

k) training material and courses (refer to clause 5.14);

l) impact recorders and

m) the submission, where applicable, of the following additional information:

- quality control plans indicating all inspection hold points (refer to sub-clause 5.10.2);
- details of equipment requiring maintenance during storage (refer to sub-clause 13.2.2 a));
- copy of the storage and handling procedures which indicate the maximum recommended period of storage (refer to sub-clause 13.2.1 d));
- a written commitment from the supplier regarding the submission of the maintenance DVD (refer to sub-clause 5.10.5); and
- spares availability philosophy (refer to clause 11);
- Information about bushes and method of lubrication (refer to sub-clause 5.8.3).
- Information about rating plate fixing (refer to sub-clause 13.2.1a)).
- The list of greases as per clause sub-clause 5.9.5.

All the documentation required in this standard and Schedule A to be submitted at tendering stage. This includes the following, but not limited to:-

- Method used to achieve immunity from spurious operation due to induced surges in the control cables is subject to approval by Eskom.
- Provide the details of the specified training by the OEM accredited trainers as per document 240-56065202: Switchgear training from original equipment manufacturers.

13.2.2 Supplier's Responsibility upon Awarding Contract:

a) Supply of all equipment in acceptable working condition for on-site handover, inclusive of all phases prior to handover i.e. packaging, transportation, storage and erection on site (if applicable).

b) Where heaters need to be energised, an electrical connection point (refer to sub-clause 7.5c)) shall be provided to enable Eskom to supply power to the heaters.

c) Within one month of contract award supply documentation as per this clause 13.

d) Provision of OEM accredited off-loading, erection and pre-commissioning activities.

e) All documentation relevant to the disconnector, including routine factory test certification shall be available with the equipment on-site, prior to any erection taking place.

f) Unless otherwise ordered, provision of fully compatible type hot-dip galvanised steel support structures and drawings for disconnectors and earthing switches.

g) Checking and verifying that supporting structures are erected and aligned to the requisite standard before commencing with erection.

h) Provision of all necessary auxiliary equipment such as manual operating handles for motor drives.

i) Supply of conductor terminal pad and all necessary bolts and fasteners for erection and any further items required to complete the installation.

j) Complete assembly and erection of the main equipment (if erection is called for) ready for service. This shall include items such as the upper contact assembly for pantograph type disconnectors – see paragraph below.

k) For disconnectors of the pantograph type, provision of all associated equipment such as upper contact assemblies (including bus transfer switching devices), upper conductor clamping arrangements and main terminal adapters (if required).

l) Re-alignment and re-adjustment of equipment after connection of the main conductors.

m) Supply of complete disconnector or earthing switch ready for handing over.

n) Pre-commissioning testing and recordings as per sub-clause 7.7.4 of this standard using accredited resources and approved methodology.

o) If during the normal life of the supplied equipment, Eskom requires notification about necessary modifications, a field service bulletin shall be issued giving details of each modification and the reasoning for the particular modification.

p) Upon order placement provide and deliver spares to the specified sites or stores. Also notify Eskom where particular spares are no longer supplied and or provided.

q) Provide the specified training by the OEM accredited trainers as per document 240-56065202: Switchgear training from original equipment manufacturers.

r) Retaining spares for 25 years after discontinuance.

s) Any other responsibilities as set out in this standard.

13.2.3 Supplier's Responsibility Post Contract Award;

a) Manufacturing the equipment on the awarded contract using drawings that show the Eskom allocated drawing number. The same drawings shall be issued to representatives of Eskom upon request during contract tenure.

b) Inform Eskom on modifications, for approval and drawings and relevant documentation revisions.

c) Unless otherwise specified in schedule A, the manufacturer shall submit the following documentation with each disconnector delivered to Eskom:

- a schematic wiring diagram of the disconnector. This shall have the manufacturer's drawing number
- and revision number. Provision shall be made on each sheet for an Eskom-allocated drawing number as well as for the Eskom contract number – for population after awarding of the contract;
- a complete set of routine test certificates;
- a commissioning and hand-over test sheet; and
- one set of transport, storage, installation, operating and maintenance manuals

The above documents supplied with the disconnector shall be stored in the documentation pocket on the inside of the disconnector mechanism enclosure front access door.

NOTE: In addition to the documents supplied with the disconnector, all documents shall be made available in electronic format for publication on the Eskom internal equipment database.

13.3 Eskom's Responsibilities

13.3.1 Eskom shall be Responsible for the following:

a) The supply of the specification and the completed schedule A with the enquiry.

b) Undertake in-depth technical evaluations of tenders and the equipment offered, during the tendering phase including, when called for, perform evaluation at the manufacturer premises.

c) Allocate Eskom numbers and approve drawings supplied by the contractor i.e. outline, wiring, main terminals, support structure interface (where applicable) and rating plate.

d) Approve all documentation supplied by the supplier i.e. erection and maintenance instructions, manuals, inspection and test plans, training material, maintenance DVD and other supporting documents.

e) Provide electrical power connection for heater energisation during storage.

f) Provide storage if longer than scheduled time to installation is anticipated.

g) Provide the necessary, main conductor stringing, conductor clamps, secondary cabling, identification labels, connections to the substation earth mat and standard type padlocks.

h) Provide the steel support structure and civil foundation drawings for the disconnector and earthing switch.

i) Provide the steel support structure and civil foundation for the disconnector and earthing switch upon order placement.

j) In case of replacement of existing disconnectors, provide structural and civil details to the supplier in order to determine modifications to be made to the disconnector.

k) Supply and install all control, relaying and signalling equipment remote from the equipment.

l) When installation is done by the supplier, Eskom to witness and approve first off complete installation. This shall include testing and reports produced for the equipment.

13.4 Type Test Evidence

A summary of all the type tests performed on the equipment, indicating compliance with the requirements of this standard and SANS 62271-102. It shall include the testing authority and dates when type tests were performed.

13.5 Manuals

13.5.1 General

Transport, storage, installation (erection), operation and maintenance information shall be submitted in the form of manuals. These manuals shall be in English and provided in the following formats:

a) Hard copy A4 form; and

b) Electronic copy form copied onto an appropriate medium such as Compact Disc (CD), in PDF format.

The manual and contents shall be approved by Eskom. The approval process shall be initiated immediately upon contract award and completed within three months. The onus shall be upon the supplier to meet this programme. If further material is required, then this shall be subject to negotiation.

13.5.2 On Contract Awarding, Manuals shall be submitted as per Approved Schedule B.

13.5.2.1 Content

The instruction manual(s) shall cover transport, storage, installation, operation and maintenance and shall fulfil the following requirements:

- The manuals shall be written in English only;
- It shall be specifically compiled for the disconnector with which it has been supplied;
- Torque wrench settings, clearances, settings and other important information shall be listed, e.g. the typical operating times, speed curves and tolerances in synchronism;
- It shall give a clear description of the operation, and the diagrams and description shall be easily read together;
- Inspection), scheduled and specialised (intrusive) maintenance procedures shall be given together with a list of lubricants, recommended spares and/or special tools and so on, required for these operations;
- It shall contain high-quality diagrams showing details of operating components of the disconnector, which also identify and list separately each component making up the diagram;

- Seals and gaskets requiring replacement during overhaul shall be detailed and the suppliers of these components, together with the part number(s), shall be listed; and
- The names and addresses of suppliers of lubricants, oils, gases, and compounds and so on shall be listed.

13.5.2.2 Personnel

Qualified personnel will install, operate, maintain and repair the equipment with the aid of the manufacturer's instruction manuals and DVD aids. The manuals shall contain at least the following information (where applicable):

- Title page: title of equipment, equipment ratings, contract and order numbers, supplier's reference numbers. This information shall also appear on the outside of the binder and on the first page;
- Table of contents: the manual shall be sectionalised and numbered sequentially;
- equipment make and type to which the manuals apply;
- List of all drawings, by number and title;
- Description and summary of disconnector operation;
- Where applicable, details of interlocking between phases;
- Schematic wiring diagram of disconnector; and
- Where applicable, full details of all valves, including information regarding materials of valves and valve seals. If materials such as synthetic rubber or other equivalent types are used, the method of bonding or clamping these materials shall be given.

13.5.3 Transport and Storage Instructions

- Packaging requirements;
- Transport instructions;
- Storage instructions: indoor, outdoor and special information for equipment storage; and
- The measures required to make sure all the manufacturer's transportation and storage requirements are met.

13.5.4 Installation Instructions

- Complete step-by-step instructions and detailed drawings, including alignment, installation and dimensional tolerances for preparing the equipment for service;
- Inspection procedures before and after unloading, pre-installation tests, and monitoring procedures;
- The levels of expertise required for the construction team;
- A man-hour estimate for the installation work required on site;
- A list of special equipment and tools required for unloading and positioning components of the disconnector on site; and
- Tolerances for field assembly.

The supplier shall supply a DVD to supplement installation information given in the installation manual. This visual information may be provided separately or may form part of the maintenance DVD required.

13.5.5 Testing

- functional testing, dielectric testing, operating instructions, operating limits and starting-up instructions (complete with sketches or drawings); and
- A separate set of record sheets, showing measurements and tolerances for each test for separate items of equipment.

13.5.6 Inspection and Maintenance

The maintenance manual shall contain the typical contents as described in 5.10.

13.5.7 Dismantling, Repair, Settings Inspection and Lubrication

- Instructions for dismantling the equipment, as well as repair instructions and settings of critical clearances and adjustments, complete with photographs and sketches or drawings;
- Special tools shall be clearly described;
- Guide to inspection frequency;
- All gaskets, seals and O-rings which have to be replaced during scheduled maintenance or after a specified period, shall be identified;
- Lubrication chart and schedule (including component quantities). Lubricants shall be clearly identified. If no lubrication is required, it shall be clearly stated;
- Procedures for the discharge of stored energies in the mechanical and electric systems; and
- Trouble-shooting procedures shall be provided.

13.5.8 Spare Parts

- Spare parts list, including quantities and manufacturer's part numbers. Spare part numbers shall be cross-referenced with drawings in the instruction manual;
- Drawings (sectional or "exploded" views, etc.) of the equipment/sub-assemblies shall identify every component (excluding standard bolts, nuts, washers, etc.) referenced to the spare parts list, including component description and manufacturer's part number; and
- Delivery times for recommended spare parts shall be stated.

13.5.9 Drawings for Equipment

A complete set of approved drawings specific to the equipment being supplied:-. The drawings shall show dimensions and tolerances of the major components and assemblies. Details of the drawings required are given in c).

14. Training

The supplier shall provide first hand training of an international standard on the supplied equipment by OEM accredited instructors.

Refer to 240-56065202 for the switchgear training requirements from original equipment manufacturers.

15. Authorisation

This document has been seen and accepted by:

Name and surname	Designation
B Ntshangase	Senior Manager HV Plant
J Cebekhulu	AIS Care Group Convener
B Ntshangase	Plant Equipment SC Chairperson
	Rev 1 Document Approved by TDAC ROD 27 February 2013
	Rev 2 Document Approval via SCOT Chairman

16. Revisions

Date	Rev	Compiler	Remarks
Dec 2015	3	I Sibeko	Minor changes in the context and revision number and figure 1 updated.
June 2014	2	I Sibeko	Updated tables 1 & 2 and minor changes in clauses 3.18.1; 3.20.3 and 3.25.9
Aug 2013	1	I Sibeko	Final Document for Authorisation Updated document Final after Comments Review Updated document for Comments Review Updated all references from “this specification” to “this standard”; Included special requirements and designs that offer environmental friendliness. Updated all references from “this specification” to “this standard”; Included special requirements and designs that offer Environmental friendliness. Added on clause on Condition monitoring of disconnectors.
Nov 2012	0	I Sibeko	Draft document for Review created from ESP 32-536

17. Development team

The specification was revised by a cross functional team consisting of Eskom’s Transmission & Distribution switchgear equipment specialists.

The following people were involved in the development of this document:

- Fanie Botha — Transmission Free State Grid
- Isaac Sibeko — Technology PDE HV Plant Engineering
- Grant Ruiters — Transmission Northern Cape Grid
- Hennie de Bod — Transmission Western Cape Grid
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- Len Ludik Transmission Southern Grid.
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- Quinten Nepgen Transmission North East Grid
- Sipho Zulu Technology PDE Substation Engineering
- JD Fourie Transmission North West Grid
- TN Van Den Berg Transmission North West Grid
- Jack Wilson Distribution KZN OU
- Bernie Murfin QA CED 765kV Projects

18. Acknowledgements

The Compiler acknowledges the contributions to this revision from Technology, Distribution, Transmission and Quality.

Annex A – Technical Schedules A & B

Technical Schedules A and B for HV Outdoor disconnectors (Generic)

Schedule A: Purchasers specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

1	2	3		4	5
Item	**Clause of 240-56063815**	**Description**		**Schedule A**	**Schedule B**
1		**Purchasing details**			
1.1		Quantity of units required			xxxxxxxxxx
1.2		SAP No			xxxxxxxxxx
1.3		Region			xxxxxxxxxx
1.4		Site Name			xxxxxxxxxx
1.5		Nearest Town			xxxxxxxxxx
1.6		Province			xxxxxxxxxx
1.7		Distance from nearest town	km		xxxxxxxxxx
1.8		Access to site			xxxxxxxxxx
2		**Delivery and off-loading**			
2.1		Disconnector delivered to:			xxxxxxxxxx
2.2		Delivery effected not before	Date		xxxxxxxxxx
2.3		Erection completed not later than	Date		xxxxxxxxxx
2.4		Off-loaded from transport vehicle and transferred to intended operating position by supplier.		YES	
2.5		Construction supply available			xxxxxxxxxx
3		**Site conditions of service**			
		Altitude	m	1 800	
3.1		Ambient air temperature range			
3.2		Maximum (Peak)	°C	+45	
3.3		Highest average daily	°C	+35	

1	2	3	4	5
Item	**Clause of 240-56063815**	**Description**	**Schedule A**	**Schedule B**
3.4		□ Lowest average daily maximum °C	+5	
3.5		□ Minimum °C	-10	
3.6		□ Maximum average daily variation °C	25	
3.7		□ Design level °C	50	
		□		
3.8		□ Icing conditions	None	
		□		
3.9		□ Humidity		
3.10		□ Relative humidity conditions		
3.11		□ Minimum %	5	
3.12		□ Maximum %	99	
3.13		□ Average %	50	
		□		
3.14		□ Solar radiation W/m²	1 100	
3.15		□		
3.16		□ Wind loadings		
3.17		□ Basic design velocity km/hr	115	
3.18		□ Maximum wind speed km/hr	144	
3.19		□ Wind loadings Pascals	1 000	
		□		
3.20		□ Lightning flash density flashes/km²/yr	8	
4 4.1		**System conditions of service** □ Nominal system voltage kV		
4.2		□ Number of phases	3	
4.3		□ Nominal system frequency Hz	50	
4.4		□ System earthing	Effectively earthed	
		□		

1	2	3		4	5
Item	**Clause of 240-56063815**	**Description**		**Schedule A**	**Schedule B**
5 5.1		**Type of Disconnector** □ Type of disconnector required		CRPDB / Pantograph	
		□			
6 6.1		**Detail of disconnector** □ Manufacturer		xxxxxxxxxx	
6.2		□ Type designation		xxxxxxxxxx	
6.3		□ Number of breaks		xxxxxxxxxx	
6.4		□ Main contacts		xxxxxxxxxx	
6.5		□ Type		xxxxxxxxxx	
6.6		□ Entry		Free/Friction	
6.7		□ Contact force	N	xxxxxxxxxx	
6.8		□ Materials		xxxxxxxxxx	
6.9		□ Wear allowance		xxxxxxxxxx	
		□			
7 7.1		□ **Disconnector ratings (IEC 62271-102)** □ Rated nominal voltage	kV	xxxxxxxxxx	
7.2		□ Rated normal current	A	xxxxxxxxxx	
7.3		□ Rated short-time withstand current	kA	xxxxxxxxxx	
7.4		□ Rated duration of short circuit	s	3	
7.5		□ Rated peak withstand current	kA	xxxxxxxxxx	
7.6		□ Rated short-duration power frequency withstand voltage	kV	xxxxxxxxxx	
7.7		□ Rated lightning impulse withstand voltage	kV	Xxxxxxxxxx	
8		□ **Mounting of disconnector**			
8.1		□ Upright, horizontal or vertical			
8.2		□ Phase spacing	mm	xxxxxxxxxx	
8.3		□ Mounting height (lowest part of insulation above ground level)	mm	xxxxxxxxxx	
8.4		□ Arrangement of phases, in-line or transverse		Transverse / Clamping	

1	2	3		4	5
Item	**Clause of 240-56063815**	**Description**		**Schedule A**	**Schedule B**
8.5		Is mounting structure for the isolator to be provided by the supplier		No	
8.6		Is mounting structure for the separate earth switch to be provided by the supplier		Yes	
9		**Type of operation**			
9.1		Isolator		Hand / Motor	
9.2		Earth switch		Hand	
10		**Operating movement (for hand driven mechanism)**			
10.1		Isolators		Horizontal	
10.2		Earth switch		Horizontal	
11		**Motor driven mechanism**			
11.1		Motor voltage	V	xxxxxxxxxx	
11.2		Rated torque of drive	Nm	xxxxxxxxxx	
11.3		Maximum starting current	A	xxxxxxxxxx	
11.4		Operating times			
11.5		Opening	s	xxxxxxxxxx	
11.6		Closing	s	xxxxxxxxxx	
12		**Auxiliary switches**			
12.1		Number of contacts for disconnectors			
12.2		Type G		10	
12.3		Type GS		2	
12.4		Type M		5	
12.5		Type F		2	
12.6		Type N		5	
12.7		Number of contacts for earthing switches			
12.8		Type M		4	

1	2	3		4	5
Item	**Clause of 240-56063815**	**Description**		**Schedule A**	**Schedule B**
12.9		□ Type N		4	
13		□ **Ratings for auxiliary switches**			
13.1		□ Breaking current	A		
13.2		□ AC - 110 Volts (power factor 0,5)	A	10	
13.3		□ DC - 220 Volts (t=60 ms)	A	2	
13.4		□ Continuous current	A	xxxxxxxxxx	
13.5		□ Short-time current for 1 second	(□= 60 ms)	100	
13.6		□ Volt drop across contacts for a current of 10A DC	mV		
		□			
14 14.1		□ **Main terminals** □ Type		 Pad	
14.2		□ Material		Aluminium	
14.3		□ Orientation: vertical or horizontal			
14.4		□ Dimension of pads:			
14.5		□ Number of holes		8	
14.6		□ Diameter of holes	mm	14	
14.7		□ Pitch of holes	mm	50	
14.8		□ Thickness of pad	mm	xxxxxxxxxx	
		□			
15		**Insulation and clearances**			
15.1		□ Details of insulators offered			
15.2		□ Manufacturer		xxxxxxxxxx	
15.3		□ Type designation		xxxxxxxxxx	
15.4		□ Number of units in stack		xxxxxxxxxx	
15.5		□ Cantilever strength class	N	xxxxxxxxxx	
15.6		□ Torsion strength	Nm	xxxxxxxxxx	
15.7		□ Creepage distance (minimum)	mm	xxxxxxxxxx	
15.8		□ Insulator material		Porcelain or silicon rubber	
		□			

1	2	3			4	5
Item	**Clause of 240-56063815**	**Description**			**Schedule A**	**Schedule B**
16		□	**Insulator test voltage**			
16.1		□	Lightning impulse withstand voltage (1,2/50 µs) referred to sea level			
16.2		□	To earth and between phases in the open position	kV	xxxxxxxxxx	
16.3		□ □	Across the isolating distance	kV	xxxxxxxxxx	
17		□	**Power frequency wet withstand voltage (60 second) referred to sea level**			
17.1		□	To earth and between phases in the open position	kV	xxxxxxxxxx	
17.2		□	Across the isolating distance	kV	xxxxxxxxxx	
18		□	**Voltage test across isolating distance (bias test)**			
18.1		□	Value of power frequency voltage	kV	xxxxxxxxxx	
18.2		□	Crest value of lightning impulse wave		xxxxxxxxxx	
18.3		□	Crest value of switching impulse wave	kV	xxxxxxxxxx	
19		□	**Radio influence voltage test**			
19.1		□	Single phase test voltage applied to disconnector in open and closed position	kV	xxxxxxxxxx	
19.2		□	Radio influence voltage at 1 MHz	µV	xxxxxxxxxx	
20		□	**Electrical clearances**			
20.1		□	Between live portions of phases	mm	xxxxxxxxxx	
20.2		□	Between live portions at system voltage and earth	mm	xxxxxxxxxx	
20.3		□	Lowest point of insulation above ground level not to be less than	mm	xxxxxxxxxx	
21		**Miscellaneous**				
21.1		□	Mass details			

1	2	3	4	5
Item	**Clause of 240-56063815**	**Description**	**Schedule A**	**Schedule B**
21.2		☐ Complete disconnector without earthing switch	kg	
21.3		☐ Complete disconnector with single earthing switch	kg	
21.4		☐ Complete disconnector with double earthing switch	kg	
21.5		☐ Separate earthing switch	kg	
22		☐ **Protection of housing and mechanism boxes**		
22.1		☐ International Protection rating	IP55	
22.2		☐ Material type	316 stainless steel	
23		☐ **Cubicle heating and ventilation**		
23.1		☐ Electrical heating		
23.2		☐ Supply voltage, 50 Hz V	230	
23.3		☐ Power rating W	xxxxxxxxxx	
24		☐ **Secondary terminals, gland plate and cable connections**		
24.1		☐ Terminal type		
24.2		☐ Manufacturer		
24.3		☐ Undrilled gland plate of minimum usable area Mm	xxxxxxxxxx	
24.4		☐ Control cable type used by Eskom	xxxxxxxxxx	
24.5		☐ Minimum distance between terminal board and gland plate mm	Xxxxxxxxxx	
25		☐ **Supporting structures to be provided**	**No, unless part of construction**	
26		☐ **Testing authority certificates held to prove all ratings**		
27		☐ **Number of complete sets of instruction manuals and routine test results to be supplied with each equipment**	**One per equipment supplied in weather protective envelop inside mechanism door**	

1	**2**	**3**		**4**	**5**
Item	**Clause of 240-56063815**	**Description**		**Schedule A**	**Schedule B**
28		□ **Number of complete sets of instruction manuals to be supplied on award of contract**		**10**	
29		□ **Terminal mechanical loading**			
29.1		□ Maximum continuous loading:			
29.2		□ Horizontal	kN		
29.3		□ 30° to horizontal	kN		
29.4		□ 60° to horizontal	kN		
30		**Documentation (to be submitted with tender)** Note: All documentation to be provided in electronic format.			
30.1		□ Type test certificates	Sets	1	
30.2		□ Outline drawings of disconnectors	Sets	1	
30.3		□ Wiring diagrams	Sets	1	
30.4		□ Operation and maintenance manuals	Sets	1	

SIGNATURES

Supplier	Name (Print)	Sign	Date
Factory	Name (Print)	Sign	Date
Eskom	Name (Print)	Sign	Date

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
3,3	**132 kV Disconnectors and Earthing Switches**			
III	**Horizontal break isolators rated 1600 Amperes without an earth switch**			
1	**Details of disconnector**			
1,1	manufacturer			
1,2	type designation & model			
1,3	number of breaks		2/phase	
1,4	isolating distance	mm	>=1150	
1,5	main contacts :			
1.5.1	entry (see also 4.5.1 of NRS 031)		Free exit free entry	
1.5.2	type		Centre rotate	
1.5.3	materials			
2	**Details of earthing switch**			
2,1	manufacturer			
2,2	type designation & model			
2,3	number of breaks		NA	
2,4	main contacts :			
2.4.1	entry		NA	
2.4.2	type		NA	
2.4.3	materials			
3	**Disconnector rating**			
3,1	rated voltage	kV	132	
3,2	rated current	A	1 600	
3,3	rated short-time withstand current	kA	31,5	
3,4	short-time withstand current duration	s	3	
3,5	rated peak withstand current	kA	78	
4	**Earthing switch ratings**			
4,1	rated short-time withstand current	kA	NA	
4,2	short-time withstand current duration	s	NA	
4,3	rated peak withstand current	kA	NA	
5	**Mounting of disconnectors**			
5,1	upright, horizontal or vertical		upright	
5,2	phase spacing	mm	1650 min	
5,3	arrangement of phases, in-line or transverse		transverse	
5,4	is a support structure to be provided?		Yes	
5,5	minimum mounting height (lowest part of insulator above ground level)	mm	2 500	
5,6	are necessary, shims,etc., to be provided?		Yes	
5,7	Method of alignment of insulators and contacts (shins, adjusting bolts, etc.)			
5,8	Other detail			
6	**Method of operation, i.e. hand, electric motor or other**			
6,1	For hand operation :			
6.1.1	horizontal / vertical movement offered?		Horisontal preferred	
6.1.2	are interlocking facilities required?		Yes	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
6.1.3	If YES, details		see spec.	
6.1.4	requirements for earthing of operating handle		strap	
6,2	For electric motor operation :			
6.2.1	control voltage	V	110 dc	
6.2.2	voltage range of operation	V		
6.2.3	rated power	W		
6.2.4	starting current	A		
6.2.5	alternative control switch labelling			
6.2.6	are special interlocking arrangements required?		Yes	
6.2.7	If YES, details		See spec.	
6,3	For other method of operation :			
6.3.1	requirements			
6.3.2	details			
7	**Are spark gaps and arching horns required for disconnectors**		No	
8	**Auxiliary switches**			
8,1	number of contacts for disconnectors :			
8.1.1	Type G (EM/LB)		8	
8.1.2	Type M (LM/EB)		8	
8.1.3	Type F (LB/EM)		2	
8.1.4	Type N (EB/LM)		6	
8,2	number of contacts for disconnectors :			
8.2.1	Type M (LM/EB)		NA	
8.2.2	Type N (EB/LM)		NA	
8,3	Rating of auxiliary switches :			
8.3.1	continuous current	A	5	
8.3.2	current overload for 1 s	A	100	
9	**Main terminals**			
9,1	type, stem or pad?		stem	
9,2	orientation : horizontal or vertical?		horizontal	
9,3	if stems :			
9.3.1	diameter	mm	38	
9.3.2	length	mm	120	
9,4	if pads :			
9.4.1	number of holes			
9.4.2	diameter of holes	mm		
9.4.3	pitch of holes	mm		
9.4.4	thickness of pad	mm		
10	**Secondary terminals if other than spring-loaded**			
10,1	type required		Springloaded	
10,2	type and make offered for approval		See Part 3.10	
11	**Minimum size for gland plate**	mm	150 x 100	
12	**Metal finish**			
12,1	is electrogalvanizing, sherardizing or metal spraying of ferrous parts accptable?		No	
12,2	Finish offered on ferrous parts (to be approved)			

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
12,3	Finish offered on non-ferrous parts (to be approved)			
12,4	Method of rectifying damaged galvanizing (to be approved)			
13	**Insulators**			
13,1	Details of insulators offered :			
13.1.1	manufacturer			
13.1.2	type designation			
13.1.3	number of units in stack			
13.1.4	cantilever strength class	N	4 000	
13.1.5	torsional strength	N.m	6 000	
14	**Insulator test voltages**			
14,1	peak value of impulse voltage referred to sea level :			
14.1.1	to earth and between phases in the open position	kV	650	
14.1.2	across the isolating distance	kV	750	
14,2	Characteristic waveshape of impulse :			
14.2.1	(LIW = Lightning Impulse Withstand)	mic. s	1/50	
14.2.2	(SIW = Switching Impulse Withstand)	mic. s	-	
14,3	60 s power frequency wet withstand voltage referred to sea level :			
14.3.1	to earth and between phases in the open position	kV	275	
14.3.2	across the isolating distance	kV		
15	**Insulator dimensions**			
15,1	top flange PCD	mm	127	
15,2	bottom flange PCD	mm	127	
15,3	overall height	mm	1500	
16	**Insulators arcing distances**	mm	1200	
17	**Creepage distance**			
17,1	minimum creepage distance for other than medium pollution level	mm	3625	
18	**Recommended spare parts**		Tenderer to list	
19	**Special tools required**		Tenderer to list	
20	**Tests**			
20,1	what type test certification for similar equipment is available?			
21	**Period and value for short-time current test**	s		
22	**Marking/labelling/documentation**			
22,1	language(s) for labels, drawings, certificates and manuals		English	
22,2	number of instruction manuals required		3	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
3,2	**132 kV Disconnectors and Earthing Switches**			
II	**Horizontal break isolators rated 1600 Amperes with an earth switch on one side**			
1	**Details of disconnector**			
1,1	manufacturer			
1,2	type designation & model			
1,3	number of breaks		2/phase	
1,4	isolating distance	mm	>=1150	
1,5	main contacts :			
1.5.1	entry (see also 4.5.1 of NRS 031)		Free exit free entry	
1.5.2	type		Centre rotate	
1.5.3	materials			
2	**Details of earthing switch**			
2,1	manufacturer			
2,2	type designation & model			
2,3	number of breaks		1/phase	
2,4	main contacts :			
2.4.1	entry		Friction	
2.4.2	type		Vertical Side break	
2.4.3	materials			
3	**Disconnector rating**			
3,1	rated voltage	kV	132	
3,2	rated current	A	1 600	
3,3	rated short-time withstand current	kA	31.5	
3,4	short-time withstand current duration	s	3	
3,5	rated peak withstand current	kA	78	
4	**Earthing switch ratings**			
4,1	rated short-time withstand current	kA	31,5	
4,2	short-time withstand current duration	s	3	
4,3	rated peak withstand current	kA	78	
5	**Mounting of disconnectors**			
5,1	upright, horizontal or vertical		upright	
5,2	phase spacing	mm	1650min	
5,3	arrangement of phases, in-line or transverse		in-line	
5,4	is a support structure to be provided?		Yes	
	if YES			
5,5	minimum mounting height (lowest part of insulator above ground level	mm	2 500	
5,6	are necessary fixing bolts,shims, etc., to be provided?		Yes	
5,7	Method of alignment of insulators and contacts (shins, adjusting bolts, etc.)			
5,8	Other detail			
6	**Method of operation, i.e. hand, electric motor or other**			
6,1	For hand operation :			
6.1.1	horizontal or vertical movement offered?		Horisontal preferred	
6.1.2	are interlocking facilities required?		Yes	
6.1.3	If YES, details		see spec.	
6.1.4	requirements for earthing of operating handle		strap	
6,2	For electric motor operation :			
6.2.1	control voltage	V	110 dc	
6.2.2	voltage range of operation	V		
6.2.3	rated power	W		
6.2.4	starting current	A		
6.2.5	alternative control switch labelling			
6.2.6	are special interlocking arrangements required?		Yes	
6.2.7	If YES, details		see spec.	
6,3	For other method of operation			
6.3.1	requirements			
6.3.2	details			

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
7	**Are spark gaps and arcing horns required for disconnectors**		No	
8	**Auxiliary switches**			
8,1	number of contacts for disconnectors :			
8.1.1	Type G (EM/LB)		8	
8.1.2	Type M (LM/EB)		8	
8.1.3	Type F (LB/EM)		2	
8.1.4	Type N (EB/LM)		6	
8,2	Number of contacts for earthing switches :			
8.2.1	Type M (LM/EB)		6	
8.2.2	Type N (EB/LM)		6	
8,3	rating of auxiliary switches :			
8.3.1	continuous current	A	5	
8.3.2	current overload for 1 s	A	100	
9	**Main terminals**			
9,1	type, stem of pad?		stem	
9,2	orientation : horizontal / vertical		horizontal	
9,3	if stems :			
9.3.1	diameter	mm	38	
9.3.2	length	mm	120	
9,4	if pads :			
9.4.1	number of holes			
9.4.2	diameter of holes	mm		
9.4.3	pitch of holes	mm		
9.4.4	thickness of pad	mm		
10	**Secondary terminals if other than spring-loaded**			
10,1	type required		Spring-loaded	
10,2	type and make offered for approval		See Part 3.10	
11	**Minimum size for gland plate**	mm	150 x 100	
12	**Metal finish**			
12,1	is electrogalvanizing, sherardizing or metal spraying of ferrous parts acceptable?		No	
12,2	finish offered on ferrous parts (to be approved)			
12,3	finish offered on non-ferrous parts (to be approved)			
12,4	method of rectifying damaged galvanizing (to be approved)			

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
13	**Insulators**			
13,1	Details of insulators offered :			
13.1.1	manufacturer			
13.1.2	type designation			
13.1.3	number of units in stack			
13.1.4	cantilever strength class	N	4 000	
13.1.5	torsional strength	N.m	6 000	
14	**Insulator test voltages**			
14,1	peak value of impulse voltage referred to sea level :			
14.1.1	to earth and between phases in the open position	kV	650	
14.1.2	across the isolating distance	kV	750	
14,2	characteristic waveshape of impulse :			
14.2.1	(LIW = Lightning Impulse Withstand)	mic. s	1/50	
	(SIW = Switching Impulse Withstand)	mic. s	-	
14,3	60 s power frequency wet withstand voltage referred to sea level :			
14.3.1	to earth and between phases in the open position	kV	275	
14.3.2	in the open position across the isolating distance	kV		
15	**Insulator dimensions**			
15,1	top flange PCD	mm	127	
15,2	bottom flange PCD	mm	127	
15,3	overall height	mm	1500	
16	**Insulator arcing distances**	mm	1200	
17	**Creepage distance**			
17,1	minimum creepage distance for other than medium pollution level	mm	3 625	
18	**Recommended spare parts**		Tenderer to list	
19	**Special tools required**		Tenderer to list	
20	**Tests**			
20,1	What type test certification for similar equipment is available?			
21	**Period and value for short-time current test**	s		
22	**Marking/labelling/documentation**			
22,1	language(s) for labels, drawings, certificates and manuals		English	
22,2	number of instruction manuals required		3	

SECTION 5: PARTICULARS AND GUARANTEES

PART 3.1: 132KV DISCONNECTORS AND EARTH SWITCHES

SPECIFICATION NO:

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
	Horizontal break isolators rated 1600 Amperes and earth switch on both sides			
1	**Details of disconnector**			
1,1	Manufacturer			
1,2	type designation & model			
1,3	number of breaks		2/phase	
1,4	isolating distance	mm	1300	
1,5	main contacts :			
1.5.1	entry (see also 4.5.1 of NRS 031)		Free exit / free entry	
1.5.2	type		Centre rotate	
1.5.3	contact force	N		
1.5.4	materials			
1.5.5	wear allowance			
2	**Details of earthing switch**			
2,1	manufacturer			
2,2	type designation & model			
2,3	number of breaks		1/phase	
2,4	main contacts :			
2.4.1	entry		Friction	
2.4.2	type		Vertical side break	
2.4.3	contact force	N		
2.4.4	materials			
2.4.5	wear allowance			
3	**Disconnector rating**			
3,1	rated voltage	kV	132	
3,2	rated current	A	1600	
3,3	rated short-time withstand current	kA	31,5	
3,4	short-time withstand current duration	s	3	
3,5	rated peak withstand current	kA	78	
4	**Earthing switch ratings**			
4,1	rated short-time withstand current	kA	31,5	
4,2	short-time withstand current duration	s	3	
4,3	rated peak withstand current	kA	78	
5	**Mounting of disconnectors**			
5,1	upright, horizontal or vertical		upright	
5,2	phase spacing	mm	1650min	
5,3	arrangement of phases, in-line or transverse		in-line	
5,4	is a support structure to be provided?		Yes	
	If YES			
5,5	minimum mounting height (lowest part of insulator above ground level)	mm	2500	
5,6	are necessary fixing bolts, shims, etd., to be provided?		Yes	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
5,7	Method of alignment of insulators and contacts (shins, adjusting bolts, etc.)			
5,8	Other detail			
6	**Method of operation, i.e. hand, electric motor or other**			
6,1	For hand operation :			
6.1.1	horizontal / vertical movement offered?		Horizontal preferred	
6.1.2	are interlocking facilities required?		Yes	
6.1.3	If YES, details		see spec.	
6.1.4	requirements for earthing of operating handle		strap	
6,2	For electric motor operation :			
6.2.1	control voltage	V	110 dc	
6.2.2	voltage range of operation	V		
6.2.3	rated power	W		
6.2.4	starting current	A		
6.2.5	alternative control switch labelling			
6.2.6	are special interlocking arrangements required?		Yes	
6.2.7	If YES, details		see spec.	
6,3	For other method of operation :			
6.3.1	requirements			
6.3.2	details			
7	**Are spark gaps and arcing horns required for disconnectors**		No	
8	**Auxiliary switches**			
8,1	number of contacts for disconnectors :			
8.1.1	Type G (EM/LB)		8	
8.1.2	Type M (LM/EB)		8	
8.1.3	Type F (LB/EM)		2	
8.1.4	Type N (EB/LM)		6	
8,2	Number of contacts for earthing switches :			
8.2.1	Type M (LM/EB)		6	
8.2.2	Type N (EB/LM)		6	
8,3	Rating of auxiliary switches :			
8.3.1	continuous current	A	5	
8.3.2	current overload for 1 s	A	100	
9	**Main terminals**			
9,1	type, stem or pad?		stem	
9,2	orientation : horizontal / vertical?		Horizontal	
9,3	if stems :			
9.3.1	diameter	mm	38	
9.3.2	length	mm	120	
9,4	if pads :			
9.4.1	number of holes	mm		
9.4.2	diameter of holes	mm		
9.4.3	pitch of holes	mm		
9.4.4	thickness of pad			
10	**Secondary terminals if other than spring-**			
10,1	type required		Spring-loaded	
10,2	type and make offered for approval		See Part 3. 10	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
11	**Minimum size for gland plate**	mm	150 x 100	
12	**Metal finish**			
12,1	is electrogalvanizing, sherardizing or metal spraying of ferrous parts acceptable?		No	
12,2	finish offered on ferrous parts (to be approved)			
12,3	finish offered on non-ferrous parts (to be			
12,4	method of rectifying damaged galvanizing (to be approved)			
13	**Insulators**			
13,1	Details of insulators offered :			
13.1.1	manufacturer			
13.1.2	type designation			
13.1.3	number of units in stack			
13.1.4	cantilever strength class	N	4 000	
13.1.5	torsional strength	N.m	6 000	
13.1.6	flash over distance	mm	1200	
14	**Insulator test voltages**			
14,1	peakvalue of impulse voltage referred to sea	kV		
14.1.1	to earth and between phases in the open	kV	650	
14.1.2	across the isolating distance		750	
14,2	characteristic waveshape of impulse	kV		
14.2.1	(LIW = Lightning Impulse Withstand)	mic. s	1/50	
14.2.2	(SIW = Switching Impulse Withstand)	mic. s	-	
14,3	60 s power frequency wet withstand voltage referred to sea level :			
14.3.1	to earth and between phases in the open position	kV	275	
14.3.2	in the open position across the isolating distance	kV		
15	**Insulator dimensions**			
15,1	top flange PCD	mm	127	
15,2	bottom flange PCD	mm	127	
15,3	overall height	mm	1500	
16	**Insulator arcing distances**	mm	1200	
17	**Creepage distance**			
17,1	minimum creepage distance for other than medium pollution level	mm	3 625	
18	**Recommended spare parts**		Tenderer to list	
19	**Special tools required**		Tenderer to list	
20	**Tests**			
20,1	what type test certification for similar equipment is available?			
21	**Period and value for short-time current test**	s		

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
22	**Marking / labelling / documentation**			
22,1	language(s) for labels, drawings, certificates and manuals		English	
22,2	number of instruction manuals required		3	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED	
Item 3	**DISCONNECTORS AND EARTHING SWITCHES**				
4	**Horizontal break isolators rated 2 500 A with an earth switch on one side**				
4.1	Details of disconnector				
4.1.1	manufacturer				
4.1.2	type designation				
4.1.3	number of breaks				
4.1.4	isolating distance	mm	1150		
4.1.5	main contacts				
4.1.5.1	entry (see also 4.5.1 NRS 031)				
4.1.5.2	type				
4.1.5.3	materials				
4.1.5.4	wear allowance				
4,2	Details of earthing switch				
4.2.1	manufacturer				
4.2.2	type designation				
4.2.3	number of breaks				
4.2.4	main contacts				
4.2.4.1	entry				
4.2.4.2	type				
4.2.4.3	materials				
4.2.4.4	wear allowance				
4.3	Disconnector rating				
4.3.1	rated voltage	kV	132		
4.3.2	rated current	A	2 500		
4.3.3	rated short-time withstand current	kA	31,5		
4.3.4	short-time withstand current duration	s	3		
4.3.5	rated peak withstand current	kA	78		
,::					
4,4	Earthing switch ratings				
4.4.1	rated voltage	kV	132		
4.4.2	rated short-time withstand current	kA	31,5		
4.4.3	rated short-time withstand current duration	s	3		
4.4.4	rated peak withstand current	kA	78		
4,5	Mounting of disconnectors				
4.5.1	upright, horizontal / vertical		upright		
4.5.2	phase spacing	mm	3 000		
4.5.3	arrangement of phases, in-line or transverse		in-line		
4.5.4	is a support structure to be provided? if YES		Yes		

4.5.5	minimum mounting height (lowest part of insulator above ground level)	mm	2 500		
4.6.5	are necessary fixing bolts, shims, etc., to be provided?		see spec.		
4.5.7	other details				
4,6	Method of operation, i.e. hand, electric motor or other				
4.6.1	For hand operation				
4.6.1.1	horizontal / vertical movement offered?				
4.6.1.2	are interlocking facilities required?		Yes		
4.6.1.3	If YES, details		see spec.		
4.6.1.4	requirements for earthing of operating handle		strap		
4.6.2	For electric motor operation				
4.6.2.1	control voltage	V	110 dc		
4.6.2.2	rated power	W			
4.6.2.3	starting current	A			
4.6.2.4	alternative control switch labelling				
4.6.2.5	are special interlocking arrangements required?		Yes		
4.6.2.6	If Yes, details		see spec.		
4.6.3	For other method of operation				
4.6.3.1	requirements				
4.6.3.2	details				
4,7	Are spark gaps and arcing horns required for disconnectors		No		
4,8	Auxiliary switches				
4.8.1	number of contacts for disconnectors				
4.8.1.1	Type G		8		
4.8.1.2	Type M		8		
4.8.1.3	Type F		2		
4.8.1.4	Type N		6		
4.8.1.5	Type D		0		
4.8.2	number of contacts for earthing switches				
4.8.2.1	Type M		4		
4.8.2.2	Type N		4		
4.8.3	rating of auxiliary switches				
4.8.3.1	continuous current	A	5		
4.8.3.2	current overload for 1 s	A	100		
4,9	Main terminals				
4.9.1	type, stem of pad?		stem		
4.9.2	orientation : horizontal / vertical?		hor		
4.9.3	if stems				
4.9.3.1	diameter	mm	38		
4.9.3.2	length	mm			

4.9.4	if pads				
4.9.4.1	number of holes				
4.9.4.2	diameter of holes	mm			
4.9.4.3	pitch of holes	mm			
4.9.4.4	thickness of pad	mm			
4,10	Secondary terminals if other than spring-loaded				
4.10.1	type required				
4.10.2	type and make offered for approval				
4,11	Minimum size for gland plate	mm	150 x 100		
4,12	Metal finish				
4.12.1	is electrogalvanizing, sherardizing or metal spraying of ferrous parts acceptable?		No		
4.12.2	finish offered on ferrous parts (to be approved)				
4.12.3	finish offered on non-ferrous parts (to be approved)				
4.12.4	method of rectifying damaged galvanizing (to be approved)				
4,13	Insulators				
4.13.1	Details of insulators offered				
4.13.1.1	manufacturer				
4.13.1.2	type designation				
4.13.1.3	number of units in stack				
4.13.1.4	cantilever strength class	N	4 000		
4.13.1.5	torsional strength	N.m	6 000		
4,14	Insulator test voltages				
4.14.1	peak value of impulse voltage referred to sea level	kV	650		
4.14.1.1	to earth and between phases in the open position	kV	750		
4.14.1.2	Across the isolating distance				
4.14.2	characteristic waveshape of impulse				
4.14.2.1	(LIW – Lightning Impulse Withstand)	æs	1/50		
4.14.2.2	(SIW – Switching Impulse Withstand)	æs	-		
4.14.3	60 s power frequency wet withstand voltage referred to sea level				
4.14.3.1	to earth and between phases in the open position	kV	275		
4.14.3.2	across the isolating distance	kV			
4,15	insulator dimensions				
4.15.1	top flange PCD	mm			
4.15.2	bottom flange PCD	mm			
4.15.3	overall height	mm			
4,16	Insulator arcing distances	mm			

4,17	Creepage distance				
4.17.1	minimum creepage distance for other than medium pollution level	mm	3 625		
4,18	Recommended spare parts				
4,19	Special tools required				
4,20	Tests				
4.20.1	What type test certification for similar equipment is available?				
4,21	Period and value for short-time current test	s			
4,22	Marking/ labelling / documentation				
4.22.1	language(s) for labels, drawings, certificates and manuals				
4.22.2	number of instruction manuals required		3		

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
Item 3	**DISCONNECTORS AND EARTHING SWITCHES**			
5	**Horizontal break isolators rated 2 500 A with an earth switch on both sides**			
5,1	Details of disconnector			
5.1.1	manufacturer			
5.1.2	type designation			
5.1.3	number of breaks			
5.1.4	isolating distance	mm		
5.1.5	main contacts		1 150	
5.1.5.1	entry (see also 4.5.1 NRS 031)			
5.1.5.2	type			
5.1.5.3	materials			
5.1.5.4	wear allowance			
5,2	Details of earthing switch			
5.2.1	manufacturer			
5.2.2	type designation			
5.2.3	number of breaks			
5.2.4	main contacts			
5.2.4.1	entry			
5.2.4.2	type			
5.2.4.3	materials			
5.2.4.4	wear allowance			
5,3	Disconnector rating			
5.3.1	rated voltage	kV	132	
5.3.2	rated current	A	2 500	
5.3.3	rated short-time withstand current	kA	31,5	
5.3.4	short-time withstand current duration	s	3	
5.3.5	rated peak withstand current	kA	78	
5,4	Earthing switch ratings			
5.4.1	rated voltage	kV	132	
5.4.2	rated short-time withstand current	kA	31,5	
5.4.3	rated short-time withstand current duration	s	3	
5.4.4	rated peak withstand current	kA	78	
5,5	Mounting of disconnectors			
5.5.1	upright, horizontal / vertical		upright	
5.5.2	phase spacing	mm	3 000	
5.5.3	arrangement of phases, in-line or transverse		in-line	
5.5.4	is a support structure to be provided?		Yes	
	if YES			
5.5.5	minimum mounting height (lowest part of insulator above ground level)	mm	2 500	
5.5.6	are necessary fixing bolts, shims, etc., to be provided?		see spec.	
5.5.7	other details			
5,6	Method of operation, i.e. hand, electric motor or other			
5.6.1	For hand operation			
5.6.1.1	horizontal / vertical movement offered?			
5.6.1.2	are interlocking facilities required?		Yes	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
Item 3	**DISCONNECTORS AND EARTHING SWITCHES**			
5	**Horizontal break isolators rated 2 500 A with an earth switch on both sides**			
5.6.1.3	If YES, details		see spec.	
5.6.1.4	requirements for earthing of operating handle		strap	
5.6.2	For electric motor operation			
5.6.2.1	control voltage	V	110 dc	
5.6.2.2	rated power	W		
5.6.2.3	starting current	A		
5.6.2.4	alternative control switch labelling			
5.6.2.5	are special interlocking arrangements required?		Yes	
5.6.2.6	If Yes, details		see spec.	
,::				
5.6.3	For other method of operation			
5.6.3.1	requirements			
5.6.3.2	details			
5,7	Are spark gaps and arcing horns required for disconnectors		No	
5,8	Auxiliary switches			
5.8.1	number of contacts for disconnectors			
5.8.1.1	Type G		8	
5.8.1.2	Type M		8	
5.8.1.3	Type F		2	
5.8.1.4	Type N		6	
5.8.1.5	Type D		0	
5.8.2	number of contacts for earthing switches			
5.8.2.1	Type M		4	
5.8.2.2	Type N		4	
5.8.3	rating of auxiliary switches			
5.8.3.1	continuous current	A	5	
5.8.3.2	current overload for 1 s	A	100	
5,9	Main terminals			
5.9.1	type, stem of pad?		stem	
5.9.2	orientation : horizontal / vertical?		hor	
5.9.3	if stems			
5.9.3.1	diameter	mm	38	
5.9.3.2	length	mm		
5.9.4	if pads			
5.9.4.1	number of holes			
5.9.4.2	diameter of holes	mm		
5.9.4.3	pitch of holes	mm		
5.9.4.4	thickness of pad	mm		
5,10	Secondary terminals if other than spring-loaded			
5.10.1	type required			
5.10.2	type and make offered for approval			

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
Item 3	**DISCONNECTORS AND EARTHING SWITCHES**			
5	**Horizontal break isolators rated 2 500 A with an earth switch on both sides**			
5,11	Minimum size for gland plate	mm	150 x 100	
5,12	Metal finish			
5.12.1	is electrogalvanizing, sherardizing or metal spraying of ferrous parts acceptable?		No	
5.12.2	finish offered on ferrous parts (to be approved)			
5.12.3	finish offered on non-ferrous parts (to be approved)			
5.12.4	method of rectifying damaged galvanizing (to be approved)			
5,13	Insulators			
5.13.1	Details of insulators offered			
5.13.1.1	manufacturer			
5.13.1.2	type designation			
5.13.1.3	number of units in stack			
5.13.1.4	cantilever strength class	N	4 000	
5.13.1.5	torsional strength	N.m	6 000	
5,14	Insulator test voltages			
5.14.1	peak value of impulse voltage referred to sea level			
5.14.1.1	to earth and between phases in the open position	kV	650	
5.14.1.2	Across the isolating distance	kV	750	
5.14.2	characteristic waveshape of impulse			
5.14.2.1	(LIW = Lightning Impulse Withstand)	æs	1/50	
5.14.2.2	(SIW = Switching Impulse Withstand)	æs	-	
5.14.3	60 s power frequency wet withstand voltage referred to sea level			
5.14.3.1	to earth and between phases in the open position	kV	275	
5.14.3.2	across the isolating distance	kV		
5,15	Insulator dimensions			
5.15.1	top flange PCD	mm		
5.15.2	bottom flange PCD	mm		
5.15.3	overall height	mm		
5,16	Insulator arcing distances	mm		
5,17	Creepage distance			
5.17.1	minimum creepage distance for other than medium pollution level	mm	3 625	
5,18	Recommended spare parts			
5,19	Special tools required			

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
Item 3	**DISCONNECTORS AND EARTHING SWITCHES**			
5	**Horizontal break isolators rated 2 500 A with an earth switch on both sides**			
5,20	Tests			
5.20.1	What type test certification for similar equipment is available?			
5,21	Period and value for short-time current test	s		
5,22	Marking/ labelling / documentation			
5.22.1	language(s) for labels, drawings, certificates and manuals			
5.22.2	number of instruction manuals required		3	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
Item 3	**DISCONNECTORS AND EARTHING SWITCHES**			
6	**Pantograph isolators rated 1 600 A without an earth switch**			
6,1	Details of disconnector			
6.1.1	Manufacturer			
6.1.2	Type designation			
6.1.3	Number of breaks			
6.1.4	Isolating distance	mm		
6.1.5	Main contacts		1 150	
6.5.1.1	entry (see also 4.5.1 NRS 031)			
6.1.5.2	Type			
6.1.5.3	Contact force	N		
6.1.5.4	Materials			
6.1.5.5	wear allowance			
6,2	Details of earthing switch			
6.2.1	manufacturer			
6.2.2	type designation			
6.2.3	number of breaks			
6.2.4	main contacts			
6.2.4.1	entry			
6.2.4.2	type			
6.2.4.3	contact force	N		
6.2.4.4	materials			
6.2.4.5	wear allowance			
6.3	Disconnector rating			
6.3.1	rated voltage	kV	132	
6.3.2	rated current	A	1600	
6.3.3	rated short-time withstand current	kA	31,5	
6.3.4	short-time withstand current duration	s	3	
6.3.5	rated peak withstand current	kA	78	
6,4	Earthing switch ratings			
6.4.1	rated voltage	kV	132	
6.4.12	rated short-time withstand current	kA	31,5	
6.4.3	rated short-time withstand current duration	s	3	
6.4.4	rated peak withstand current	kA	78	
6,5	Mounting of disconnectors			
6.5.1	upright, horizontal / vertical		upright	
6.5.2	phase spacing	mm	3 000	

6.5.3	arrangement of phases, in-line or transverse		in-line	
6.5.4	is a support structure to be provided?		Yes	
	if YES			
6.5.5	minimum mounting height (lowest part of insulator above ground level)	mm	2 500	
6.5.6	are neccessary fixing bolts, shims, etc., to be provided?		see spec.	
6.5.7	other details			
6,6	Method of operation, i.e. hand, electric motor or other			
6.6.1	For hand operation			
6.6.1.1	horizontal / vertical movement offered?			
6.6.1.2	are interlocking facilities required?		Yes	
6.6.1.3	If YES, details		see spec.	
6.6.1.4	requirements for earthing of operating handle		strap	
6.6.2	For electric motor operation			
6.6.2.1	control voltage	V	110 dc	
6.6.2.2	rated power	W		
6.6.2.3	starting current	A		
6.6.2.4	alternative control switch labelling			
6.6.2.5	are special interlocking arrangements required?		Yes	
6.6.2.6	If Yes, details		see spec.	
6.6.3	For other method of operation			
6.6.3.1	requirements			
6.6.3.2	details			
6,7	Are spark gaps and arcing horns required for disconnectors		No	
6,8	Auxiliary switches			
6.8.1	number of contacts for disconnectors			
6.8.1.1	Type G		8	
6.8.1.2	Type M		8	
6.8.1.3	Type F		2	
6.8.1.4	Type N		6	
6.8.1.5	Type D		0	
6.8.2	number of contacts for earthing switches			
6.8.2.1	Type M		4	
6.8.2.2	Type N		4	
6.8.3	rating of auxiliary switches			

6.8.3.1	continuous current	A	5	
6.8.3.2	current overload for 1 s	A	100	
6,9	Main terminals			
6.9.1	type, stem of pad?		stem	
6.9.2	orientation : horizontal / vertical?		hor	
6.9.3	if stems			
6.9.3.1	diameter	mm	38	
6.9.3.2	length	mm		
,::				
6.9.4	if pads			
6.9.4.1	number of holes			
6.9.4.2	diameter of holes	mm		
6.9.4.3	pitch of holes	mm		
6.9.4.4	thickness of pad	mm		
6,10	Secondary terminals if other than spring-loaded			
6.10.1	type required			
6.10.2	type and make offered for approval			
6,11	Minimum size for gland plate	mm	150 x 100	
6,12	Metal finish			
6.12.1	is electrogalvanizing, sherardizing or metal spraying of ferrous parts acceptable?		No	
6.12.2	finish offered on ferrous parts (to be approved)			
6.12.3	finish offered on non-ferrous parts (to be approved)			
6.12.4	method of rectifying damaged galvanizing (to be approved)			
6,13	Insulators			
6.13.1	Details of insulators offered			
6.13.1.1	manufacturer			
6.13.1.2	type designation			
6.13.1.3	number of units in stack			
6.13.1.4	cantilever strength class	N	4 000	
6.13.1.5	torsional strength	N.m	6 000	
6,14	Insulator test voltages			
6.14.1	peak value of impulse voltage referred to sea level			
6.14.1.1	to earth and between phases in the open positon	kV		
6.14.1.2	Across the isolating distance	kV		
6.14.2	characteristic waveshape of impulse			

6.14.2.1	(LIW = Lightning Impulse Withstand)	æs	1/50	
6.14.2.2	(SIW = Switching Impulse Withstand)	æs	-	
6.14.3	60 s power frequency wet withstand voltage referred to sea level			
6.14.3.1	to earth and between phases in the open position	kV	275	
6.14.3.2	across the isolating distance	kV		
6,15	Insulator dimensions			
6.15.1	top flange PCD	mm		
6.15.2	bottom flange PCD	mm		
6.15.3	overall height	mm		
6,16	Insulator arcing distances	mm		
6,17	Creepage distance			
6.17.1	minimum creepage distance for other than medium pollution level (see also B.2)	mm	3 625	
6,18	Recommended spare parts			
6,19	Special tools required			
6,20	Tests			
6.20.1	What type test certification for similar equipment is available?			
6,21	Period and value for short-time current test	s		
6,22	Marking/ labelling / documentation			
6.22.1	language(s) for labels, drawings, certificates and manuals			
6.22.2	number of instruction manuals required		3	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
Item 3	**DISCONNECTORS AND EARTHING SWITCHES**			
7	**Pantograph isolators rated 1 600 A with an earth switch**			
7,1	Details of disconnector			
7.1.1	manufacturer			
7.1.2	type designation			
7.1.3	number of breaks			
7.1.4	isolating distance	mm	1 150	
7.1.5	main contacts			
7.1.5.1	entry (see also 4.5.1 NRS 031)			
7.1.5.2	type			
7.1.5.3	contact force	N		
7.1.5.4	materials			
7.1.5.5	wear allowance			
7,2	Details of earthing switch			
7.2.1	manufacturer			
7.2.2	type designation			
7.2.3	number of breaks			
7.2.4	main contacts			
7.2.4.1	entry			
7.2.4.2	type			
7.2.4.3	contact force	N		
7.2.4.4	materials			
7.2.4.5	wear allowance			
7,3	Disconnector rating			
7.3.1	rated voltage	kV	132	
7.3.2	rated current	A	1600	
7.3.3	rated short-time withstand current	kA	31,5	
7.3.4	short-time withstand current duration	s	3	
7.3.4	rated peak withstand current	kA	78	
7,4	Earthing switch ratings			
7.4.1	rated voltage	kV	132	
7.4.2	rated short-time withstand current	kA	31,5	
7.4.3	rated short-time withstand current duration	s	3	
7.4.4	rated peak withstand current	kA	78	
7,5	Mounting of disconnectors			
7.5.1	upright, horizontal / vertical		upright	
7.5.2	phase spacing	mm	3 000	
7.5.3	arrangement of phases, in-line or transverse		in-line	
7.5.4	is a support structure to be provided?		Yes	
	if YES			

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
7.5.5	minimum mounting height (lowest part of insulator above ground level)	mm	2 500	
7.5.6	are neccessary fixing bolts, shims, etc., to be provided?		see spec.	
7.5.7	other details			
7,6	Method of operation, i.e. hand, electric motor or other			
7.6.1	For hand operation			
7.6.1.1	horizontal / vertical movement offered?			
7.6.1.2	are interlocking facilities required?		Yes	
7.6.1.3	If YES, details		see spec.	
7.6.1.4	requirements for earthing of operating handle		strap	
7.6.2	For electric motor operation			
7.6.2.1	control voltage	V	110 dc	
7.6.2.2	rated power	W		
7.6.2.3	starting current	A		
7.6.2.4	alternative control switch labelling			
7.6.2.5	are special interlocking arrangements required?		Yes	
7.6.2.6	If Yes, details		see spec.	
7.6.3	For other method of operation			
7.6.3.1	requirements			
7.6.3.2	details			
7,7	Are spark gaps and arcing horns required for disconnectors		No	
7,8	Auxiliary switches			
7.8.1	number of contacts for disconnectors			
7.8.1.1	Type G		8	
7.8.1.2	Type M		8	
7.8.1.3	Type F		2	
7.8.1.4	Type N		6	
7.8.1.5	Type D		0	
7.8.2	number of contacts for earthing switches			
7.8.2.1	Type M		4	
7.8.2.2	Type N		4	
7.8.3	rating of auxiliary switches			
7.8.3.1	continuous current	A	5	
7.8.3.2	current overload for 1 s	A	100	
7,9	Main terminals			
7.9.1	type, stem of pad?		stem	
7.9.2	orientation : horizontal / vertical?		hor	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
7.9.3	if stems			
7.9.3.1	diameter	mm	38	
7.9.3.2	length	mm		
7.9.4	if pads			
7.9.4.1	number of holes			
7.9.4.2	diameter of holes	mm		
7.9.4.3	pitch of holes	mm		
7.9.4.4	thickness of pad	mm		
7,10	Secondary terminals if other than spring-loaded			
7.10.1	type required			
7.10.2	type and make offered for approval			
7,11	Minimum size for gland plat	mm	150 x 100	
7,12	Metal finish			
7.12.1	is electrogalvanizing, sherardizing or metal spraying of ferrous parts acceptable?		No	
7.12.2	finish offered on ferrous parts (to be approved)			
7.12.3	finish offered on non-ferrous parts (to be approved)			
7.12.4	method of rectifying damaged galvanizing (to be approved)			
7,13	Insulators			
7.13.1	Details of insulators offered			
7.13.1.1	manufacturer			
7.13.1.2	type designation			
7.13.1.3	number of units in stack			
7.13.1.4	cantilever strength class	N	4 000	
7.13.1.5	torsional strength	N.m	6 000	
7,14	Insulator test voltages			
7.14.1	peak value of impulse voltage referred to sea level			
7.14.1.1	to earth and between phases in the open positon	kV		
7.14.1.2	Across the isolating distance	kV		
7.14.2	characteristic waveshape of impulse			
7.14.2.1	(LIW = Lightning Impulse Withstand)	æs	1/50	
7.14.2.2	(SIW = Switching Impulse Withstand)	æs	-	
7.14.3	60 s power frequency wet withstand voltage referred to sea level			
7.14.3.1	to earth and between phases in the open position	kV	275	
7.14.3.2	across the isolating distance	kV		

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
7,15	Insulator dimensions			
7.15.1	top flange PCD	mm		
7.15.2	bottom flange PCD	mm		
7.15.3	overall height	mm		
7,16	Insulator arcing distances	mm		
7,17	Creepage distance			
7.17.1	minimum creepage distance for other than medium pollution level	mm	3 625	
7,18	Recommended spare parts			
7,19	Special tools required			
7,20	Tests			
7.20.1	What type test certification for similar equipment is available?			
7,21	Period and value for short-time current test	s		
7,22	Marking/ labelling / documentation			
7.22.1	language(s) for labels, drawings, certificates and manuals			
7.22.2	number of instruction manuals required		3	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
3,3	**132 kV Disconnectors and Earthing Switches**			
III	**Horizontal break isolators rated 1600 Amperes without an earth switch**			
1	**Details of disconnector**			
1,1	manufacturer			
1,2	type designation & model			
1,3	number of breaks		2/phase	
1,4	isolating distance	mm	>=1150	
1,5	main contacts :			
1.5.1	entry (see also 4.5.1 of NRS 031)		Free exit free entry	
1.5.2	type		Centre rotate	
1.5.3	materials			
2	**Details of earthing switch**			
2,1	manufacturer			
2,2	type designation & model			
2,3	number of breaks		NA	
2,4	main contacts :			
2.4.1	entry		NA	
2.4.2	type		NA	
2.4.3	materials			
3	**Disconnector rating**			
3,1	rated voltage	kV	132	
3,2	rated current	A	1 600	
3,3	rated short-time withstand current	kA	31,5	
3,4	short-time withstand current duration	s	3	
3,5	rated peak withstand current	kA	78	
4	**Earthing switch ratings**			
4,1	rated short-time withstand current	kA	NA	
4,2	short-time withstand current duration	s	NA	
4,3	rated peak withstand current	kA	NA	
5	**Mounting of disconnectors**			
5,1	upright, horizontal or vertical		upright	
5,2	phase spacing	mm	1650 min	
5,3	arrangement of phases, in-line or transverse		transverse	
5,4	is a support structure to be provided?		Yes	
5,5	minimum mounting height (lowest part of insulator above ground level)	mm	2 500	
5,6	are necessary, shims,etc., to be provided?		Yes	
5,7	Method of alignment of insulators and contacts (shins, adjusting bolts, etc.)			
5,8	Other detail			
6	**Method of operation, i.e. hand, electric motor or other**			
6,1	For hand operation :			
6.1.1	horizontal / vertical movement offered?		Horisontal preferred	
6.1.2	are interlocking facilities required?		Yes	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
6.1.3	If YES, details		see spec.	
6.1.4	requirements for earthing of operating handle		strap	
6,2	For electric motor operation :			
6.2.1	control voltage	V	110 dc	
6.2.2	voltage range of operation	V		
6.2.3	rated power	W		
6.2.4	starting current	A		
6.2.5	alternative control switch labelling			
6.2.6	are special interlocking arrangements required?		Yes	
6.2.7	If YES, details		See spec.	
6,3	For other method of operation :			
6.3.1	requirements			
6.3.2	details			
7	**Are spark gaps and arching horns required for disconnectors**		No	
8	**Auxiliary switches**			
8,1	number of contacts for disconnectors :			
8.1.1	Type G (EM/LB)		8	
8.1.2	Type M (LM/EB)		8	
8.1.3	Type F (LB/EM)		2	
8.1.4	Type N (EB/LM)		6	
8,2	number of contacts for disconnectors :			
8.2.1	Type M (LM/EB)		NA	
8.2.2	Type N (EB/LM)		NA	
8,3	Rating of auxiliary switches :			
8.3.1	continuous current	A	5	
8.3.2	current overload for 1 s	A	100	
9	**Main terminals**			
9,1	type, stem or pad?		stem	
9,2	orientation : horizontal or vertical?		horizontal	
9,3	if stems :			
9.3.1	diameter	mm	38	
9.3.2	length	mm	120	
9,4	if pads :			
9.4.1	number of holes			
9.4.2	diameter of holes	mm		
9.4.3	pitch of holes	mm		
9.4.4	thickness of pad	mm		
10	**Secondary terminals if other than spring-loaded**			
10,1	type required		Springloaded	
10,2	type and make offered for approval		See Part 3.10	
11	**Minimum size for gland plate**	mm	150 x 100	
12	**Metal finish**			
12,1	is electrogalvanizing, sherardizing or metal spraying of ferrous parts accptable?		No	
12,2	Finish offered on ferrous parts (to be approved)			

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
12,3	Finish offered on non-ferrous parts (to be approved)			
12,4	Method of rectifying damaged galvanizing (to be approved)			
13	**Insulators**			
13,1	Details of insulators offered :			
13.1.1	manufacturer			
13.1.2	type designation			
13.1.3	number of units in stack			
13.1.4	cantilever strength class	N	4 000	
13.1.5	torsional strength	N.m	6 000	
14	**Insulator test voltages**			
14,1	peak value of impulse voltage referred to sea level :			
14.1.1	to earth and between phases in the open position	kV	650	
14.1.2	across the isolating distance	kV	750	
14,2	Characteristic waveshape of impulse :			
14.2.1	(LIW = Lightning Impulse Withstand)	mic. s	1/50	
14.2.2	(SIW = Switching Impulse Withstand)	mic. s	-	
14,3	60 s power frequency wet withstand voltage referred to sea level :			
14.3.1	to earth and between phases in the open position	kV	275	
14.3.2	across the isolating distance	kV		
15	**Insulator dimensions**			
15,1	top flange PCD	mm	127	
15,2	bottom flange PCD	mm	127	
15,3	overall height	mm	1500	
16	**Insulators arcing distances**	mm	1200	
17	**Creepage distance**			
17,1	minimum creepage distance for other than medium pollution level	mm	3625	
18	**Recommended spare parts**		Tenderer to list	
19	**Special tools required**		Tenderer to list	
20	**Tests**			
20,1	what type test certification for similar equipment is available?			
21	**Period and value for short-time current test**	s		
22	**Marking/labelling/documentation**			
22,1	language(s) for labels, drawings, certificates and manuals		English	
22,2	number of instruction manuals required		3	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
3,2	**132 kV Disconnectors and Earthing Switches**			
II	**Horizontal break isolators rated 1600 Amperes with an earth switch on one side**			
1	**Details of disconnector**			
1,1	manufacturer			
1,2	type designation & model			
1,3	number of breaks		2/phase	
1,4	isolating distance	mm	>=1150	
1,5	main contacts :			
1.5.1	entry (see also 4.5.1 of NRS 031)		Free exit free entry	
1.5.2	type		Centre rotate	
1.5.3	materials			
2	**Details of earthing switch**			
2,1	manufacturer			
2,2	type designation & model			
2,3	number of breaks		1/phase	
2,4	main contacts :			
2.4.1	entry		Friction	
2.4.2	type		Vertical Side break	
2.4.3	materials			
3	**Disconnector rating**			
3,1	rated voltage	kV	132	
3,2	rated current	A	1 600	
3,3	rated short-time withstand current	kA	31.5	
3,4	short-time withstand current duration	s	3	
3,5	rated peak withstand current	kA	78	
4	**Earthing switch ratings**			
4,1	rated short-time withstand current	kA	31,5	
4,2	short-time withstand current duration	s	3	
4,3	rated peak withstand current	kA	78	
5	**Mounting of disconnectors**			
5,1	upright, horizontal or vertical		upright	
5,2	phase spacing	mm	1650min	
5,3	arrangement of phases, in-line or transverse		in-line	
5,4	is a support structure to be provided?		Yes	
	if YES			
5,5	minimum mounting height (lowest part of insulator above ground level	mm	2 500	
5,6	are necessary fixing bolts,shims, etc., to be provided?		Yes	
5,7	Method of alignment of insulators and contacts (shins, adjusting bolts, etc.)			
5,8	Other detail			
6	**Method of operation, i.e. hand, electric motor or other**			
6,1	For hand operation :			
6.1.1	horizontal or vertical movement offered?		Horisontal preferred	
6.1.2	are interlocking facilities required?		Yes	
6.1.3	If YES, details		see spec.	
6.1.4	requirements for earthing of operating handle		strap	
6,2	For electric motor operation :			
6.2.1	control voltage	V	110 dc	
6.2.2	voltage range of operation	V		
6.2.3	rated power	W		
6.2.4	starting current	A		
6.2.5	alternative control switch labelling			
6.2.6	are special interlocking arrangements required?		Yes	
6.2.7	If YES, details		see spec.	
6,3	For other method of operation			
6.3.1	requirements			
6.3.2	details			

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
7	**Are spark gaps and arcing horns required for disconnectors**		No	
8	**Auxiliary switches**			
8,1	number of contacts for disconnectors :			
8.1.1	Type G (EM/LB)		8	
8.1.2	Type M (LM/EB)		8	
8.1.3	Type F (LB/EM)		2	
8.1.4	Type N (EB/LM)		6	
8,2	Number of contacts for earthing switches :			
8.2.1	Type M (LM/EB)		6	
8.2.2	Type N (EB/LM)		6	
8,3	rating of auxiliary switches :			
8.3.1	continuous current	A	5	
8.3.2	current overload for 1 s	A	100	
9	**Main terminals**			
9,1	type, stem of pad?		stem	
9,2	orientation : horizontal / vertical		horizontal	
9,3	if stems :			
9.3.1	diameter	mm	38	
9.3.2	length	mm	120	
9,4	if pads :			
9.4.1	number of holes			
9.4.2	diameter of holes	mm		
9.4.3	pitch of holes	mm		
9.4.4	thickness of pad	mm		
10	**Secondary terminals if other than spring-loaded**			
10,1	type required		Spring-loaded	
10,2	type and make offered for approval		See Part 3.10	
11	**Minimum size for gland plate**	mm	150 x 100	
12	**Metal finish**			
12,1	is electrogalvanizing, sherardizing or metal spraying of ferrous parts acceptable?		No	
12,2	finish offered on ferrous parts (to be approved)			
12,3	finish offered on non-ferrous parts (to be approved)			
12,4	method of rectifying damaged galvanizing (to be approved)			

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
13	**Insulators**			
13,1	Details of insulators offered :			
13.1.1	manufacturer			
13.1.2	type designation			
13.1.3	number of units in stack			
13.1.4	cantilever strength class	N	4 000	
13.1.5	torsional strength	N.m	6 000	
14	**Insulator test voltages**			
14,1	peak value of impulse voltage referred to sea level :			
14.1.1	to earth and between phases in the open position	kV	650	
14.1.2	across the isolating distance	kV	750	
14,2	characteristic waveshape of impulse :			
14.2.1	(LIW = Lightning Impulse Withstand)	mic. s	1/50	
	(SIW = Switching Impulse Withstand)	mic. s	-	
14,3	60 s power frequency wet withstand voltage referred to sea level :			
14.3.1	to earth and between phases in the open position	kV	275	
14.3.2	in the open position across the isolating distance	kV		
15	**Insulator dimensions**			
15,1	top flange PCD	mm	127	
15,2	bottom flange PCD	mm	127	
15,3	overall height	mm	1500	
16	**Insulator arcing distances**	mm	1200	
17	**Creepage distance**			
17,1	minimum creepage distance for other than medium pollution level	mm	3 625	
18	**Recommended spare parts**		Tenderer to list	
19	**Special tools required**		Tenderer to list	
20	**Tests**			
20,1	What type test certification for similar equipment is available?			
21	**Period and value for short-time current test**	s		
22	**Marking/labelling/documentation**			
22,1	language(s) for labels, drawings, certificates and manuals		English	
22,2	number of instruction manuals required		3	

SECTION 5: PARTICULARS AND GUARANTEES

PART 3.1: 132KV DISCONNECTORS AND EARTH SWITCHES

SPECIFICATION NO:

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
	Horizontal break isolators rated 1600 Amperes and earth switch on both sides			
1	**Details of disconnector**			
1,1	Manufacturer			
1,2	type designation & model			
1,3	number of breaks		2/phase	
1,4	isolating distance	mm	1300	
1,5	main contacts :			
1.5.1	entry (see also 4.5.1 of NRS 031)		Free exit / free entry	
1.5.2	type		Centre rotate	
1.5.3	contact force	N		
1.5.4	materials			
1.5.5	wear allowance			
2	**Details of earthing switch**			
2,1	manufacturer			
2,2	type designation & model			
2,3	number of breaks		1/phase	
2,4	main contacts :			
2.4.1	entry		Friction	
2.4.2	type		Vertical side break	
2.4.3	contact force	N		
2.4.4	materials			
2.4.5	wear allowance			
3	**Disconnector rating**			
3,1	rated voltage	kV	132	
3,2	rated current	A	1600	
3,3	rated short-time withstand current	kA	31,5	
3,4	short-time withstand current duration	s	3	
3,5	rated peak withstand current	kA	78	
4	**Earthing switch ratings**			
4,1	rated short-time withstand current	kA	31,5	
4,2	short-time withstand current duration	s	3	
4,3	rated peak withstand current	kA	78	
5	**Mounting of disconnectors**			
5,1	upright, horizontal or vertical		upright	
5,2	phase spacing	mm	1650min	
5,3	arrangement of phases, in-line or transverse		in-line	
5,4	is a support structure to be provided?		Yes	
	If YES			
5,5	minimum mounting height (lowest part of insulator above ground level)	mm	2500	
5,6	are necessary fixing bolts, shims, etd., to be provided?		Yes	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
5,7	Method of alignment of insulators and contacts (shins, adjusting bolts, etc.)			
5,8	Other detail			
6	**Method of operation, i.e. hand, electric motor or other**			
6,1	For hand operation :			
6.1.1	horizontal / vertical movement offered?		Horizontal preferred	
6.1.2	are interlocking facilities required?		Yes	
6.1.3	If YES, details		see spec.	
6.1.4	requirements for earthing of operating handle		strap	
6,2	For electric motor operation :			
6.2.1	control voltage	V	110 dc	
6.2.2	voltage range of operation	V		
6.2.3	rated power	W		
6.2.4	starting current	A		
6.2.5	alternative control switch labelling			
6.2.6	are special interlocking arrangements required?		Yes	
6.2.7	If YES, details		see spec.	
6,3	For other method of operation :			
6.3.1	requirements			
6.3.2	details			
7	**Are spark gaps and arcing horns required for disconnectors**		No	
8	**Auxiliary switches**			
8,1	number of contacts for disconnectors :			
8.1.1	Type G (EM/LB)		8	
8.1.2	Type M (LM/EB)		8	
8.1.3	Type F (LB/EM)		2	
8.1.4	Type N (EB/LM)		6	
8,2	Number of contacts for earthing switches :			
8.2.1	Type M (LM/EB)		6	
8.2.2	Type N (EB/LM)		6	
8,3	Rating of auxiliary switches :			
8.3.1	continuous current	A	5	
8.3.2	current overload for 1 s	A	100	
9	**Main terminals**			
9,1	type, stem or pad?		stem	
9,2	orientation : horizontal / vertical?		Horizontal	
9,3	if stems :			
9.3.1	diameter	mm	38	
9.3.2	length	mm	120	
9,4	if pads :			
9.4.1	number of holes	mm		
9.4.2	diameter of holes	mm		
9.4.3	pitch of holes	mm		
9.4.4	thickness of pad			
10	**Secondary terminals if other than spring-**			
10,1	type required		Spring-loaded	
10,2	type and make offered for approval		See Part 3. 10	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
11	**Minimum size for gland plate**	mm	150 x 100	
12	**Metal finish**			
12,1	is electrogalvanizing, sherardizing or metal spraying of ferrous parts acceptable?		No	
12,2	finish offered on ferrous parts (to be approved)			
12,3	finish offered on non-ferrous parts (to be			
12,4	method of rectifying damaged galvanizing (to be approved)			
13	**Insulators**			
13,1	Details of insulators offered :			
13.1.1	manufacturer			
13.1.2	type designation			
13.1.3	number of units in stack			
13.1.4	cantilever strength class	N	4 000	
13.1.5	torsional strength	N.m	6 000	
13.1.6	flash over distance	mm	1200	
14	**Insulator test voltages**			
14,1	peakvalue of impulse voltage referred to sea	kV		
14.1.1	to earth and between phases in the open	kV	650	
14.1.2	across the isolating distance		750	
14,2	characteristic waveshape of impulse	kV		
14.2.1	(LIW = Lightning Impulse Withstand)	mic. s	1/50	
14.2.2	(SIW = Switching Impulse Withstand)	mic. s	-	
14,3	60 s power frequency wet withstand voltage referred to sea level :			
14.3.1	to earth and between phases in the open position	kV	275	
14.3.2	in the open position across the isolating distance	kV		
15	**Insulator dimensions**			
15,1	top flange PCD	mm	127	
15,2	bottom flange PCD	mm	127	
15,3	overall height	mm	1500	
16	**Insulator arcing distances**	mm	1200	
17	**Creepage distance**			
17,1	minimum creepage distance for other than medium pollution level	mm	3 625	
18	**Recommended spare parts**		Tenderer to list	
19	**Special tools required**		Tenderer to list	
20	**Tests**			
20,1	what type test certification for similar equipment is available?			
21	**Period and value for short-time current test**	s		

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
22	**Marking / labelling / documentation**			
22,1	language(s) for labels, drawings, certificates and manuals		English	
22,2	number of instruction manuals required		3	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED	
Item 3	**DISCONNECTORS AND EARTHING SWITCHES**				
4	**Horizontal break isolators rated 2 500 A with an earth switch on one side**				
4.1	Details of disconnector				
4.1.1	manufacturer				
4.1.2	type designation				
4.1.3	number of breaks				
4.1.4	isolating distance	mm	1150		
4.1.5	main contacts				
4.1.5.1	entry (see also 4.5.1 NRS 031)				
4.1.5.2	type				
4.1.5.3	materials				
4.1.5.4	wear allowance				
4,2	Details of earthing switch				
4.2.1	manufacturer				
4.2.2	type designation				
4.2.3	number of breaks				
4.2.4	main contacts				
4.2.4.1	entry				
4.2.4.2	type				
4.2.4.3	materials				
4.2.4.4	wear allowance				
4.3	Disconnector rating				
4.3.1	rated voltage	kV	132		
4.3.2	rated current	A	2 500		
4.3.3	rated short-time withstand current	kA	31,5		
4.3.4	short-time withstand current duration	s	3		
4.3.5	rated peak withstand current	kA	78		
,::					
4,4	Earthing switch ratings				
4.4.1	rated voltage	kV	132		
4.4.2	rated short-time withstand current	kA	31,5		
4.4.3	rated short-time withstand current duration	s	3		
4.4.4	rated peak withstand current	kA	78		
4,5	Mounting of disconnectors				
4.5.1	upright, horizontal / vertical		upright		
4.5.2	phase spacing	mm	3 000		
4.5.3	arrangement of phases, in-line or transverse		in-line		
4.5.4	is a support structure to be provided? if YES		Yes		

4.5.5	minimum mounting height (lowest part of insulator above ground level)	mm	2 500		
4.6.5	are necessary fixing bolts, shims, etc., to be provided?		see spec.		
4.5.7	other details				
4,6	Method of operation, i.e. hand, electric motor or other				
4.6.1	For hand operation				
4.6.1.1	horizontal / vertical movement offered?				
4.6.1.2	are interlocking facilities required?		Yes		
4.6.1.3	If YES, details		see spec.		
4.6.1.4	requirements for earthing of operating handle		strap		
4.6.2	For electric motor operation				
4.6.2.1	control voltage	V	110 dc		
4.6.2.2	rated power	W			
4.6.2.3	starting current	A			
4.6.2.4	alternative control switch labelling				
4.6.2.5	are special interlocking arrangements required?		Yes		
4.6.2.6	If Yes, details		see spec.		
4.6.3	For other method of operation				
4.6.3.1	requirements				
4.6.3.2	details				
4,7	Are spark gaps and arcing horns required for disconnectors		No		
4,8	Auxiliary switches				
4.8.1	number of contacts for disconnectors				
4.8.1.1	Type G		8		
4.8.1.2	Type M		8		
4.8.1.3	Type F		2		
4.8.1.4	Type N		6		
4.8.1.5	Type D		0		
4.8.2	number of contacts for earthing switches				
4.8.2.1	Type M		4		
4.8.2.2	Type N		4		
4.8.3	rating of auxiliary switches				
4.8.3.1	continuous current	A	5		
4.8.3.2	current overload for 1 s	A	100		
4,9	Main terminals				
4.9.1	type, stem of pad?		stem		
4.9.2	orientation : horizontal / vertical?		hor		
4.9.3	if stems				
4.9.3.1	diameter	mm	38		
4.9.3.2	length	mm			

4.9.4	if pads				
4.9.4.1	number of holes				
4.9.4.2	diameter of holes	mm			
4.9.4.3	pitch of holes	mm			
4.9.4.4	thickness of pad	mm			
4,10	Secondary terminals if other than spring-loaded				
4.10.1	type required				
4.10.2	type and make offered for approval				
4,11	Minimum size for gland plate	mm	150 x 100		
4,12	Metal finish				
4.12.1	is electrogalvanizing, sherardizing or metal spraying of ferrous parts acceptable?		No		
4.12.2	finish offered on ferrous parts (to be approved)				
4.12.3	finish offered on non-ferrous parts (to be approved)				
4.12.4	method of rectifying damaged galvanizing (to be approved)				
4,13	Insulators				
4.13.1	Details of insulators offered				
4.13.1.1	manufacturer				
4.13.1.2	type designation				
4.13.1.3	number of units in stack				
4.13.1.4	cantilever strength class	N	4 000		
4.13.1.5	torsional strength	N.m	6 000		
4,14	Insulator test voltages				
4.14.1	peak value of impulse voltage referred to sea level	kV	650		
4.14.1.1	to earth and between phases in the open position	kV	750		
4.14.1.2	Across the isolating distance				
4.14.2	characteristic waveshape of impulse				
4.14.2.1	(LIW – Lightning Impulse Withstand)	æs	1/50		
4.14.2.2	(SIW – Switching Impulse Withstand)	æs	-		
4.14.3	60 s power frequency wet withstand voltage referred to sea level				
4.14.3.1	to earth and between phases in the open position	kV	275		
4.14.3.2	across the isolating distance	kV			
4,15	insulator dimensions				
4.15.1	top flange PCD	mm			
4.15.2	bottom flange PCD	mm			
4.15.3	overall height	mm			
4,16	Insulator arcing distances	mm			

4,17	Creepage distance				
4.17.1	minimum creepage distance for other than medium pollution level	mm	3 625		
4,18	Recommended spare parts				
4,19	Special tools required				
4,20	Tests				
4.20.1	What type test certification for similar equipment is available?				
4,21	Period and value for short-time current test	s			
4,22	Marking/ labelling / documentation				
4.22.1	language(s) for labels, drawings, certificates and manuals				
4.22.2	number of instruction manuals required		3		

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
Item 3	**DISCONNECTORS AND EARTHING SWITCHES**			
5	**Horizontal break isolators rated 2 500 A with an earth switch on both sides**			
5,1	Details of disconnector			
5.1.1	manufacturer			
5.1.2	type designation			
5.1.3	number of breaks			
5.1.4	isolating distance	mm		
5.1.5	main contacts		1 150	
5.1.5.1	entry (see also 4.5.1 NRS 031)			
5.1.5.2	type			
5.1.5.3	materials			
5.1.5.4	wear allowance			
5,2	Details of earthing switch			
5.2.1	manufacturer			
5.2.2	type designation			
5.2.3	number of breaks			
5.2.4	main contacts			
5.2.4.1	entry			
5.2.4.2	type			
5.2.4.3	materials			
5.2.4.4	wear allowance			
5,3	Disconnector rating			
5.3.1	rated voltage	kV	132	
5.3.2	rated current	A	2 500	
5.3.3	rated short-time withstand current	kA	31,5	
5.3.4	short-time withstand current duration	s	3	
5.3.5	rated peak withstand current	kA	78	
5,4	Earthing switch ratings			
5.4.1	rated voltage	kV	132	
5.4.2	rated short-time withstand current	kA	31,5	
5.4.3	rated short-time withstand current duration	s	3	
5.4.4	rated peak withstand current	kA	78	
5,5	Mounting of disconnectors			
5.5.1	upright, horizontal / vertical		upright	
5.5.2	phase spacing	mm	3 000	
5.5.3	arrangement of phases, in-line or transverse		in-line	
5.5.4	is a support structure to be provided?		Yes	
	if YES			
5.5.5	minimum mounting height (lowest part of insulator above ground level)	mm	2 500	
5.5.6	are necessary fixing bolts, shims, etc., to be provided?		see spec.	
5.5.7	other details			
5,6	Method of operation, i.e. hand, electric motor or other			
5.6.1	For hand operation			
5.6.1.1	horizontal / vertical movement offered?			
5.6.1.2	are interlocking facilities required?		Yes	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
Item 3	**DISCONNECTORS AND EARTHING SWITCHES**			
5	**Horizontal break isolators rated 2 500 A with an earth switch on both sides**			
5.6.1.3	If YES, details		see spec.	
5.6.1.4	requirements for earthing of operating handle		strap	
5.6.2	For electric motor operation			
5.6.2.1	control voltage	V	110 dc	
5.6.2.2	rated power	W		
5.6.2.3	starting current	A		
5.6.2.4	alternative control switch labelling			
5.6.2.5	are special interlocking arrangements required?		Yes	
5.6.2.6	If Yes, details		see spec.	
,::				
5.6.3	For other method of operation			
5.6.3.1	requirements			
5.6.3.2	details			
5,7	Are spark gaps and arcing horns required for disconnectors		No	
5,8	Auxiliary switches			
5.8.1	number of contacts for disconnectors			
5.8.1.1	Type G		8	
5.8.1.2	Type M		8	
5.8.1.3	Type F		2	
5.8.1.4	Type N		6	
5.8.1.5	Type D		0	
5.8.2	number of contacts for earthing switches			
5.8.2.1	Type M		4	
5.8.2.2	Type N		4	
5.8.3	rating of auxiliary switches			
5.8.3.1	continuous current	A	5	
5.8.3.2	current overload for 1 s	A	100	
5,9	Main terminals			
5.9.1	type, stem of pad?		stem	
5.9.2	orientation : horizontal / vertical?		hor	
5.9.3	if stems			
5.9.3.1	diameter	mm	38	
5.9.3.2	length	mm		
5.9.4	if pads			
5.9.4.1	number of holes			
5.9.4.2	diameter of holes	mm		
5.9.4.3	pitch of holes	mm		
5.9.4.4	thickness of pad	mm		
5,10	Secondary terminals if other than spring-loaded			
5.10.1	type required			

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
Item 3	**DISCONNECTORS AND EARTHING SWITCHES**			
5	**Horizontal break isolators rated 2 500 A with an earth switch on both sides**			
5.10.2	type and make offered for approval			
5,11	Minimum size for gland plate	mm	150 x 100	
5,12	Metal finish			
5.12.1	is electrogalvanizing, sherardizing or metal spraying of ferrous parts acceptable?		No	
5.12.2	finish offered on ferrous parts (to be approved)			
5.12.3	finish offered on non-ferrous parts (to be approved)			
5.12.4	method of rectifying damaged galvanizing (to be approved)			
5,13	Insulators			
5.13.1	Details of insulators offered			
5.13.1.1	manufacturer			
5.13.1.2	type designation			
5.13.1.3	number of units in stack			
5.13.1.4	cantilever strength class	N	4 000	
5.13.1.5	torsional strength	N.m	6 000	
5,14	Insulator test voltages			
5.14.1	peak value of impulse voltage referred to sea level			
5.14.1.1	to earth and between phases in the open position	kV	650	
5.14.1.2	Across the isolating distance	kV	750	
5.14.2	characteristic waveshape of impulse			
5.14.2.1	(LIW = Lightning Impulse Withstand)	æs	1/50	
5.14.2.2	(SIW = Switching Impulse Withstand)	æs	-	
5.14.3	60 s power frequency wet withstand voltage referred to sea level			
5.14.3.1	to earth and between phases in the open position	kV	275	
5.14.3.2	across the isolating distance	kV		
5,15	Insulator dimensions			
5.15.1	top flange PCD	mm		
5.15.2	bottom flange PCD	mm		
5.15.3	overall height	mm		
5,16	Insulator arcing distances	mm		
5,17	Creepage distance			
5.17.1	minimum creepage distance for other than medium pollution level	mm	3 625	
5,18	Recommended spare parts			

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
Item 3	**DISCONNECTORS AND EARTHING SWITCHES**			
5	**Horizontal break isolators rated 2 500 A with an earth switch on both sides**			
5,19	Special tools required			
5,20	Tests			
5.20.1	What type test certification for similar equipment is available?			
5,21	Period and value for short-time current test	s		
5,22	Marking/ labelling / documentation			
5.22.1	language(s) for labels, drawings, certificates and manuals			
5.22.2	number of instruction manuals required		3	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
Item 3	**DISCONNECTORS AND EARTHING SWITCHES**			
6	**Pantograph isolators rated 3150 A without an earth switch**			
6,1	Details of disconnector			
6.1.1	Manufacturer			
6.1.2	Type designation			
6.1.3	Number of breaks			
6.1.4	Isolating distance	mm		
6.1.5	Main contacts			
6.5.1.1	entry (see also 4.5.1 NRS 031)			
6.1.5.2	Type			
6.1.5.3	Contact force	N		
6.1.5.4	Materials			
6.1.5.5	wear allowance			
6,2	Details of earthing switch			
6.2.1	manufacturer			
6.2.2	type designation			
6.2.3	number of breaks			
6.2.4	main contacts			
6.2.4.1	entry			
6.2.4.2	type			
6.2.4.3	contact force	N		
6.2.4.4	materials			
6.2.4.5	wear allowance			
6.3	Disconnector rated insulation voltages			
6.3.1	Rated nominal system voltage	kV	275	
	Rated voltage for equivalent	kV	300	
	Rated short- duration power frequencies withstand voltage (common value)	kV	395	
	Rated short- duration power frequencies withstand voltage (Across the isolating distance)	kV	435	
	Rated lightining impulse withstand peak voltage (common value)	kV	950	
	Rated lightining impulse withstand peak voltage (Across the isolating distance)	kV	950+(170)	
	Rated switching impulse withstand peak voltage(Phase to earth and across open switching device)	kV	750	
	Rated switching impulse withstand peak voltage(between phases)	kV	1125	

	Rated switching impulse withstand peak voltage(Across isolating distance)	kV	700+(245)	
6.3.2	Rated current	A	3150	
6.3.3	Rated short-time withstand current	kA	50	
6.3.4	Short-time withstand current duration	s	3	
6.3.5	Rated peak withstand current	kA	125	
6,4	Earthing switch ratings			
6.4.1	Rated voltage	kV	3150	
6.4.12	Rated short-time withstand current	kA	50	
6.4.3	Rated short-time withstand current duration	s	3	
6.4.4	Rated peak withstand current	kA	125	
6,5	Mounting of disconnectors			
6.5.1	upright, horizontal / vertical		upright	
6.5.2	Phase spacing	mm	4300	
6.5.3	Arrangement of phases, in-line or transverse		in-line	
6.5.4	Is a support structure to be provided?		Yes	
	if YES			
6.5.5	Minimum mounting height (lowest part of insulator above ground level)	mm	2 500	
6.5.6	Are neccessary fixing bolts, shims, etc., to be provided?		Attach spec	
6.5.7	Other details			
6,6	Method of operation, i.e. hand, electric motor or other			
6.6.1	For hand operation			
6.6.1.1	Horizontal / vertical movement offered?			
6.6.1.2	Are interlocking facilities required?		Yes	
6.6.1.3	If YES, details		see spec.	
6.6.1.4	Requirements for earthing of operating handle		strap	
6.6.2	For electric motor operation			
6.6.2.1	Control voltage	V	110 dc	
6.6.2.2	Rated power	W		
6.6.2.3	Starting current	A		
6.6.2.4	Alternative control switch labelling			
6.6.2.5	Are special interlocking arrangements required?		Yes	
6.6.2.6	If Yes, details		see spec.	
6.6.3	For other method of operation			
6.6.3.1	Requirements			
6.6.3.2	Details			

6,7	Are spark gaps and arcing horns required for disconnectors		No	
6,8	Auxiliary switches			
6.8.1	number of contacts for disconnectors			
6.8.1.1	Type G		8	
6.8.1.2	Type M		8	
6.8.1.3	Type F		2	
6.8.1.4	Type N		6	
6.8.1.5	Type D		0	
6.8.2	number of contacts for earthing switches			
6.8.2.1	Type M		4	
6.8.2.2	Type N		4	
6.8.3	rating of auxiliary switches			
6.8.3.1	continuous current	A	5	
6.8.3.2	current overload for 1 s	A	100	
6,9	Main terminals			
6.9.1	type, stem of pad?		stem	
6.9.2	orientation : horizontal / vertical?		hor	
6.9.3	if stems			
6.9.3.1	diameter	mm	38	
6.9.3.2	length	mm		
,::				
6.9.4	if pads			
6.9.4.1	number of holes			
6.9.4.2	diameter of holes	mm		
6.9.4.3	pitch of holes	mm		
6.9.4.4	thickness of pad	mm		
6,10	Secondary terminals if other than spring-loaded			
6.10.1	type required			
6.10.2	type and make offered for approval			
6,11	Minimum size for gland plate	mm	150 x 100	
6,12	Metal finish			
6.12.1	is electrogalvanizing, sherardizing or metal spraying of ferrous parts acceptable?		No	
6.12.2	finish offered on ferrous parts (to be approved)			
6.12.3	finish offered on non-ferrous parts (to be approved)			
6.12.4	method of rectifying damaged galvanizing (to be approved)			

6,13	Insulators			
6.13.1	Details of insulators offered			
6.13.1.1	manufacturer			
6.13.1.2	type designation			
6.13.1.3	number of units in stack			
6.13.1.4	cantilever strength class	N	4 000	
6.13.1.5	torsional strength	N.m	6 000	
6,14	Insulator test voltages			
6.14.1	rated lightining impulse withstand voltage	kV	1175	
6.14.1.1	rated switching impulse withstand (wet) voltage	kV	850	
6.14.1.2	Across the isolating distance	kV		
6.14.2	characteristic waveshape of impulse			
6.14.2.1	(LIW = Lightning Impulse Withstand)	æs	1/50	
6.14.2.2	(SIW = Switching Impulse Withstand)	æs	-	
6.14.3	60 s power frequency wet withstand voltage referred to sea level			
6.14.3.1	to earth and between phases in the open position	kV	275	
6.14.3.2	across the isolating distance	kV		
6,15	Insulator dimensions			
6.15.1	top flange PCD	mm		
6.15.2	bottom flange PCD	mm		
6.15.3	overall height	mm		
6,16	Insulator arcing distances	mm		
6,17	Creepage distance			
6.17.1	minimum creepage distance for other than medium pollution level (see also B.2)	mm	3 625	
6,18	Recommended spare parts			
6,19	Special tools required			
6,20	Tests			
6.20.1	What type test certification for similar equipment is available?			
6,21	Period and value for short-time current test	s		
6,22	Marking/ labelling / documentation			
6.22.1	language(s) for labels, drawings, certificates and manuals			

6.22.2	number of instruction manuals required		3	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
Item 3	**DISCONNECTORS AND EARTHING SWITCHES**			
7	**Pantograph isolators rated 1 600 A with an earth switch**			
7,1	Details of disconnector			
7.1.1	manufacturer			
7.1.2	type designation			
7.1.3	number of breaks			
7.1.4	isolating distance	mm	1 150	
7.1.5	main contacts			
7.1.5.1	entry (see also 4.5.1 NRS 031)			
7.1.5.2	type			
7.1.5.3	contact force	N		
7.1.5.4	materials			
7.1.5.5	wear allowance			
7,2	Details of earthing switch			
7.2.1	manufacturer			
7.2.2	type designation			
7.2.3	number of breaks			
7.2.4	main contacts			
7.2.4.1	entry			
7.2.4.2	type			
7.2.4.3	contact force	N		
7.2.4.4	materials			
7.2.4.5	wear allowance			
7,3	Disconnector rating			
7.3.1	rated voltage	kV	132	
7.3.2	rated current	A	1600	
7.3.3	rated short-time withstand current	kA	31,5	
7.3.4	short-time withstand current duration	s	3	
7.3.4	rated peak withstand current	kA	78	
7,4	Earthing switch ratings			
7.4.1	rated voltage	kV	132	
7.4.2	rated short-time withstand current	kA	31,5	
7.4.3	rated short-time withstand current duration	s	3	
7.4.4	rated peak withstand current	kA	78	
7,5	Mounting of disconnectors			
7.5.1	upright, horizontal / vertical		upright	
7.5.2	phase spacing	mm	3 000	
7.5.3	arrangement of phases, in-line or transverse		in-line	
7.5.4	is a support structure to be provided?		Yes	
	if YES			

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
7.5.5	minimum mounting height (lowest part of insulator above ground level)	mm	2 500	
7.5.6	are neccessary fixing bolts, shims, etc., to be provided?		see spec.	
7.5.7	other details			
7,6	Method of operation, i.e. hand, electric motor or other			
7.6.1	For hand operation			
7.6.1.1	horizontal / vertical movement offered?			
7.6.1.2	are interlocking facilities required?		Yes	
7.6.1.3	If YES, details		see spec.	
7.6.1.4	requirements for earthing of operating handle		strap	
7.6.2	For electric motor operation			
7.6.2.1	control voltage	V	110 dc	
7.6.2.2	rated power	W		
7.6.2.3	starting current	A		
7.6.2.4	alternative control switch labelling			
7.6.2.5	are special interlocking arrangements required?		Yes	
7.6.2.6	If Yes, details		see spec.	
7.6.3	For other method of operation			
7.6.3.1	requirements			
7.6.3.2	details			
7,7	Are spark gaps and arcing horns required for disconnectors		No	
7,8	Auxiliary switches			
7.8.1	number of contacts for disconnectors			
7.8.1.1	Type G		8	
7.8.1.2	Type M		8	
7.8.1.3	Type F		2	
7.8.1.4	Type N		6	
7.8.1.5	Type D		0	
7.8.2	number of contacts for earthing switches			
7.8.2.1	Type M		4	
7.8.2.2	Type N		4	
7.8.3	rating of auxiliary switches			
7.8.3.1	continuous current	A	5	
7.8.3.2	current overload for 1 s	A	100	
7,9	Main terminals			
7.9.1	type, stem of pad?		stem	
7.9.2	orientation : horizontal / vertical?		hor	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
7.9.3	if stems			
7.9.3.1	diameter	mm	38	
7.9.3.2	length	mm		
7.9.4	if pads			
7.9.4.1	number of holes			
7.9.4.2	diameter of holes	mm		
7.9.4.3	pitch of holes	mm		
7.9.4.4	thickness of pad	mm		
7,10	Secondary terminals if other than spring-loaded			
7.10.1	type required			
7.10.2	type and make offered for approval			
7,11	Minimum size for gland plat	mm	150 x 100	
7,12	Metal finish			
7.12.1	is electrogalvanizing, sherardizing or metal spraying of ferrous parts acceptable?		No	
7.12.2	finish offered on ferrous parts (to be approved)			
7.12.3	finish offered on non-ferrous parts (to be approved)			
7.12.4	method of rectifying damaged galvanizing (to be approved)			
7,13	Insulators			
7.13.1	Details of insulators offered			
7.13.1.1	manufacturer			
7.13.1.2	type designation			
7.13.1.3	number of units in stack			
7.13.1.4	cantilever strength class	N	4 000	
7.13.1.5	torsional strength	N.m	6 000	
7,14	Insulator test voltages			
7.14.1	peak value of impulse voltage referred to sea level			
7.14.1.1	to earth and between phases in the open positon	kV		
7.14.1.2	Across the isolating distance	kV		
7.14.2	characteristic waveshape of impulse			
7.14.2.1	(LIW = Lightning Impulse Withstand)	æs	1/50	
7.14.2.2	(SIW = Switching Impulse Withstand)	æs	-	
7.14.3	60 s power frequency wet withstand voltage referred to sea level			
7.14.3.1	to earth and between phases in the open position	kV	275	
7.14.3.2	across the isolating distance	kV		

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
7,15	Insulator dimensions			
7.15.1	top flange PCD	mm		
7.15.2	bottom flange PCD	mm		
7.15.3	overall height	mm		
7,16	Insulator arcing distances	mm		
7,17	Creepage distance			
7.17.1	minimum creepage distance for other than medium pollution level	mm	3 625	
7,18	Recommended spare parts			
7,19	Special tools required			
7,20	Tests			
7.20.1	What type test certification for similar equipment is available?			
7,21	Period and value for short-time current test	s		
7,22	Marking/ labelling / documentation			
7.22.1	language(s) for labels, drawings, certificates and manuals			
7.22.2	number of instruction manuals required		3	

Eskom	Standard	Technology

Title: **SPECIFICATION FOR STATION CLASS METAL OXIDE SURGE ARRESTERS**

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SCOT Study Committee Number/Name: **<Number or name>**

Content

Figures

Tables

1. Introduction

Surge arresters are installed in substations and on transmission lines to limit transient overvoltages that may lead to flashovers and failure of substation HV terminal equipment. To ensure that surge arresters perform satisfactorily in service, they must be designed, constructed and tested according to specified technical requirements. This specification sets out Eskom's requirements for the design, manufacture, testing, delivery and installation, where applicable, of non-linear metal oxide station class surge arresters for use on the Eskom network, excluding Line Surge Arresters.

2. Supporting Clauses

2.1 Scope

This specification sets out Eskom's requirements for the manufacture, testing, supply and delivery of station class, non-linear metal-oxide surge arresters for installation on 6,6kV, 11kV, 22kV, 33kV, 44kV, 66kV, 88kV, 132kV, 220kV, 275kV, 400kV and 765kV distribution, sub-transmission and transmission networks.

2.1.1 Purpose

The purpose of this specification is to ensure that station class metal oxide surge arresters for use in Eskom's distribution, sub-transmission and transmission network are designed, manufactured, tested, supplied, delivered and installed, where applicable, in accordance with Eskom's requirements to satisfy the desired technical performance.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 Normative/Informative References

Parties using this document shall apply the most recent edition and applicable amendments of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001: 2015 Quality Management Systems.

[2] SANS/IEC 60099-4: 2014 Surge Arresters - Part 4: Metal-oxide surge arresters without gaps for a.c. systems

[3] SANS 60815: 2009/IEC 60815: 2008 Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles - Part 3: Polymer insulators for a.c systems

[4] SANS 121: 2011/ISO 1461:2009: Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods.

[5] SANS 17025: 2018/IEC/ISO 17025: 2017, General requirements for the competence of testing and calibration laboratories

2.2.2 Informative

[6] IEEE Std C62.11-1999: IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits (> 1 kV)

[7] IEC 60071-1:2006, Insulation co-ordination – Part 1: Definitions, principles and rules

[8] Eskom Procedure, 240-95453610, Management of Manufacturers/Supplier Equipment Drawings, Revision 3.

2.3 Definitions

2.3.1 General

The Station class surge arresters are classified according to Table 1. The table is adopted from SANS/IEC60099-4:2014 and only shows the information relevant to Station class surge arresters.

Table 1: Station Arrester Classification [2]

Station Arrester class				
Typical nominal voltage in Eskom	**765 kV**	**400 kV**	**132 kV – 275 kV**	**6.6 kV – 132 kV**
Designation	**SH**	**SH**	**SM**	**SL**
Nominal discharge current	20 kA	20 kA	10 kA	10 kA
Switching impulse discharge current	2 kA	2 kA	1 kA	0.5 kA
Q_{rs} (C)	>= 3.6	>= 2.4	>= 1.6	>= 1
W_{th} (kJ/kV)	>= 14	>= 10	>= 7	>= 4
Line Discharge Class (IEC/SANS 60099-4: 2014)	5	4	3	2
Note: The letter “S” refers to Station class. Letters “H”, “M” and “L” in the designation stand for “High”, “Medium” and “Low” duty, respectively.				

Table 2: Site Pollution Severity Class [3]

Site Pollution Severity Class (SPS)	Specific creepage distance for three-phase ac systems in mm/kV (**SCD**)	Unified Specific creepage distance for the rms voltage across the insulator in mm/kV (**USCD**)
Light	16	28
Medium	20	35
Heavy	25	44
Very Heavy	31	55
Extreme	38	66

Only the definitions related to the identification and classification of Station Class Metal Oxide Surge Arresters are provided in definitions. Refer to SANS/IEC60099-4:2014 for other related terms and defintions.

Definition	**Description**
Maximum continuous operating voltage (MCOV or U_c)	The highest r.m.s. power-frequency voltage that an arrester can withstand continuously.
Mean Breaking Load (MBL)	The average breaking load for porcelain or cast resin-housed arresters determined from tests
Nominal discharge current of an arrester (I_n)	The peak value of lightning impulse current which is used to classify an arrester.
Rated voltage of an arrester (U_r)	The maximum permissible 10 s power frequency r.m.s voltage that can be applied between its terminals at which it is designed to operate correctly under temporary overvoltage conditions as established in the operating duty tests. NOTE — The rated voltage is used as a reference parameter for the specification of operating characteristics.

Definition	Description
Repetitive Charge Transfer Rating (Q_{rs})	Maximum specified charge transfer capability of an arrester, in the form of a single event or group of surges that may be transferred through an arrester without causing mechanical failure or unacceptable electrical degradation to the Metal Oxide resistors. **Note** — The charge is calculated as the absolute value of current integrated over time. For the purpose of this standard this is the charge that is accumulated in a single event or group of surges lasting for not more than 2 s and which may be followed by a subsequent event at a time interval not shorter than 60 s.
Specified long-term load (SLL)	Force perpendicular to the longitudinal axis of an arrester, allowed to be continuously applied during service without causing any mechanical damage to the arrester
Specified short-term Load (SSL)	Greatest force perpendicular to the longitudinal axis of an arrester, allowed to be applied during service for short periods and for relatively rare events (for example, short-circuit current loads and extreme wind gusts) without causing any mechanical damage to the arrester
Thermal charge transfer rating(Q_{th})	Maximum specified charge that may be transferred through an arrester or arrester section within 3 minutes in a thermal recovery test without causing a thermal runaway. Only relevant for Distribution class arresters.
Thermal energy rating (W_{th})	Maximum specified energy (kJ/kV) as a function of the Rated voltage (U_r), that may be injected into an arrester or arrester section within 3 minutes in a thermal recovery test without causing a thermal runaway.

2.3.2 Disclosure Classification

Controlled disclosure: Controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
µs	Microsecond
A	Ampere
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
ISO	Internal Standardization Organisation
kA	kiloAmpere
kJ	kiloJoule
kV	kiloVolt
OEM	Original Equipment Manufacturer
PCD	Pitch Circle Diameter
SA	Surge Arrester
SANS	South African National Standard
SCD	Specific Creepage Distance
SPS	Site Pollution Severity Class

2.5 Roles and Responsibilities

The designated Technical Specialist shall ensure that this document is updated, renewed and current at all times. Any person in Eskom and its subsidiaries shall use this standard.

2.6 Process for Monitoring

Not applicable.

2.7 Related/Supporting Documents

The following documents have been superseded by this document and shall be archived for reference purposes only:

- 240-56062896: Specification for Outdoor Metal Oxide Surge Arresters Without Spark Gaps for System Voltages of 220kV and Above Standard (Alternative Reference Number: TSP 41-363)
- 240-56030659: Station Class, Metal-Oxide Surge Arresters Without Spark-Gaps Standard (Alternative Reference Number: 34-419)

3. Specification for Station Class Metal Oxide Surge Arresters

3.1 Requirements

3.1.1 Operating Conditions

Table 3: Operating Conditions

A.	Altitude	Up to 1800 m above Sea Level
B.	Average humidity	30% to 90%;
C.	Ambient temperature	Minimum: - 10 °C Maximum: + 40 °C
D.	Daily temperature variation	Maximum: 30 °C
E.	Solar radiation	1.1 kW/m^2
F.	IEC 60815 Pollution Severity Class	See Table 2
G.	Earthing	6.6 to 88 kV networks: Non-effectively earthed; 44 to 765 kV networks: Effectively earthed Note – Some 44 kV, 66 kV and 88 kV systems are Non-effectively earthed.
H.	System configuration	Three-phase, three wire
I.	Nominal system voltage (Un)	6.6, 11, 22, 33, 44, 66, 88, 132, 220, 275, 400, 765 kV;
J.	System frequency	50 Hz
K.	Seismic	0.3 G

3.1.2 General Requirements

For each Nominal System Voltage level, the major performance requirements are set out in the respective Schedule A. In addition to these requirements, the following should be met:

a) Arresters will be able to withstand the effects of airborne contamination on the external surfaces of the arrester housing as specified and evaluated by clause 3.1.1.F.

b) For Nominal System Voltages of 400 kV and below, only single column (series stack) arresters are acceptable.

c) Internal components shall be dry at the time of assembly and arresters shall be permanently sealed. If elastomer gaskets or seals are used, precautions shall be taken to ensure adequate compression and that such gaskets or seals do not deteriorate in service as a result of exposure to the environment or electrical stresses.

d) All ferrous, non-current carrying components exposed to the atmosphere shall be hot-dip galvanized in accordance with SANS 121.

e) The SA will be mounted on a galvanised structure. The OEM shall ensure that no galvanic (bi-metal) corrosion can occur.

f) Arresters shall withstand short-circuit currents without violent shattering, and shall have the ability to self-extinguish any fire caused by the arc. The short circuit performance of the arrester shall be as per IEC/SANS 60099-4, declared over a period of 200ms(0.2s)

g) All SAs are to be housed in polymeric insulation, and profiles are to be designed in accordance with the requirements in IEC 60815 with no deviations. Open, flat profiles are preferred.

h) Only conventional silicone rubber polymer will be accepted for the polymeric housing material. Non-conventional or exotic blends of material are not acceptable.

i) Any design changes shall be verified by testing and shall be subject to Eskom's written approval.

j) Samples, shall be available for inspection at the premises of the supplier. Eskom reserves the right to sample test any unit(s) available or so requested.

k) Unique product code shall be assigned per arrester rating. The product codes shall also distinguish between arresters intended for heavy or very heavy applications, as well as mechanical load bearing applications.

l) The guarantees of all major performance criteria stated in Schedule B shall be supported by evidence in the form of type test certificates.

m) Grading rings, if required, and associated fittings must be securely attached without the possibility of coming loose during normal operation. The grading ring itself is preferred to be a single welded unit, but other designs of grading rings are allowed. Method of attachment must be submitted with tender returnables for approval by Eskom.

n) Arresters shall be designed for an expected lifespan of 30 years.

o) All information to be supplied in English.

3.1.3 Mechanical Requirements

3.1.3.1 Sealing

Sealing, except where the external housing is directly moulded on the internal components:

- Surge arresters will be permanently sealed. Dryness of internal components will be ensured by hermetic seals and moisture absorption devices e.g. silica gel.
- An approved routine test of seal integrity must be carried out on every assembled arrester or arrester unit.
- Technical details of the sealing arrangements and the routine seal test must be submitted for approval.
- The sealing requirement is not applicable where the external housing is directly moulded to the internal components of the surge arrester.

3.1.3.2 Mounting

3.1.3.1 Nominal System Voltages Greater than 220 kV

a) All arresters shall be isolated from the support structure by either an insulated base or support insulators. Support insulators may be constructed of epoxy or porcelain. Once installed, the arrester shall be able to stand upright without additional support and shall not slide off the support/insulated base insulators. Method and details of components supplied for mounting shall be submitted with tender returnables for approval by Eskom.

3.1.3.2 Nominal System Voltages from 6.6 kV to 44 kV

a) The 6.6 kV to 44 kV arresters shall be arranged for base mounting.

b) Eskom's mounting bracket is 70 mm wide and has a single 14 mm diameter mounting hole.

c) A threaded stud (M12 x 50 mm), a nut, spring washer and two flat washers shall be supplied per arrester.

3.1.3.3 Nominal System Voltages from 66 kV to 132 kV

a) The 66 kV to 132 kV arresters shall be arranged for base mounting and shall be compatible with the drilling plan specified in 1.

b) A tripod base shall be provided.

c) Eskom's mounting bracket is 15 mm thick, with 14 mm diameter mounting holes.

d) Three mounting bolts shall be supplied per arrester. Each mounting bolt shall be supplied complete with a nut, tapered washer (See 2) and two flat washers.

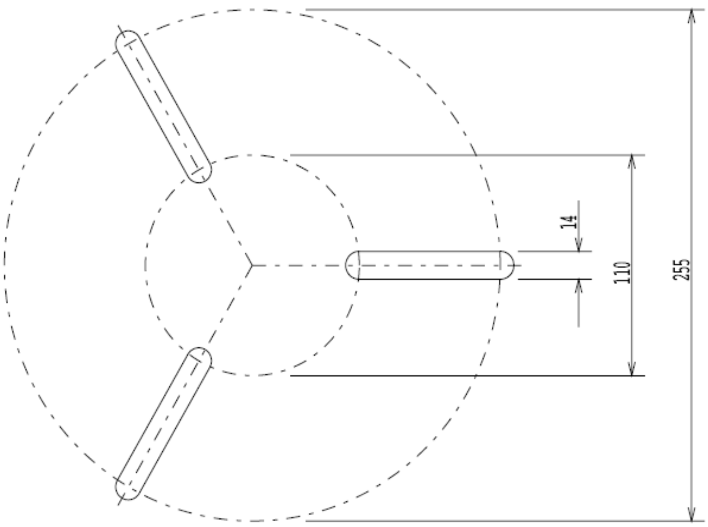


Figure 1: Drilling plan for surge arrester base mounting (66 kV, 88kV and 132 kV arresters)

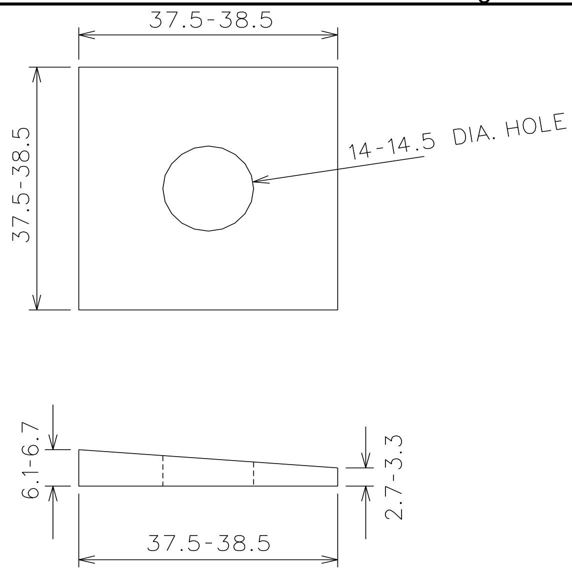


Figure 2: Tapered washer

3.1.3.3 Line and Earth End Terminals

3.1.3.3.1 Nominal System Voltages from 6.6 kV to 44 kV

On arresters equipped for service, there shall be no visible permanent deformation of the terminals of the arrester when a force of 100 N is applied for 1 minute to the tip of the terminal.

If dissimilar metals are used for the arrester terminals and conductor clamping arrangements, proof shall be provided of the galvanic compatibility of these materials.

The line terminal of the 6,6 kV to 44 kV arresters shall consist of a threaded stud (M12 x 50 mm), a nut, two flat washers and spring washer (for application of a crimped lug, M12 hole).

Line terminals shall be centred on the surge arrester.

No additional earth terminal is required on the 6,6 kV to 44 kV arresters.

3.1.3.3.2 Nominal System Voltages from 66 kV to 132 kV

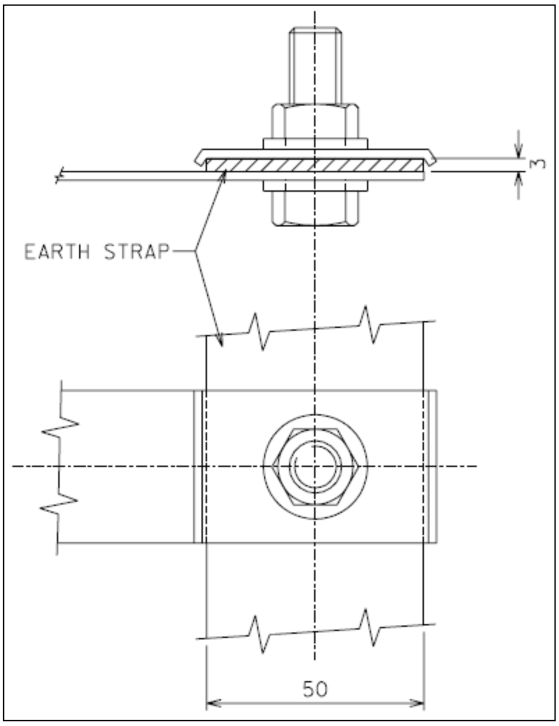
On arresters equipped for service, there shall be no visible permanent deformation of the terminals of the arrester when a force of 100 N is applied for 1 min to the tip of the terminal.

If dissimilar metals are used for the arrester terminals and conductor clamping arrangements, proof shall be provided of the galvanic compatibility of these materials.

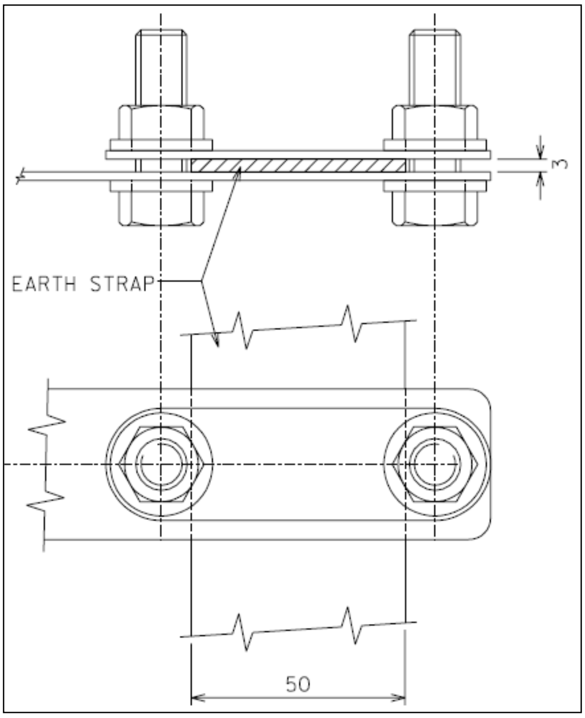
The line terminal of the 66 kV to 132 kV arresters shall consist of a 26 mm x 100 mm aluminium stem (for application of a K-clamp). Terminals must be constructed out of a solid piece of material. Screw-on extensions used for increasing the diameter of terminal up to the required diameter are not acceptable.

Line terminals shall be centred on the surge arrester.

An earth terminal in accordance with Example 1 or Example 2 of 3 shall be provided for the 66 kV to 132 kV arresters. The earth termination shall accommodate a 3 mm x 50 mm copper strap.



Example 1



Example 2

Figure 3: Earth terminal, Examples 1 and 2

3.1.3.3.3 Nominal System Voltages of and Greater than 220 kV

Both line and earth-lead terminations shall be suitable for the standard conductor of dimensions and materials specified in Schedule A.

Terminals shall be of sufficient strength to withstand forces arising during installation and service. Such forces shall not overstress the components of the arrester, particularly the sealing system. If dissimilar metals are used for the arrester terminals and conductor clamping arrangements, proof shall be provided of the galvanic compatibility of these materials.

All line terminals shall be 38 mm in diameter. Terminals shall be constructed out of a solid piece of material. Screw-on extensions used for increasing the diameter of terminal up to the required diameter are not acceptable.

3.1.3.4 Finish

All ferrous components exposed to the atmosphere, excluding those of stainless steel and aluminium, will be hot-dip galvanized in accordance with SANS 121. This includes earth terminals and holding-down bolts.

3.1.3.5 Dimension limitations for 132 kV Surge Arrestors

This specification caters for two applications for 132 kV surge arrester installations;

a) The installation of surge arresters on the transformer mounted bracket. The grading rings for these surge arresters shall not exceed 160mm in diameter.

Note: If the grading ring exceeds the 160mm diameter, the phase to phase clearance of 1650mm will be breached. This measurement is based on the minimum bracket phase spacing of 1815mm.

b) All other installations within the substation. The grading rings for these surge arresters are not limited to a certain diameter.

The dimension between the absolute base and the closest live point shall not exceed 1200mm.

The Eskom Substation Layout Design Guide requires a vertical working clearance of 3.7 m for 132 kV installations. In order to accommodate the standard 2500mm medium equipment support, the SA needs te be at least 1200mm from bottom to nearest live point to accommodate the 3700mm requirement.

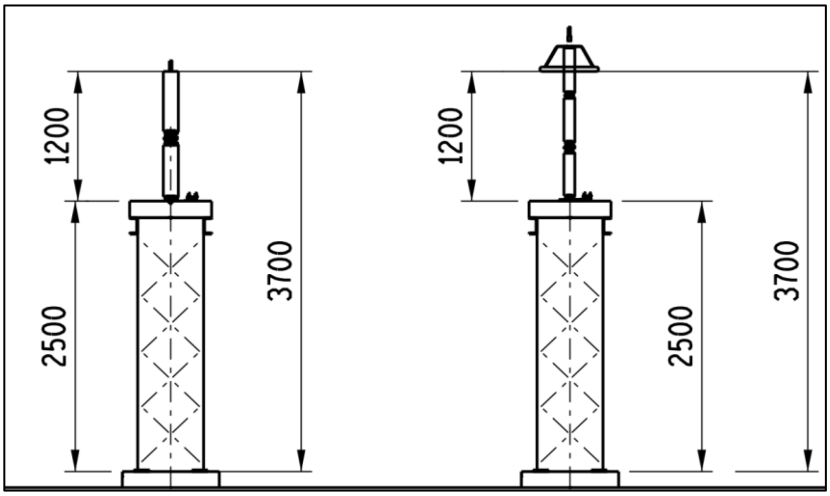


Figure 4: Phase to ground clearance limitation

3.2 Tests

3.2.1 General

a) All type and routine tests on arresters, or where applicable pro-rata sections, identical to those stipulated in Technical Schedule A and offered in Technical Schedule B of an enquiry document, shall be conducted in accordance with SANS 60099-4: 2014.

b) Single copies of type test reports (in English) shall be submitted with a tender. If all the required type test reports are not submitted, the tender will be rated incomplete and will be excluded. If required, any special test reports will be submitted as soon as possible and at least three months before dispatch of the arresters.

c) Type tests reports from in-house testing laboratories must be compliant to ISO/IEC 17025 and have beeen witnessed by an independent accredited body to assess the validity of such tests.

d) Eskom reserves the right to demand test reports from an accredited testing laboratory should any problems arise that question the validity of the in-house test reports. An accredited testing laboratory is defined as that which is ISO/IEC 17025 accredited and/or which holds valid certification issued by ILAC (International Laboratory Accreditation Corporation) or one of its members.

e) Eskom reserves the right to appoint a representative to inspect the arresters at any stage of manufacture and to witness and sanction any tests. If inspection or witnessing of tests is required, Eskom will advise the contractor who will then give at least eight weeks notice of the date on which impending inspection or testing will take place.

f) Any design change must be verified by tests wherever applicable and shall be subject to Eskom's approval.

3.2.2 Type Tests

a) Test certificates and reports shall be provided to prove that the surge arresters comply fully with the provisions of SANS 60099-4:2014 for polymer-housed arresters as well as for any further requirements as stipulated in this specification as well as the relevant Technical Schedule A.

b) Should such evidence not be available, the relevant type tests shall be performed and the costs thereof paid by the manufacturer or supplier.

c) Type test reports shall be arranged and numbered in the order set out in Annex B and shall be marked clearly with the identification and description of the relevant test number in Annex B.

d) Should the product naming convention used in the type test report differ from that of the product offered, clear unambiguous explanation must be given indicating how the product tested is applicable to that offered.

e) The following type tests shall be conducted as per SANS 60099-4:2014 and submitted for review:

Table 4: Type test summary

Test		SANS/IEC60099-4 Reference Section
1	Insulation withstand test on the arrester housing	Lighting Impulse 10.8.2 Switching Impulse 10.8.2 Power Frequency 10.8.2
2	Residual voltage test	Steep Current 10.8.3 Switching Impulse 10.8.3 Power Frequency 10.8.3
3	Test to verify long term stability under continuous operating voltage	10.8.4
4	Repetitive charge transfer withstand	10.8.5
5	Heat dissipation behaviour verification of test sample	10.8.6
6	Operating duty test	10.8.7
7	Power-frequency voltage versus time	10.8.8
8	Short-circuit tests	10.8.10
9	Bending moment test	10.8.11
10	Seal leak rate (Applicable to housings having an enclosed gas volume)	10.8.13
11	Radio interference voltage (RIV) test	10.8.14
12	Test to verify the dielectric withstand of internal components(where applicable)	10.8.15
13	Weather ageing	10.8.17
	NB! Alternative pollution tests for polymer arresters at 132kV and below only, per 3.2.2 (f) applies	

f) For polymer arresters with voltage level at 132kV and below and to be utilised in Very Heavy pollution site severities(as defined in SANS/IEC60815) , thus requiring specific creepage distances of 31mm/kV(USCD of 55mm/kV) or higher, test reports in accordance with one of the following alternative technical standards or guidelines can be provided;

- Cigre TB 555, Solid Layer pollution test with preconditioning (without recovery)
- Cigre TB 691, Rapid flashover test with artificial pollution and without recovery
- IEC TR 62730, 5000hr multistress test

The test must relate to products that share similar shed profiles, creepage and material composition.

3.2.3 Routine Tests

Routine tests shall be performed on the arresters in accordance with SANS 60099-4:2014 clause 9.

3.2.3.1 Measure reference voltage (Uref)

The test shall be conducted in accordance with IEC60099-4, clause 9.1.a.

3.2.3.2 Residual voltage test

The test shall be conducted in accordance with IEC60099-4, clause 9.1.b.

3.2.3.3 Internal partial discharge test

The tests shall be conducted in accordance with IEC60099-4, clause 9.1.c.

3.2.3.4 Leakage check

The tests shall be conducted in accordance with IEC60099-4, clause 9.1.e where required.

3.3 Documentation

3.3.1 Supporting Data

Supporting data in the form of marketing brochures or catalogues stating the electrical characteristics of the arresters on offer shall be included with the tender. Deviations between the published data and the completed Technical Schedule B shall be pointed out and clarified.

3.3.2 Characteristics Curves

The manufacturer of the metal oxide surge arresters shall furnish Eskom with the following characteristic data per item:

a) V-I characteristics (protective level characteristics) at 8/20 µs, 30/60 µs and 1/2 µs (steep current) impulses

b) Temporary overvoltage withstand capability curve with and without prior duty.

c) AC voltage-resistive current curves from 20°C to 180°C

Note: These curves shall be submitted as drawings that contain the manufacturers name, logo and a unique drawing number as a minimum. Clear unambiguous definitions of rated voltage, reference voltage and protective level must be provided. Curves submitted as part of a test report and/or data sheet are not acceptable. Items a and b are mandatory requirements, items c and d may be required before contract award or to be made available during factory inspection.

3.3.3 Drawings Submitted with Tender

Single copies of drawings shall be submitted as part of the original tender showing the following details:

a) Overall dimensions, including mounting details with drilling plan.

b) Line conductor and earth conductor clamping arrangements.

c) Line and earth terminal type details and physical dimensions.

d) Minimum electrical clearances.

e) Details of special items such as the disconnecting device or overpressure relief device.

f) Insulating base type details and physical dimensions (where applicable).

g) Total creepage and SCD.

3.3.4 Drawings (Contractual)

Outline drawings, electronic copies in scale PDF and acceptable CAD format, will be submitted and must contain the following information as a minimum:

a) Overall dimensions, including mounting details

b) Plan view of a three phase layout of the surge arrester application with dimensions indicating edge-to-edge of the surge arrester grading rings (where applicable) and between phases.

c) Details of main and earthing terminals and conductor clamping arrangements

d) Mass of complete arrester, and if applicable, individual arrester sections

e) Minimum electrical clearances

f) Creepage distances

g) A drawing indicating the position of the identification rating plate and the detail that will be provided on the rating plate.

h) Surge arrester electrical and mechanical ratings

Drawings will be submitted not later than one month from contract award date for approval. Once the drawings have been approved by Eskom, the contractor will be notified and supplied with an Eskom drawing number and additional details (if required). The Eskom drawing number as well as additional details (if required) must then be incorporated in the approved drawing and sent back to Eskom for acceptance and archiving.

3.3.5 Supporting Documentation

Single copies of the following documentation will be submitted as part of the original tender:

a) Product catalogue.

b) Transport, storage and installation procedure.

c) Compliance to ISO 9001 and IEC/ ISO 17025 certificates.

d) Customer reference list for each item type tendered for.

e) Factory location, facility name, production start date and routine test failure rate for each item tendered for.

3.3.6 Electronic File structure

For electronic/softcopy files submitted as part of the technical component of the tender submission, the folder structure given in Figure 5 is preferred. The folder structure should be arranged per item offered and should contained all relevant information relating to that item.

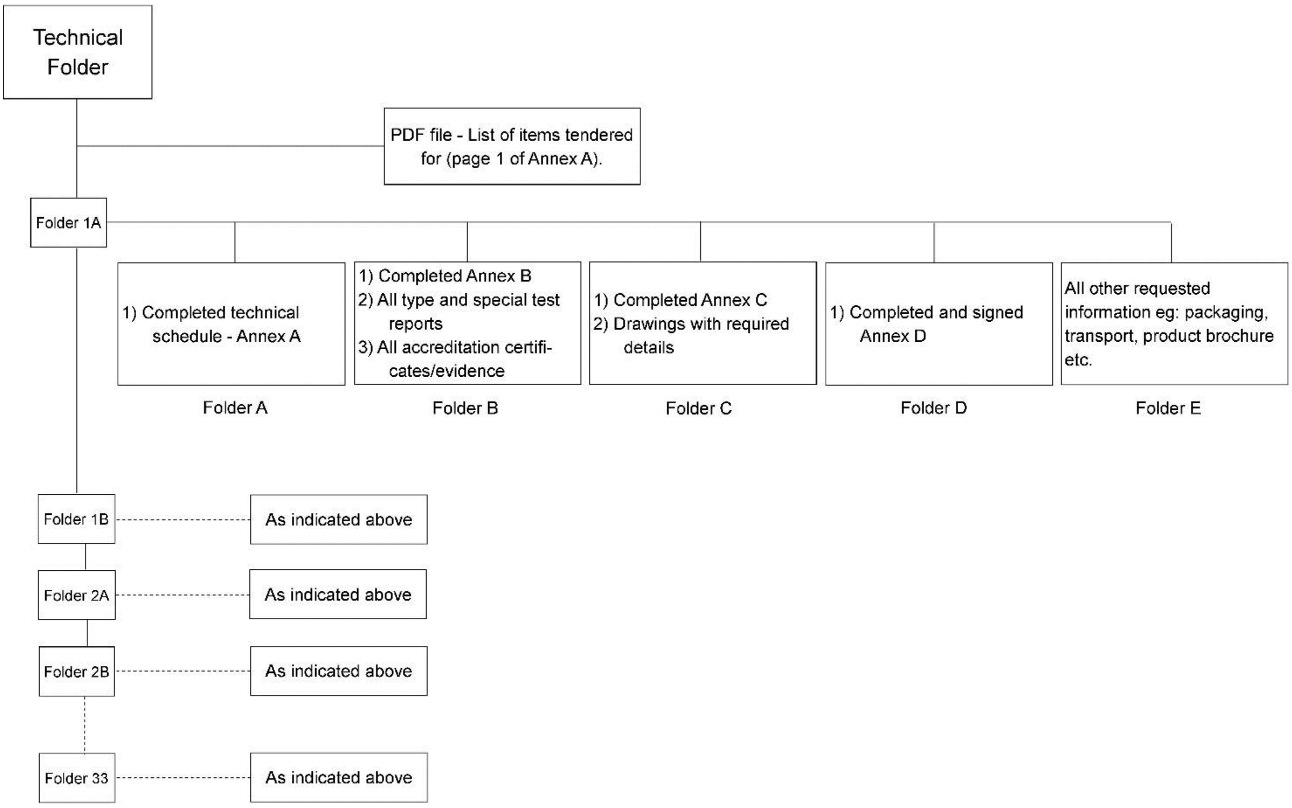


Figure 5: Folder structure for electronic files

3.4 Marking and Packaging

3.4.1 Marking

The minimum required information as per clause 4.1 shall appear on a rating plate permanently attached to the arrester. In addition the following shall appear:

a) Repetitive charge transfer rating, Qrs.

b) Contamination withstand level or specific creepage distance in mm/kV.

c) Name of Manufacturer.

3.4.2 Packaging

All packaging shall be such as to protect the arrester and its components against corrosion and damage during normal handling, uncarting and transportation.

The crate must be able to be lifted using forklifts and/or slings. Lifting positions must be marked. Crates must be designed such that inspections of the contents can be undertaken without damaging the crate.

It is preferred that the packing should allow for surge arresters to be transported and stored on a horizontal position which would prevent toppling over during transportation and storage.

The packing should protect the profile of the shed from deformity or damage during transport and for both outdoor and indoor storage

Further,for arresters to be used on systems ≥ 132 kV, the arrester shall be packaged in crates and enable outdoor storage for a period up to two years.

a) Marking of packaging shall be such as to permit easy identification of the components without their removal from the packing.

b) Each crate shall bear the following information on the outside of the crate:

- Product description;
- Product code or part number;
- Name of manufacturer and contact details;
- Number of components of each type in the container;
- Address of the destination;
- Eskom's purchase order number;
- Eskom's material SAP number(s).

c) If the product is supplied by a third party supplier (e.g. importers, agents, etc.) the crate shall additionally bear the following information:

- Name of the supplier;
- Contact details of the supplier.

d) Where arresters are supplied with grading rings, the arrester, it's corresponding grading ring and associated fittings must be housed in a single package or alternatively in uniquely numbered packages identifying each arrester, its corresponding grading ring and associated fittings. It is not acceptable to have multiple arresters, grading rings and or fittings in one package. The method of packaging and numbering must be submitted for approval.

e) Assembly diagrams and installation/instruction manual must be supplied with each arrester and associated fittings in weather proof housing to ensure correct usage and installation at site.

4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Bheki Ntshangase	Senior Manager: PDE – High Voltage Plant
Kevin Kleinhans	Chief Engineer

5. Revisions

Date	Rev	Compiler	Remarks
Oct 2020	5	F Witbooi	Complete alignment with SANS/IEC60099-4:2014. Remove KIPTS requirements and items. Revised Technical Schedules, included additional parameters including mechanical load ratings.
April 2015	4	T Govender	Revision and updates to general requirements, type test requirements, materials, schedules and annexes.
June 2014	3	T Govender	Changes undertaken to comply with new procurement policy. Non-KIPTS items included. RIV and pollution test requirements detailed further.
May 2014	2	T Govender	Torsional load values for mechanical load bearing units increased. Extreme pollution environment items included.

6. Development Team

The following people were involved in the development of this document:

- M Sekgobela
- K Kleinhans
- F Witbooi
- P Seboco
- P.J Schutte
- K Naidoo
- M Khan
- M Peffer

7. Acknowledgements

The Insulation Coordination Care Group members are acknowledged for their input in compiling this document.

Annex A – List of Items Offered

Item Nr	**Description** Nominal system voltage and earthing philosophy	**Application** SCD and mechanical load bearing requirements	**Offered (Y/N)**
Surge Arresters for Nominal Voltages that includes only Non-Effectively earthed systems			
1A	6.6 kV Nominal Voltage Non-Effectively earthed	31 mm/kV	
2A	11 kV Nominal Voltage Non-Effectively earthed	31 mm/kV	
3A	22 kV Nominal Voltage Non-Effectively earthed	31 mm/kV	
4A	33 kV Nominal Voltage Non-Effectively earthed	31 mm/kV	
Surge Arresters for Nominal Voltages that includes both Effectively and Non-Effectively earthed systems			
5A	44 kV Nominal Voltage Non-Effectively earthed	31 mm/kV	
5B	44 kV Nominal Voltage Effectively earthed	31 mm/kV	
6A	66 kV Nominal Voltage Non-Effectively earthed	31 mm/kV	
6B		31 mm/kV and mechanical load bearing	
6C	66 kV Nominal Voltage Effectively earthed	31 mm/kV	
6D		31 mm/kV and mechanical load bearing	
7A	88 kV Nominal Voltage Non-Effectively earthed	31 mm/kV	
7B		31 mm/kV and mechanical load bearing	
7C	88 kV Nominal Voltage Effectively earthed	31 mm/kV	
7D		31 mm/kV and mechanical load bearing	

Surge Arresters for Nominal Voltages that includes only Effectively earthed systems			
8A	132 kV Nominal Voltage	31 mm/kV	
8B		Extreme Pollution Environment	
8C		31 mm/kV and mechanical load bearing	
8D		Extreme Pollution Environment and mechanical load bearing	
8E		31mm/kV Transformer application with max 160mm diameter grading ring	
9A	220 kV Nominal Voltage	25 mm/kV	
9B		31 mm/kV	
9C		25 mm/kV and mechanical load bearing	
9D		31 mm/kV and mechanical load bearing	
10A	275 kV Nominal Voltage	25 mm/kV	
10B		31 mm/kV	
10c		25 mm/kV and mechanical load bearing	
10D		31 mm/kV and mechanical load bearing	
11A	400 kV Nominal Voltage	25 mm/kV	
11B		31 mm/kV	
11C		25 mm/kV and mechanical load bearing	
11D		31 mm/kV and mechanical load bearing	
11E		Extreme Pollution Environment	
11F		Extreme Pollution Environment and mechanical load bearing	
12A	765 kV Nominal Voltage	25 mm/kV	
12B		31 mm/kV	

Operating Conditions

The following table details the standard service conditions which the surge arresters must be rated for:

1	**Operating conditions:**		xxxxxxxxx	Confirm compliance(Yes/No)
1.1	Altitude	m	1800	
1.2	Average humidity	%	30 to 90	
1.3	Minimum ambient temperature	ºC	-10	
1.4	Maximum ambient temperature	ºC	40	
1.5	Maximum diurnal variation	ºC	30	
1.6	Intensity of solar radiation	kW/m^2	1.1	
1.7	System configuration		3 phase, 3 wire	

Annex B – Technical Schedules

Technical Schedule: Surge Arresters for Nominal Voltages that includes only Non-Effectively earthed systems

Item 1A : 6.6 kV Nominal voltage Non-Effectively Earthed (31 mm/kV)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxxx	
1.3	Product code		xxxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class		Very Heavy	
2.2	System earthing		Non-effective	
2.3	Nominal system voltage (U_n)	kV	6.6	
2.4	Maximum system voltage	kV	7.3	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Level(LIWL)	$kV_{(peak)}$	75	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	22	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		2	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	7.3	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	27	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	4	
4	**Arrester housing**		xxxxxxxxxx	xxxxxxxxxx

4.1	Housing material		Silicone Polymer	
4.2	Minimum external creepage distance [Um x 31 mm/kV]	mm	226	
4.3	Arrester housing profile designed in strict accordance with IEC 60815 with no deviations		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Base	
5.3	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**		xxxxxxxxx	xxxxxxxxx
6.1	Type		Threaded	
6.2	Diameter		M12	
6.3	Minimum length	mm	50	
6.4	Orientation		Vertical	
6.5	Supplied with: M12 nut, two flat washers and spring washer		Yes	
6.6	Material		xxxxxx	
6.7	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
7.1	Type		Threaded	
7.2	Diameter		M12	
7.3	Minimum length	mm	50	
7.4	Orientation		Vertical	
7.5	Supplied with nut, two flat washers and spring washer		Yes	
7.6	Material		xxxxxx	
7.7	Reference number of drawing showing details of line terminal		xxxxxxx	
8	**Drawings to be submitted with tender (Single copies of drawings shall be submitted as part of the original tender showing the following detail):**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	

9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Minimum external flashover distance	mm	200	
10.3	External diameter of arrester housing	mm	xxxxxx	
11	**Miscellaneous**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40°C and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	300	
12.2	Minimum Specified Short-term Load(SSL)	Nm	400	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 2A : 11 kV Nominal Voltage Non-Effectively Earthed (31 mm/kV)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxxxxx	
1.3	Product code		xxxxxxxxx	
2	**Electrical Characteristics**			
2.1	IEC 60815 Pollution class		Very Heavy	
2.2	System earthing		Non-effective	
2.3	Nominal system voltage (U_n)	kV	11	
2.4	Maximum system voltage	kV	12	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Limit(LIWL)	$kV_{(peak)}$	95	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	28	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		2	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxxxxx	
3.6	MCOV (U_c)	kV	12	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	45	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	4	
4	**Arrester housing**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material		Silicone Polymer	
4.2	Minimum external creepage distance[Um x 31 mm/kV]	mm	372	
4..3	Arrester housing profile designed in strict accordance with IEC 60815 with no deviations		Yes	

5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Base	
5.3	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**		xxxxxxxxx	xxxxxxxxx
6.1	Type		Threaded	
6.2	Diameter		M12	
6.3	Minimum length	mm	50	
6.4	Orientation		Vertical	
6.5	Supplied with: M12 nut, two flat washers and spring washer		Yes	
6.6	Material		xxxxxx	
6.7	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**			
7.1	Type		Threaded	
7.2	Diameter		M12	
7.3	Minimum length	mm	50	
7.4	Orientation		Vertical	
7.5	Supplied with nut, two flat washers and spring washer		Yes	
7.6	Material		xxxxxxx	
7.7	Reference number of drawing showing details of line terminal		xxxxxxx	
8	**Drawings to be submitted with tender**		xxxxxxxxx	xxxxxxxxx
	Single copies of drawings shall be submitted as part of the original tender showing the following detail:			
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**			
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	

10.2	Minimum external flashover distance	mm	200	
10.3	External diameter of arrester housing	mm	xxxxxx	
11	**Miscellaneous**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	300	
12.2	Minmum Specified Short-term Load (SSL)	Nm	400	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 3A : 22 kV Nominal voltage Non-Effectively Earthed (31 mm/kV)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class		Very Heavy	
2.2	System earthing		Non-effective	
2.3	Nominal system voltage (U_n)	kV	22	
2.4	Maximum system voltage	kV	24	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Limit(LIWL)	$kV_{(peak)}$	150	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	50	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		2	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	24	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	85	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	4	
4	**Arrester housing**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance[Um x 31 mm/kV]	mm	744	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		xxxxxxxxx	
5	**Arrester mounting details:**		xxxxxxxxx	xxxxxxxxx

5.1	Orientation		Vertical	
5.2	Method of mounting		Base	
5.3	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal:**			
6.1	Type		Threaded	
6.2	Diameter		M12	
6.3	Minimum length	mm	50	
6.4	Orientation		Vertical	
6.5	Supplied with: M12 nut, two flat washers and spring washer		Yes	
6.6	Material		xxxxxx	
6.7	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal:**		xxxxxxxxx	xxxxxxxxx
7.1	Type		Threaded	
7.2	Diameter		M12	
7.3	Minimum length	mm	50	
7.4	Orientation		Vertical	
7.5	Supplied with nut, two flat washers and spring washer		Yes	
7.6	Material		xxxxxx	
7.7	Reference number of drawing showing details of line terminal		xxxxxx	
8	**Drawings to be submitted with tender (Single copies of drawings shall be submitted as part of the original tender showing the following detail):**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
9	**Arrester characteristic data required:**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters:**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Minimum external flashover distance	mm	320	
10.3	External diameter of arrester housing	mm	xxxxxx	

11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	300	
12.2	Minimum Specified Short-term Load (SSL)	Nm	400	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 4A : 33 kV Nominal voltage Non-Effectively Earthed (31 mm/kV)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Operating conditions**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Non-effective	
2.3	Nominal system voltage (U_n)	kV	33	
2.4	Maximum system voltage	kV	36	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Level(LIWL)	$kV_{(peak)}$	200	
2.7	Power Frequency Withstand Voltage (wet)	kV_{rms}	70	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Electrical characteristics of arrester:**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		2	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxx	
3.6	MCOV (U_c)	kV	36	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	125	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	4	
4	**Arrester housing**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	

4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	1488	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details:**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Base	
5.3	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal:**		xxxxxxxxx	xxxxxxxxx
6.1	Type		Threaded	
6.2	Diameter		M12	
6.3	Minimum length	mm	50	
6.4	Orientation		Vertical	
6.5	Supplied with: M12 nut, two flat washers and spring washer		Yes	
6.6	Material		xxxxxx	
6.7	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal:**		xxxxxxxxx	xxxxxxxxx
7.1	Type		Threaded	
7.2	Diameter		M12	
7.3	Minimum length	mm	50	
7.4	Orientation		Vertical	
7.5	Supplied with nut, two flat washers and spring washer		Yes	
7.6	Material		xxxxxx	
7.7	Reference number of drawing showing details of line terminal		xxxxxx	
8	**Drawings to be submitted with tender (Single copies of drawings shall be submitted as part of the original tender showing the following detail):**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
9	**Arrester characteristic data required:**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	

10	**Physical dimensions of arresters:**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Minimum external flashover distance	mm	400	
10.3	External diameter of arrester housing	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40^{o}C and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	300	
12.2	Minmum Specified Short-term Load (SSL)	Nm	400	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Technical Schedule: Surge Arresters for Nominal Voltages that includes both Effectively and Non-Effectively earthed systems

Item 5A : 44 kV Nominal voltage Non-Effectively Earthed (31 mm/kV)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Operating conditions**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Non-effective	
2.3	Nominal system voltage (U_n)	kV	44	
2.4	Maximum system voltage	kV	48	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Level(LIWL)	$kV_{(peak)}$	250	
2.7	Power Frequency Withstand Voltage (wet)	kV_{rms}	70	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Electrical characteristics of arrester:**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		2	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxx	
3.6	MCOV (U_c)	kV	48	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	125	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	4	
4	**Arrester housing**		xxxxxxxxx	xxxxxxxxx

4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance:Um x 31 mm/kV	mm	1488	xxxxxxxxx
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details:**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Base	
5.3	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal:**		xxxxxxxxx	xxxxxxxxx
6.1	Type		Threaded	
6.2	Diameter		M12	
6.3	Minimum length	mm	50	
6.4	Orientation		Vertical	
6.5	Supplied with: M12 nut, two flat washers and spring washer		Yes	
6.6	Material		xxxxxx	
6.7	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal:**		xxxxxxxxx	xxxxxxxxx
7.1	Type		Threaded	
7.2	Diameter		M12	
7.3	Minimum length	mm	50	
7.4	Orientation		Vertical	
7.5	Supplied with nut, two flat washers and spring washer		Yes	
7.6	Material		xxxxxx	
7.7	Reference number of drawing showing details of line terminal		xxxxxx	
8	**Drawings to be submitted with tender (Single copies of drawings shall be submitted as part of the original tender showing the following detail)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	

9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters:**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Minimum external flashover distance	mm	400	
10.3	External diameter of arrester housing	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	300	
12.2	Minimum Specified Short-term Load (SSL)	Nm	400	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 5B : 44 kV Nominal voltage Effectively Earthed (31 mm/kV)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Operating conditions**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Effective	
2.3	System configuration		3 phase, 3 wire	
2.4	Nominal system voltage (U_n)	kV	44	
2.5	Maximum system voltage	kV	48	
2.6	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Limit(LIWL)	$kV_{(peak)}$	250	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	70	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Electrical characteristics of arrester:**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		2	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxx	
3.6	MCOV (U_c)	kV	36	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	125	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	4	
4	**Arrester housing**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	

4.2	**Minimum external creepage distance:** [Um x 31 mm/kV]	mm	1488	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details:**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Base	
5.3	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal:**		xxxxxxxxx	xxxxxxxxx
6.1	Type		Threaded	
6.2	Diameter		M12	
6.3	Minimum length	mm	50	
6.4	Orientation		Vertical	
6.5	Supplied with: M12 nut, two flat washers and spring washer		Yes	
6.6	Material		xxxxxx	
6.7	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal:**		xxxxxxxxx	xxxxxxxxx
7.1	Type		Threaded	
7.2	Diameter		M12	
7.3	Minimum length	mm	50	
7.4	Orientation		Vertical	
7.5	Supplied with nut, two flat washers and spring washer		Yes	
7.6	Material		xxxxxx	
7.7	Reference number of drawing showing details of line terminal		xxxxxx	
8	**Drawings to be submitted with tender (Single copies of drawings shall be submitted as part of the original tender showing the following detail):**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
9	**Arrester characteristic data required:**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters:**		xxxxxxxxx	xxxxxxxxx

10.1	Overall height of arrester	mm	xxxxxx	
10.2	Minimum external flashover distance	mm	400	
10.3	External diameter of arrester housing	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	300	
12.2	Minimum Specified Short-term Load (SSL)	Nm	400	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 6A : 66 kV Nominal voltage Non-Effectively Earthed (31 mm/kV)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for**.**

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item 1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Non-Effective	
2.3	Nominal system voltage (U_n)	kV	66	
2.4	Maximum system voltage	kV	73	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Level(LIWL)	$kV_{(peak)}$	350	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	90	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		2	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxx	
3.6	MCOV (U_c)	kV	62	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	165	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	4	
4	**Arrester housing**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	2263	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Tripod base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110 - 255	

5.5	Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**		xxxxxxxxx	xxxxxxxxx
6.1	Type		Stem	
6.2	Diameter		26	
6.3	Minimum length	mm	100	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender (Single copies of drawings shall be submitted as part of the original tender showing the following detail):**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
9	**Arrester characteristic data required:**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters:**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Minimum external flashover distance	mm	450	
10.3	External diameter of arrester housing	mm	xxxxxx	

11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	800	
12.2	Minimum Specified Short-term Load (SSL)	Nm	1000	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 6B : 66 kV Nominal voltage Non-Effectively Earthed (31 mm/kV and mechanical load bearing)

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Operating conditions**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Non-Effective	
2.3	Nominal system voltage (U_n)	kV	66	
2.4	Maximum system voltage	kV	73	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Level(LIWL)	$kV_{(peak)}$	350	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	90	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Electrical characteristics of arrester**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		2	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxx	
3.6	MCOV (U_c)	kV	62	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	165	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	4	
4	**Arrester housing**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	2263	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Tripod base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110 - 255	

5.5	Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**		xxxxxxxxx	xxxxxxxxx
6.1	Type		Stem	
6.2	Diameter		26	
6.3	Minimum length	mm	100	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender (*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required:**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters:**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Minimum external flashover distance	mm	450	

10.3	External diameter of arrester housing	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		**xxxxxx**	**xxxxxx**
12.1	Minimum Specified Long-term Load (SLL)	Nm	2000	
12.2	Minimum Specified Short-term Load (SSL)	Nm	3000	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 6C : 66 kV Nominal voltage Effectively Earthed (31 mm/kV)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	66	
2.4	Maximum system voltage	kV	73	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Limit(LIWL)	$kV_{(peak)}$	350	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	90	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		2	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxx	
3.6	MCOV (U_c)	kV	48	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	165	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	4	
4	**Arrester housing**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	2263	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx

5.1	Orientation		Vertical	
5.2	Method of mounting		Tripod base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110 - 255	
5.5	Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**		xxxxxxxxx	xxxxxxxxx
6.1	Type		Stem	
6.2	Diameter		26	
6.3	Minimum length	mm	100	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender (Single copies of drawings shall be submitted as part of the original tender showing the following detail)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
9	**Arrester characteristic data required:**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	

10	**Physical dimensions of arresters:**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Minimum external flashover distance	mm	450	
10.3	External diameter of arrester housing	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	800	
12.2	Minimum Specified Short-term Load (SSL)	Nm	1000	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 6D : 66 kV Nominal voltage Effectively Earthed (31 mm/kV and mechanical load bearing)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	66	
2.4	Maximum system voltage	kV	73	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Limit(LIWL)	$kV_{(peak)}$	350	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	90	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		2	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxx	
3.6	MCOV (U_c)	kV	48	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	165	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	4	
4	**Arrester housing**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	2263	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Tripod base	

5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110 - 255	
5.5	Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**		xxxxxxxxx	xxxxxxxxx
6.1	Type		Stem	
6.2	Diameter		26	
6.3	Minimum length	mm	100	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender (*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
9	**Arrester characteristic data required:**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters:**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	

10.2	Minimum external flashover distance	mm	450	
10.3	External diameter of arrester housing	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		**xxxxxx**	**xxxxxx**
12.1	Minimum Specified Long-term Load (SLL)	Nm	2000	
12.2	Minimum Specified Short-term Load (SSL)	Nm	3000	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 7A : 88 kV Nominal voltage Non-Effectively Earthed (31 mm/kV)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxx x
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxx x
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Non-Effective	
2.3	Nominal system voltage (U_n)	kV	88	
2.4	Maximum system voltage	kV	97	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Limit(LIWL)	$kV_{(peak)}$	380	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}		
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxx x
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		2	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxx	
3.6	MCOV (U_c)	kV	77	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	249	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	4	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxx x

4.1	Housing material		Silicone Polymer	
4.2	**Minimum external creepage distance:** [Um x 31 mm/kV]	mm	3007	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details:**		xxxxxxxxx	xxxxxxxx x
5.1	Orientation		Vertical	
5.2	Method of mounting		Tripod base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110 - 255	
5.5	Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal:**		xxxxxxxxx	xxxxxxxx x
6.1	Type		Stem	
6.2	Diameter		26	
6.3	Minimum length	mm	100	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxxxxx	xxxxxxxx x
7	**Arrester earth terminal:**		xxxxxxxxx	xxxxxxxx x
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxx x
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender (*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxx x
8.1	Outline dimensions of arrester, fit as for service		Referenc e Number:	

8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
9	**Arrester characteristic data required:**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters:**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Minimum external flashover distance	mm	900	
10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Diameter of voltage grading rings	mm	xxxxxx	
12	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	800	
12.2	Minimum Specified Short-term Load (SSL)	Nm	1000	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 7B : 88 kV Nominal voltage Non-Effectively Earthed (31 mm/kV and mechanical load bearing)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Non-Effective	
2.3	Nominal system voltage (U_n)	kV	88	
2.4	Maximum system voltage	kV	97	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Limit(LIWL)	$kV_{(peak)}$	380	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	150	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		2	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxx	
3.6	MCOV (U_c)	kV	77	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	249	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV$_r$	4	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material		Silicone Polymer	
4.2	**Minimum external creepage distance:**		xxxxxxxxx	xxxxxxxxx
4.2.1	SCD [Um x 31 mm/kV]	mm	3007	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	

5	**Arrester mounting details:**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Tripod base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110 - 255	
5.5	Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal:**		xxxxxxxxx	xxxxxxxxx
6.1	Type		Stem	
6.2	Diameter		26	
6.3	Minimum length	mm	100	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxxxxx	xxxxxxxxx
7	**Arrester earth terminal:**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender (*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
9	**Arrester characteristic data required:**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters:**		xxxxxxxxx	xxxxxxxxx

10.1	Overall height of arrester	mm	xxxxxx	
10.2	Minimum external flashover distance	mm	900	
10.3	External diameter of arrester housing	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	2000	
12.2	Minimum Specified Short-term Load (SSL)	Nm	3000	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 7C : 88 kV Nominal voltage Effectively Earthed (31 mm/kV)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxx x
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxx x
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	88	
2.4	Maximum system voltage	kV	97	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Limit(LIWL)	$kV_{(peak)}$	380	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	150	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxx x
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		2	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxx	
3.6	MCOV (U_c)	kV	56	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	210	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	4	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxx x

4.1	Housing material		Silicone Polymer	
4.2	**Minimum external creepage distance:** [Um x 31 mm/kV]	mm	3007	xxxxxxxx x
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details:**		xxxxxxxxx	xxxxxxxx x
5.1	Orientation		Vertical	
5.2	Method of mounting		Tripod base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110 - 255	
5.5	Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal:**		xxxxxxxxx	xxxxxxxx x
6.1	Type		Stem	
6.2	Diameter		26	
6.3	Minimum length	mm	100	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxxxxx	xxxxxxxx x
7	**Arrester earth terminal:**		xxxxxxxxx	xxxxxxxx x
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxx x
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender (*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxx x
8.1	Outline dimensions of arrester, fit as for service		Referenc e Number:	

8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
9	**Arrester characteristic data required:**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters:**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Minimum external flashover distance	mm	900	
10.3	External diameter of arrester housing	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	800	
12.2	Minimum Specified Short-term Load (SSL)	Nm	1000	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 7D : 88 kV Nominal voltage Effectively Earthed (31 mm/kV and mechanical load bearing)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electricl Characteristcs**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	88	
2.4	Maximum system voltage	kV	97	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Limit(LIWL)	$kV_{(peak)}$	380	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	150	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		2	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxx	
3.6	MCOV (U_c)	kV	56	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	210	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	4	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material		Silicone Polymer	
4.2	**Minimum external creepage distance:** [Um x 31 mm/kV]	mm	3007	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details:**		xxxxxxxxx	xxxxxxxxx

5.1	Orientation		Vertical	
5.2	Method of mounting		Tripod base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110 - 255	
5.5	Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal:**		xxxxxxxxx	xxxxxxxxx
6.1	Type		Stem	
6.2	Diameter		26	
6.3	Minimum length	mm	100	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxxxxx	xxxxxxxxx
7	**Arrester earth terminal:**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender (*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
9	**Arrester characteristic data required:**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters:**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	

10.2	Minimum external flashover distance	mm	900	
10.3	External diameter of arrester housing	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	2000	
12.2	Minimum Specified Short-term Load (SSL)	Nm	3000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Technical Schedule: Surge Arresters for Nominal Voltages that includes only Effectively earthed systems

Item 8A : 132 kV Nominal Voltage (31 mm/kV)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	132	
2.4	Maximum system voltage	kV	145	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Limit(LIWL)	$kV_{(peak)}$	550	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	230	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		3	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	84	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	300	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	7	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	4495	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	

5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Tripod base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110 - 255	
5.5	Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter		26	
6.3	Minimum length	mm	100	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	

10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	1100	
10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	800	
12.2	Minimum Specified Short-term Load (SSL)	Nm	1000	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 8B : 132 kV Nominal Voltage (Extreme Pollution Environment)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class		Extreme	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	132	
2.4	Maximum system voltage	kV	145	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Limit(LIWL)	$kV_{(peak)}$	550	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	230	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		3	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	84	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	300	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	7	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance [Um x 38 mm/kV]	mm	5510	
4.3	Arrester housing profile designed in strict accordance with IEC 60815 with no deviations		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Tripod base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	

5.4	PCD	mm	110 - 255	
5.5	Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter		26	
6.3	Minimum length	mm	100	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	1100	
10.3	External diameter of arrester housing	mm	xxxxxx	

10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	800	
12.2	Minmum Specified Short-term Load (SSL)	Nm	1000	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 8C : 132 kV Nominal Voltage (31 mm/kV and mechanical load bearing)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	132	
2.4	Maximum system voltage	kV	145	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Limit(LIWL)	$kV_{(peak)}$	550	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	230	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		3	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	84	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	300	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	7	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance:		xxxxxxxxx	xxxxxxxxx
4.2.1	Specific Creepage Distance [Um x 31 mm/kV]	mm	4495	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx

5.1	Orientation		Vertical	
5.2	Method of mounting		Tripod base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110 - 255	
5.5	Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter		26	
6.3	Minimum length	mm	100	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	

10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	1100	
10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	2000	
12.2	Minmum Specified Short-term Load (SSL)	Nm	3000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 8D : 132 kV Nominal Voltage (Extreme Pollution Environment and mechanical load bearing)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Extreme	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	132	
2.4	Maximum system voltage	kV	145	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Limit(LIWL)	$kV_{(peak)}$	550	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	230	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Charateristics**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		3	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	84	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	300	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	7	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 38 mm/kV]	mm	5510	xxxxxxxxx
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	

5.2	Method of mounting		Tripod base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110 - 255	
5.5	Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter		26	
6.3	Minimum length	mm	100	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	

10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	1100	
10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40°C and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	2000	
12.2	Minimum Specified Short-term Load (SSL)	Nm	3000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 8E : 132 kV Transformer Application (31 mm/kV)

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	132	
2.4	Maximum system voltage	kV	145	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Limit(LIWL)	$kV_{(peak)}$	550	
2.7	Power Fequency Withstand Voltage (wet)	kV_{rms}	230	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Characteristics**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		3	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	84	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	300	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	7	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	4495	xxxxxxxxx
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	

5.2	Method of mounting		Tripod base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110 - 255	
5.5	Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter		26	
6.3	Minimum length	mm	100	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx

10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	1100	
10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Maximum diameter of voltage grading rings	mm	160	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	800	
12.2	Minimum Specified Short-term Load (SSL)	Nm	1000	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 9A : 220 kV Nominal Voltage (25mm/kV)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	220	
2.4	Maximum system voltage (U_m)	kV	242	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Level (LIWL)	$kV_{(peak)}$	1050	
2.7	Power Frequency Withstand Voltage(wet)	kV_{rms}	460	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		3	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	154	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	300	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	7	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 25 mm/kV]	mm	6050	xxxxxxxxx
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting (Insulated or Earthed)		Insulated	
5.3	Diameter of mounting holes in base	mm	xxxxxx	

5.4	PCD	mm	110-255	
5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter	mm	38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	1850	
10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40°C and MCOV	yrs	30	

12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	2500	
12.2	Minmum Specified Short-term Load (SSL)	Nm	4000	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 9B : 220 kV Nominal Voltage (31mm/kV)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	220	
2.4	Maximum system voltage (U_m)	kV	242	
2.5	Supply frequency	Hz	50	
2.6	Minimum Lightning Impulse Withstand Level (LIWL)	$kV_{(peak)}$	1050	
2.7	Minimum Power Frequency Withstand Voltage	kV_{rms}	460	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		3	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	154	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	300	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	7	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	7502	xxxxxxxxx
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting (Insulated or Earthed)		Insulated	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110-255	

5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter	mm	38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	1850	
10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40°C and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx

12.1	Minimum Specified Long-term Load (SLL)	Nm	2500	
12.2	Minimum Specified Short-term Load (SSL)	Nm	4000	
12.3.	Test report confirming mechanical characteristics		Report reference number	

Item 9C : 220 kV Nominal Voltage (25mm/kV and mechanical load bearing)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	220	
2.4	Maximum system voltage	kV	242	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Level (LIWL)	$kV_{(peak)}$	1050	
2.7	Power Frequency Withstand Voltage(wet)	kV_{rms}	460	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		3	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	154	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	300	
3.8	Repetitive Charge Transfer Rating (Q_{rs})	C	1.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	7	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	6050	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Insulated base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	

5.4	PCD	mm	110 - 255	
5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter	mm	38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	1850	
10.3	External diameter of arrester housing	mm	xxxxxx	

10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	6000	
12.2	Minmum Specified Short-term Load (SSL)	Nm	9000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 9D : 220 kV Nominal Voltage (31mm/kV and mechanical load bearing)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	220	
2.4	Maximum system voltage	kV	242	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Level (LIWL)	$kV_{(peak)}$	1050	
2.7	Power Frequency Withstand Voltage(wet)	kV_{rms}	460	
2.8	Short Circuit current rating	kA_{rms}	40	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		3	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	154	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	300	
3.8	Repetitive Charge Transfer Rating (Q_{rs})	C	1.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	7	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	7502	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Insulated base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	

5.4	PCD	mm	110 - 255	
5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter		38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	1850	
10.3	External diameter of arrester housing	mm	xxxxxx	

10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	6000	
12.2	Minimum Specified Short-term Load (SSL)	Nm	9000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 10A : 275 kV Nominal Voltage (25mm/kV)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	275	
2.4	Maximum system voltage (U_m)	kV	300	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Level (LIWL)	$kV_{(peak)}$	1050	
2.7	Switching Impulse Withstand Level (SIWL)	$kV_{(peak)}$	850	
2.8	Short Circuit current rating	kA_{rms}	50	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		3	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	180	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	560	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	7	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 25 mm/kV]	mm	7500	xxxxxxxxx
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting (Insulated or Earthed)		Insulated	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110-255	

5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter	mm	38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	2350	
10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40^{o}C and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	2500	

12.2	Minimum Specified Short-term Load (SSL)	Nm	4000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 10B : 275 kV Nominal Voltage (31mm/kV)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	275	
2.4	Maximum system voltage (U_m)	kV	300	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Level (LIWL)	$kV_{(peak)}$	1050	
2.7	Switching Impulse Withstand Level (SIWL)	$kV_{(peak)}$	850	
2.8	Short Circuit current rating	kA_{rms}	50	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		3	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	180	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	560	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	1.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	7	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	9300	xxxxxxxxx
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting (Insulated or Earthed)		Insulated	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	110 - 255	

5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter	mm	38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	2350	
10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40°C and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx

12.1	Minimum Specified Long-term Load (SLL)	Nm	2500	
12.2	Minimum Specified Short-term Load (SSL)	Nm	4000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 10C : 275 kV Nominal Voltage (25mm/kV and mechanical load bearing)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	275	
2.4	Maximum system voltage	kV	300	
2.5	Supply frequency	Hz	50	
2.6	Minimum Lightning Impulse Withstand Level (LIWL)	$kV_{(peak)}$	1050	
2.7	Minimum Switching Impulse Withstand Level (SIWL)	$kV_{(peak)}$	850	
2.8	Short Circuit current rating	kA_{rms}	50	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		3	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	180	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	560	
3.8	Repetitive Charge Transfer Rating (Q_{rs})	C	1.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	7	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 25 mm/kV]	mm	7500	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Insulated base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	

5.4	PCD	mm	110 - 255	
5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter	mm	38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	2350	
10.3	External diameter of arrester housing	mm	xxxxxx	

10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	6000	
12.2	Minimum Specified Short-term Load (SSL)	Nm	9000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 10D : 275 kV Nominal Voltage (31mm/kV and mechanical load bearing)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	275	
2.4	Maximum system voltage	kV	300	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Level (LIWL)	$kV_{(peak)}$	1050	
2.7	Switching Impulse Withstand Level (SIWL)	$kV_{(peak)}$	850	
2.8	Short Circuit current rating	kA_{rms}	50	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		3	
3.3	Nominal discharge current	kA	10	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	1	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	180	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	560	
3.8	Repetitive Charge Transfer Rating (Q_{rs})	C	1.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	7	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	9300	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Insulated base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	

5.4	PCD	mm	110 - 255	
5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter	mm	38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	2350	
10.3	External diameter of arrester housing	mm	xxxxxx	

10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load (SLL)	Nm	6000	
12.2	Minimum Specified Short-term Load (SSL)	Nm	9000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 11A : 400 kV Nominal Voltage (25mm/kV)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	400	
2.4	Maximum system voltage (U_m)	kV	420	
2.5	Supply frequency	Hz	50	
2.6	Lightning Impulse Withstand Level (LIWL)	$kV_{(peak)}$	1550	
2.7	Switching Impulse Withstand Level (SIWL)	$kV_{(peak)}$	1050	
2.8	Short Circuit current rating	kA_{rms}	63	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		4	
3.3	Nominal discharge current	kA	20	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	2	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	245	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	xxxxx	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	2.4	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	10	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 25 mm/kV]	mm	10500	xxxxxxxxx
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting (Insulated or Earthed)		Insulated	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	225-300	

5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter	mm	38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	3200	
10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40^{o}C and MCOV	yrs	30	
12	**Mechanical characteristics**		**xxxxxx**	**xxxxxx**

12.1	Minimum Specified Long-term Load(SLL)	Nm	6000	
12.2	Minimum Specified Short-term Load(SSL)	Nm	9000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 11B : 400 kV Nominal Voltage (31mm/kV)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		XXXXXXXXX	XXXXXXXXX
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		XXXXXXXXX	XXXXXXXXX
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	400	
2.4	Maximum system voltage (U_m)	kV	420	
2.5	Supply frequency	Hz	50	
2.6	Minimum Lightning Impulse Withstand Level (LIWL)	$kV_{(peak)}$	1550	
2.7	Minimum Switching Impulse Withstand Level (SIWL)	$kV_{(peak)}$	1050	
2.8	Short Circuit current rating	kA_{rms}	63	
3	**Surge Arrester Parameters**		XXXXXXXXX	XXXXXXXXX
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		4	
3.3	Nominal discharge current	kA	20	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	2	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	245	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	xxxxx	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	2.4	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	10	
4	**Arrester housing:**		XXXXXXXXX	XXXXXXXXX
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	13020	XXXXXXXXX
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		XXXXXXXXX	XXXXXXXXX
5.1	Orientation		Vertical	
5.2	Method of mounting (Insulated or Earthed)		Insulated	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	225-300	

5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter	mm	38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	3200	
10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40°C and MCOV	yrs	30	
12	**Mechanical characteristics**		**xxxxxx**	**xxxxxx**

12.1	Minimum Specified Long-term Load(SLL)	Nm	6000	
12.2	Minimum Specified Short-term Load(SSL)	Nm	9000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 11C : 400 kV Nominal Voltage (25mm/kV and mechanical load bearing)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	400	
2.4	Maximum system voltage	kV	420	
2.5	Supply frequency	Hz	50	
2.6	Minimum Lightning Impulse Withstand Level	$kV_{(peak)}$	1550	
2.7	Minimum Switching Impulse Withstand Level	$kV_{(peak)}$	1050	
2.8	Short Circuit current rating	kA_{rms}	63	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		4	
3.3	Nominal discharge current	kA	20	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	2	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	245	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20μs)	kV	xxxxx	
3.8	Repetitive Charge Transfer Rating (Q_{rs})	C	2.4	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	10	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 25 mm/kV]	mm	1050	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Insulated base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	

5.4	PCD	mm	225-300	
5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter		38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	3200	
10.3	External diameter of arrester housing	mm	xxxxxx	

10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load(SLL)	Nm	12000	
12.2	Minimum Specified Short-term Load(SSL)	Nm	18000	
12.4	Test report confirming mechanical characteristics		Report reference number	

Item 11D : 400 kV Nominal Voltage (31mm/kV and mechanical load bearing)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	400	
2.4	Maximum system voltage	kV	420	
2.5	Supply frequency	Hz	50	
2.6	Minimum Lightning Impulse Withstand Level	$kV_{(peak)}$	1550	
2.7	Minimum Switching Impulse Withstand Level	$kV_{(peak)}$	1050	
2.8	Short Circuit current rating	kA_{rms}	63	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		4	
3.3	Nominal discharge current	kA	20	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	2	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	245	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	xxxxxx	
3.8	Repetitive Charge Transfer Rating (Q_{rs})	C	2.4	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	10	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	13020	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Insulated base	
5.3	Diameter of mounting holes in base	mm	xxxxxx	

5.4	PCD	mm	225-300	
5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter	mm	38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	3200	
10.3	External diameter of arrester housing	mm	xxxxxx	

10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load(SLL)	Nm	12000	
12.2	Minimum Specified Short-term Load(SSL)	Nm	18000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 11E : 400 kV Nominal Voltage (Extreme Pollution Environment)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		XXXXXXXXX	XXXXXXXXX
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		XXXXXXXXX	XXXXXXXXX
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	400	
2.4	Maximum system voltage (U_m)	kV	420	
2.5	Supply frequency	Hz	50	
2.6	Minimum Lightning Impulse Withstand Level (LIWL)	$kV_{(peak)}$	1550	
2.7	Minimum Switching Impulse Withstand Level (SIWL)	$kV_{(peak)}$	1050	
2.8	Short Circuit current rating	kA_{rms}	63	
3	**Surge Arrester Parameters**		XXXXXXXXX	XXXXXXXXX
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		4	
3.3	Nominal discharge current	kA	20	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	2	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	245	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	xxxxxx	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	2.4	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	10	
4	**Arrester housing:**		XXXXXXXXX	XXXXXXXXX
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 38 mm/kV]	mm	15960	XXXXXXXXX
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		XXXXXXXXX	XXXXXXXXX
5.1	Orientation		Vertical	
5.2	Method of mounting (Insulated or Earthed)		Insulated	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	225-300	

5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter	mm	38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	3200	
10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40^{o}C and MCOV	yrs	30	
12	Mechanical characteristics		xxxxxx	xxxxxx

12.1	Minimum Specified Long-term Load(SLL)	Nm	8000	
12.2	Minimum Specified Short-term Load(SSL)	Nm	10000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 11F : 400 kV Nominal Voltage (Extreme Pollution Environment and mechanical load bearing)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Extreme	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	400	
2.4	Maximum system voltage	kV	420	
2.5	Supply frequency	Hz	50	
2.6	Minimum Lightning Impulse Withstand Level (LIWL)	$kV_{(peak)}$	1550	
2.7	Minimum Switching Impulse Withstand Level (SIWL)	$kV_{(peak)}$	1050	
2.8	Short Circuit Current rating	kA_{rms}	63	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		4	
3.3	Nominal discharge current	kA	20	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	2	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	245	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	xxxxxx	
3.8	Repetitive Charge Transfer Rating (Q_{rs})	C	2.4	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	10	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 38 mm/kV]	mm	15960	
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting		Insulated base	

5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	225-300	
5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
5.6	Reference number of drawing showing mounting details		xxxxxx	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter		38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
6.6	Reference number of drawing showing details of line terminal		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
7.5	If dissimilar metals are used for clamping arrangement, state types		xxxxxx	
7.6	Reference number of drawing showing details of earth terminal		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	3200	

10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40ºC and MCOV	yrs	30	
12	**Mechanical characteristics**		xxxxxx	xxxxxx
12.1	Minimum Specified Long-term Load(SLL)	Nm	14000	
12.2	Minimum Specified Short-term Load(SSL)	Nm	20000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 12A : 765 kV Nominal Voltage (25mm/kV)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	765	
2.4	Maximum system voltage (U_m)	kV	800	
2.5	Supply frequency	Hz	50	
2.6	Minimum Lightning Impulse Withstand Level (LIWL)	$kV_{(peak)}$	2100	
2.7	Minimum Switching Impulse Withstand Level (SIWL)	$kV_{(peak)}$	1300	
2.8	Short Circuit Current rating	kA_{rms}	63	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		5	
3.3	Nominal discharge current	kA	20	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	2	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	465	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	xxxxxx	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	3.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	14	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 25 mm/kV]	mm	20125	xxxxxxxxx
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting (Insulated or Earthed)		Insulated	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	225 -350	

5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter	mm	38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	5500	
10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40°C and MCOV	yrs	30	
12	**Mechanical characteristics**		**xxxxxx**	**xxxxxx**

12.1	Minimum Specified Long-term Load(SLL)	Nm	19000	
12.2	Minimum Specified Short-term Load(SSL)	Nm	28000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Item 12B : 765 kV Nominal Voltage (31mm/kV)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Description	Unit	Schedule A	Schedule B
1	**Surge arrester identification:**		xxxxxxxxx	xxxxxxxxx
1.1	Supplier		xxxxxx	
1.2	Manufacturer, physical address and name of factory		xxxxxx	
1.3	Product code:		xxxxxx	
2	**Electrical Characteristics**		xxxxxxxxx	xxxxxxxxx
2.1	IEC 60815 Pollution class:		Very Heavy	
2.2	System earthing		Effective	
2.3	Nominal system voltage (U_n)	kV	765	
2.4	Maximum system voltage (U_m)	kV	800	
2.5	Supply frequency	Hz	50	
2.6	Minimum Lightning Impulse Withstand Level (LIWL)	$kV_{(peak)}$	2100	
2.7	Minimum Switching Impulse Withstand Level (SIWL)	$kV_{(peak)}$	1300	
2.8	Short Circuit Current rating	kA_{rms}	63	
3	**Surge Arrester Parameters**		xxxxxxxxx	xxxxxxxxx
3.1	Arrester classification		Station class	
3.2	IEC line discharge class		5	
3.3	Nominal discharge current	kA	20	
3.4	Switching Impulse discharge current	$kA_{(peak)}$	2	
3.5	Arrester rated voltage (U_r)	kV	xxxxxx	
3.6	MCOV (U_c)	kV	465	
3.7	Maximum residual voltage (U_{res}) at 10kA (8/20µs)	kV	xxxxxx	
3.8	Minimum Repetitive Charge Transfer Rating (Q_{rs})	C	3.6	
3.9	Minimum Thermal energy rating (W_{th})	kJ/kV_r	14	
4	**Arrester housing:**		xxxxxxxxx	xxxxxxxxx
4.1	Housing material:		Silicone Polymer	
4.2	Minimum external creepage distance: [Um x 31 mm/kV]	mm	24995	xxxxxxxxx
4.3	**Arrester housing profile designed in strict accordance with IEC 60815 with no deviations**		Yes	
5	**Arrester mounting details**		xxxxxxxxx	xxxxxxxxx
5.1	Orientation		Vertical	
5.2	Method of mounting (Insulated or Earthed)		Insulated	
5.3	Diameter of mounting holes in base	mm	xxxxxx	
5.4	PCD	mm	225-300	

5.5	Supplied with all bolts, nuts, tapered washers and flat washers		Yes	
6	**Arrester line terminal**			
6.1	Type		Stem	
6.2	Diameter	mm	38	
6.3	Minimum length	mm	125	
6.4	Orientation		Vertical	
6.5	Material		xxxxxx	
7	**Arrester earth terminal**		xxxxxxxxx	xxxxxxxxx
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		xxxxxxxxx	xxxxxxxxx
7.1	Conductor material		Copper	
7.2	Conductor type		Strap	
7.3	Conductor dimensions	mm	50 x 3	
7.4	Material used for clamping arrangement		xxxxxx	
8	**Drawings to be submitted with tender(*Single copies of drawings shall be submitted as part of the original tender showing the following detail*)**		xxxxxxxxx	xxxxxxxxx
8.1	Outline dimensions of arrester, fit as for service		Reference Number:	
8.2	Mounting details		Reference Number:	
8.3	Line and earth terminal, conductor clamping arrangement		Reference Number:	
8.4	Details of grading rings		Reference Number:	
9	**Arrester characteristic data required**		xxxxxxxxx	xxxxxxxxx
9.1	V-I characteristic curve, AC		Reference Number:	
9.2	V-I characteristic curve, DC		Reference Number:	
9.3	Temporary overvoltage withstand capability curve in per unit of MCOV, with and without prior duty		Reference Number:	
10	**Physical dimensions of arresters**		xxxxxxxxx	xxxxxxxxx
10.1	Overall height of arrester	mm	xxxxxx	
10.2	Preferred external flashover distance	mm	5500	
10.3	External diameter of arrester housing	mm	xxxxxx	
10.4	Diameter of voltage grading rings	mm	xxxxxx	
10.5	Distance of grading ring from top of arrester	mm	xxxxxx	
11	**Miscellaneous:**		xxxxxxxxx	xxxxxxxxx
11.1	Total mass of assembled unit	Kg	xxxxxx	
11.2	Minimum expected life of arrester at 40°C and MCOV	yrs	30	

12	**Mechanical characteristics**		**xxxxxx**	**xxxxxx**
12.1	Minimum Specified Long-term Load(SLL)	Nm	19000	
12.2	Minimum Specified Short-term Load(SSL)	Nm	28000	
12.3	Test report confirming mechanical characteristics		Report reference number	

Annex C – - Type test report summary sheet (To be completed per item)

Item Number as per Annex A convention :									**SANS/IEC60099-4 Reference Section**
Test		**File name of electronic test report submitted**	**Applicable page number**	**Product code used in type test report**	**Full product code of item offered**	**Name of test facility and electronic file name of accreditation certificate/evidence**	**Comments**	**Outcome Passed/Failed**	
1	Insulation withstand test on the arrester housing								Lighting Impulse 10.8.2 Switching Impulse 10.8.2 Power Frequency 10.8.2
2	Residual voltage test								Steep Current 10.8.3 Switching Impulse 10.8.2 Power Frequency 10.8.3
3	Test to verify long term stability under continuous operating voltage								10.8.4
4	Repetitive charge transfer withstand								10.8.5
5	Heat dissipation behaviour verification of test sample								10.8.6
6	Operating duty test								10.8.7

Item Number as per Annex A convention :										**SANS/IEC60099-4 Reference Section**
Test		**File name of electronic test report submitted**	**Applicable page number**	**Product code used in type test report**	**Full product code of item offered**	**Name of test facility and electronic file name of accreditation certificate/evidence**	**Comments**	**Outcome Passed/Failed**		
7	Power-frequency voltage versus time									10.8.8
8	Short-circuit tests									10.8.10
9	Bending test									10.8.11
10	Seal leak rate (Applicable to units with enclosed gass volume)									10.8.13
11	Radio interference voltage (RIV) test									10.8.14
12	Test to verify the dielectric withstand of internal componenets									10.8.14 Where applicable
13	Weather ageing test/ Pollution related test as per cl. 3.2.2.f									10.8.17

Notes:

1) Should the product naming convention used in type test report differ from that of the product offered, clear unambiguous explanation must be given indicating how the product tested is applicable to that offered in the comments column provided.

2) If more than one type test is contained in a single report, page numbers must also be provided.

Annex D – - Summary sheet of drawings, outlines and characteristic curves (To be completed per item)

Item Number as per Annex A convention :

Detail/Drawing required		Electronic File name of drawing/sheet	Product code used in Drawing/Sheet	Full product code of item offered	Date of Issue	Comments	Submitted (Y/N)
1	Overall dimensions, including, creepage, shed profile, mounting details with drilling plan.						
2	Line and earth terminal type details and physical dimensions.						
3	Minimum electrical clearances.						
4	Insulating base type details and physical dimensions (where applicable).						
5	V-I characteristics (protective level characteristics) at 8/20 µs, 30/60						

Item Number as per Annex A convention :							
Detail/Drawing required		**Electronic File name of drawing/sheet**	**Product code used in Drawing/Sheet**	**Full product code of item offered**	**Date of Issue**	**Comments**	**Submitted (Y/N)**
	µs and 1/2 µs front (steep current) impulses						
6	Temporary overvoltage withstand capability curve, with and without prior duty.						

Notes:

1) If a drawing or characteristic curve is not submitted or not applicable, clear justification must be provided in the comments column. Omission of key inofmration may result in disqualification.

2) Characteristic Curves submitted as part of a test report and/or data sheet are not acceptable. Curves shall be submitted as drawings that contain the manufacturers name, logo and a unique drawing number as a minimum

3) Should the product naming convention used in the drawing/sheet differ from that of the product offered, clear unambiguous explanation must be given indicating how the product indicated is applicable to that offered in the comments column provided.

4) Clear unambiguous definitions of rated voltage, reference voltage and protective level

5) AC voltage-resistive current curves from 20°C to 180°C and Region of thermal stability information may be required before contract award or to be made available during factory inspection

Annex E – - Deviations and Declaration (To be completed per item)

Item Number as per Annex A convention :		
Deviation		**Comments**
1		
2		
3		
4		
5		
6		
7		

Notes:

1) For each item, all deviations to any requirement in this specification and associated technical schedule or annex (A-C) must be listed above with clear explanations/ justification with regards to fitness for use for the full expected life of the product.

Declaration by supplier:

With the exception of the above deviations, this specification, associated technical schedules, factory evaluation and annexes together with the requirements contained within, will be fully complied with in the manufacture, testing, supply, provision of drawing and documents, packaging, labelling, transport and delivery of the product being offered, amongst others. Further it is declared that all information provided has been checked and is correct.

Signature_______________________________________ Date: _______________

Full Name and Designation of Authorised Representative:____

SECTION 5: PARTICULARS & GUARRANTEES

PART 4.1: SURGE DIVERTORS

SPECIFICATION NO:

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMEN	OFFERED AND GUARANTEED
1	**VOLTAGE LEVELS**			
1,1	Impulse withstand at sea-level (BIL)	kV	650	
1,2	Impulse withstand at Pretoria	kV	550	
1,3	System voltage	kV	132	
1,4	Earthing configuration		solid neutral	
2	**ELECTRICAL CLEARANCES**			
2,1	Minimum distance between live grading and earth (flash-over distance)	mm	min 1 450	
2,2	Total creepage distance to earth	mm		
2,3	Total protected creepage distance to earth	mm		
3	**GENERAL DESIGN DETAILS**			
3,1	Make and type / model			
3,2	Place of manufacture			
3,3	Type of surge diverter		Station type, pedestal mounted	
3,4	Active material of diverter :			
3,5	Grading rings		Preferred	
3,6	Line terminal			
3.6.1	To take stranded Aluminium		25 mm	
3.6.2	Bi-metal interface		If required	
3.6.3	Approach		Vertical	
3,7	Earth terminals - To take copper strap		50 x 3,5 mm	
3,8	Surge diverter rated voltage	kV	120	
3,9	Nominal discharge current rating (8/20 microsecond)	kA	10	
3,10	Duty class of surge diverter		Heavy duty	
3,11	Application class of surge diverter		Station type	
3,12	Diverter reseal voltage (phase to phase)	kV r.m.s.	Min 120	
3,13	Peak residual voltage for 8/20 microsecond current impulse of the following magnitudes :			
3.13.1	1 000 A	V		
3.13.2	2 000 A	V		
3.13.3	5 000 A	V		
3.13.4	10 000 A	V	maximum 400V	
3.13.5	A	-		
3.13.6	A	-		

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMEN	OFFERED AND GUARANTEED
3,14	Conditions of high current impulse tests on surge diverter :			
3.14.1	Waveshape of impulse current	micro sec	4/10	
3.14.2	Magnitude of impulse current	kA	100 minimum	
3.14.3	Number of applications		2	
3,15	Conditions for long duration impulse current test on surge diverter :			
3.15.1	Magnitude of impulse current	A	500 minimum	
3.15.2	Duration of rectangular current wave		2 000	
3.15.3	Total number of applications		20	
3.15.4	Number of groups of applications		4	
3.15.5	Number of applications in each group		5	
3.15.6	Interval between applications in group	s	50 - 60	
3.15.7	Interval between groups of applications	minutes	25 - 30	
3,16	Long duration discharge class (Table 3 BS 2014)		2	
3,17	Conditions for operating duty test on diverter or diverter units :			
3.17.1	Wave shape of impulse current	micro sec	8/20	
3.17.2	Peak value of impulse discharge current	kA	10	
3.17.3	Total number of applications		20	
3.17.4	Number of groups of applications		4	
3.17.5	Number of applications in each group		4	
3.17.6	Interval between applications in group	s	50 - 60	
3.17.7	Interval between groups of applications	minutes	25 - 30	
3.17.8	Peak magnitude of follow current			
3.17.9	Power-frequency voltage across diverter terminals during flow of follow current not less than		100% rated voltage	
3,18	Pressure relief class rating	Class A		
3,19	Minimum prospective symmetrical fault current	kA	40	
3,20	Surge diverter insulation voltage withstand tests with internal parts removed (at sea-level) :			
3.20.1	1,2/50 microsecond wave shape impulse	kA peak	650	
3.20.2	'60 second wet 50 Hz voltage	kV r.m.s.		
3,21	Leakage current through complete surge diverter at rated system phase voltage	kA		
3,22	Voltage grading achieved by means of (non-linear resistors, capacitance etc.)		-	
3,23	State voltage distribution uniform or non-uniform		-	
3,24	Rated voltage of pro-rated diverter units stacked to form complete arrester		-	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMEN	OFFERED AND GUARANTEED
3,25	Number of resistor blocks in each prorated diverter unit (valve resistor) in each			
3.25.1	Top unit :			
	a) In series		-	
	b) In parallel		-	
	c) Total		-	
3.25.2	Bottom unit :			
	a) In series		-	
	b) In parallel		-	
	c) Total		-	
3,26	Dimensions of resistor blocks:			
3.26.1	Outside diameter	mm		
3.26.2	Length	mm		
3,27	Radio noise influence 1,0 MHz of single-phase diverter measured in accordancewith NEMA Publication 107 when diverter is energised to :			
3.27.1	80% of diverter rated voltage	micro-sec.	-	
3.27.2	100% of diverter rated voltage	micro-sec.		
3,28	Number of diverter units stacked in complete surge diverter			
3,29	Total mass assembled arrester complete surge diverter	kg	Maximum	
3,30	Total mass assembled arrester complete surge diverter	kg	-	
3,31	Overall height of assembled diverter above mounting level	mm	-	
3,32	Largest major diameter over porcelain sheds	mm	-	
3,33	Largest minor diameter over porcelain sheds	mm	-	
3,34	Smallest major diameter over porcelain sheds	mm	-	
3,35	Smallest minor diameter over porcelai sheds	mm	-	
3,36	Filling medium of surge arrestor housing (nitrogen, air, etc.)		-	
3,37	Method of sealing surge arrestor units	m	-	
3,38	Altitude above sea-level corresponding to internal pressure of sealed surge arrester	m		
3,39	Maximum ambient temperature rating of diverter	Deg C	-	
3,40	Maximum ambient temperature rating of diverter	Deg C		
3,41	Maximum wind speeds that complete surge diverter mounted on insulating base will withstand :			
3.41.1	Steady wind conditions	km/h		
3.41.2	Gusty conditions	km/h		
3,42	Ultimate bending moment rating for surge diverter	Nm		

SECTION 5: PARTICULARS & GUARRANTEES

PART 4.1: SURGE DIVERTORS

SPECIFICATION NO:

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMEN	OFFERED AND GUARANTEED
1	**VOLTAGE LEVELS**			
1,1	Impulse withstand at sea-level (BIL)	kV	1050	
1,3	System voltage	kV	275	
1,4	Earthing configuration		solid neutral	
2	**ELECTRICAL CLEARANCES**			
2,1	Minimum distance between live grading and earth (flash-over distance)	mm	2350 (minimum)	
2,2	Total creepage distance to earth	mm		
2,3	Total protected creepage distance to earth	mm		
3	**GENERAL DESIGN DETAILS**			
3,1	Make and type / model			
3,2	Place of manufacture			
3,3	Type of surge diverter		Station type, pedestal mounted	
3,4	Active material of diverter :			
3,5	Grading rings		Preferred	
3,6	Line terminal			
3.6.1	To take stranded Aluminium		25 mm	
3.6.2	Bi-metal interface		If required	
3.6.3	Approach		Vertical	
3,7	Earth terminals - To take copper strap		50 x 3,5 mm	
3,8	Surge diverter rated voltage	kV	180	
3,9	Nominal discharge current rating (8/20 microsecond)	kA	10	
3,10	Duty class of surge diverter		Heavy duty	
3,11	Application class of surge diverter		Station type	
3,12	Diverter reseal voltage (phase to phase)	kV r.m.s.	Min 120	
3,13	Peak residual voltage for 8/20 microsecond current impulse of the following magnitudes :			
3.13.1	10kA	kV(peak)		
3.13.2	20kA	kV(peak)		
3.13.3	30kA	kV(peak)		
3.13.4	1 micro second (not greater than)	kV(peak)	612	
3.13.5	IEC long duration Class		3	
3.13.6				

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMEN	OFFERED AND GUARANTEED
3,14	Conditions of high current impulse tests on surge diverter :			
3.14.1	High current (4/10 micro second)	kA (peak)	100	
3.14.2	Magnitude of impulse current	kA	100 minimum	
3.14.3	Number of applications		2	
3,15	Conditions for long duration impulse current test on surge diverter :			
3.15.1	Magnitude of impulse current	A	500 minimum	
3.15.2	Duration of rectangular current wave		2 000	
3.15.3	Total number of applications		20	
3.15.4	Number of groups of applications		4	
3.15.5	Number of applications in each group		5	
3.15.6	Interval between applications in group	s	50 - 60	
3.15.7	Interval between groups of applications	minutes	25 - 30	
3,16	Long duration discharge class (Table 3 BS 2014)		2	
3,17	Conditions for operating duty test on diverter or diverter units :			
3.17.1	Wave shape of impulse current	micro sec	8/20	
3.17.2	Peak value of impulse discharge current	kA	10	
3.17.3	Total number of applications		20	
3.17.4	Number of groups of applications		4	
3.17.5	Number of applications in each group		4	
3.17.6	Interval between applications in group	s	50 - 60	
3.17.7	Interval between groups of applications	minutes	25 - 30	
3.17.8	Peak magnitude of follow current			
3.17.9	Power-frequency voltage across diverter terminals during flow of follow current not less than		100% rated voltage	
3,18	Pressure relief class rating	Class A		
3,19	Minimum prospective symmetrical fault current	kA	40	
3,20	Surge diverter insulation voltage withstand tests with internal parts removed (at sea-level) :			
3.20.1	1,2/50 microsecond wave shape impulse	kA peak	650	
3.20.2	'60 second wet 50 Hz voltage	kV r.m.s.		
3,21	Leakage current through complete surge diverter at rated system phase voltage	kA		
3,22	Voltage grading achieved by means of (non-linear resistors, capacitance etc.)		-	
3,23	State voltage distribution uniform or non-uniform		-	
3,24	Rated voltage of pro-rated diverter units stacked to form complete arrester		-	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMEN	OFFERED AND GUARANTEED
3,25	Number of resistor blocks in each prorated diverter unit (valve resistor) in each			
3.25.1	Top unit :			
	a) In series		-	
	b) In parallel		-	
	c) Total		-	
3.25.2	Bottom unit :			
	a) In series		-	
	b) In parallel		-	
	c) Total		-	
3,26	Dimensions of resistor blocks:			
3.26.1	Outside diameter	mm		
3.26.2	Length	mm		
3,27	Radio noise influence 1,0 MHz of single-phase diverter measured in accordancewith NEMA Publication 107 when diverter is energised to :			
3.27.1	80% of diverter rated voltage	micro-sec.	-	
3.27.2	100% of diverter rated voltage	micro-sec.		
3,28	Number of diverter units stacked in complete surge diverter			
3,29	Total mass assembled arrester complete surge diverter	kg	Maximum	
3,30	Total mass assembled arrester complete surge diverter	kg	-	
3,31	Overall height of assembled diverter above mounting level	mm	-	
3,32	Largest major diameter over porcelain sheds	mm	-	
3,33	Largest minor diameter over porcelain sheds	mm	-	
3,34	Smallest major diameter over porcelain sheds	mm	-	
3,35	Smallest minor diameter over porcelai sheds	mm	-	
3,36	Filling medium of surge arrestor housing (nitrogen, air, etc.)		-	
3,37	Method of sealing surge arrestor units	m	-	
3,38	Altitude above sea-level corresponding to internal pressure of sealed surge arrester	m		
3,39	Maximum ambient temperature rating of diverter	Deg C	-	
3,40	Maximum ambient temperature rating of diverter	Deg C		
3,41	Maximum wind speeds that complete surge diverter mounted on insulating base will withstand :			
3.41.1	Steady wind conditions	km/h		
3.41.2	Gusty conditions	km/h		
3,42	Ultimate bending moment rating for surge diverter	Nm		
	Colour of housing			
	Type of housing (Porcelain of Silicone Polymer)		Silicone Polymer	

ITEM NO	DESCRIPTION	UNIT	SPECIFIED REQUIREMEN	OFFERED AND GUARANTEED

Eskom	Standard	Technology

Title: **ESKOM STANDARD FOR CAPACITOR VOLTAGE TRANSFORMERS**

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SCOT Study Committee Number/Name: **Plant Equipment**

Content

Figures

Tables

1. Introduction

This standard stipulates Eskom's requirements for designing, manufacturing and testing of capacitor voltage transformers connected between line and ground for system nominal voltage of 66kV up to 765kV. They are intended to supply a low voltage for measurement, control and protective functions. The capacitor voltage transformer must be equipped with carrier-frequency accessories for power line carrier-frequency (PLC) application at carrier frequencies from 40kHz to 500kHz.

The requirements stipulated in this document are based on international practices combined with Eskom's experiences. The requirements are specified to ensure the integrity of the product thereby minimising the risk of failure of equipment.

2. Supporting clauses

2.1 Scope

This standard detail the requirements applicable to capacitor voltage transformers used in Eskom for nominal voltages of 66kV up to 765kV. This specification must be read in conjunction with IEC 61869-1, IEC 61869-5 and IEC 60358.

Capacitive Voltage transformers (CVTs) at 220kV and higher are required to operate in conjunction with high-speed protection apparatus and the transient response requirements at these voltages are very stringent. At 132kV and lower voltages the CVTs transient response requirements are not particularly stringent.

2.1.1 Purpose

The document is written to capture and standardise Eskom capacitor voltage transformer requirements.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] IEC 60085: Electrical insulation – Thermal classification

[2] IEC 60099-1: Surge arresters, Part 1. Non-linear resistor type gapped surge arresters for a.c. systems.

[3] IEC 60129: Alternating current disconnections (isolators) and earthing switches.

[4] IEC 60270: High voltage test techniques - Partial discharge measurements.

[5] IEC 60296: Fluids for electro technical applications unused mineral insulating oils for transformers and switchgear

[6] IEC 60358: Coupling capacitors and capacitor dividers.

[7] IEC 60481: Coupling devices for power line carrier systems

[8] IEC 60529: Degrees of protection provided by enclosures (IP code)

[9] IEC 60694: Common specifications for high-voltage switchgear and controlgear standards

[10] IEC 60815: Guide for the selection of insulators in respect of polluted conditions

[11] IEC 61869-1: Instrument Transformers – Part 1: General

[12] IEC 61869-3: Instrument Transformers – Part 3: Additional requirements for inductive voltage transformers

[13] IEC 61869-5: Instrument Transformers – Part 2: Additional requirements for capacitor voltage transformers

[14] IEC 62271-2: High-voltage switchgear and controlgear – Part 2: Seismic qualification for rated voltages of 72.5 kV and above.

[15] CISPR 18-2: Radio interference characteristics of overhead power lines and high-voltage equipment – Part 2: Methods of measurement and procedure for determining limits

[16] BS EN ISO 2081: 2008: Metallic and other inorganic coatings – Electrodeposited Coatings of Zinc with Supplementary Treatment on Iron or Steel.

[17] BS 1872:1984: Specification for electroplated coatings of tin.

[18] BS 7371-12 2008: Coatings on metal fasteners, requirements for imperial fasteners

[19] 240-57648739 – Powerline carrier line traps and associated post insulators

[20] 240-75655504 – Corrosion protection standard for new indoor and outdoor Eskom equipment, components, materials, and structures manufactured from steel

[21] 240-146088685 – Eskom Standard for Coupling Capacitors Used for Power Line Carrier-Frequency (PLC) applications

Note: Some IEC documents mentioned above are available from SABS with the same number preceded by SANS.

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

Definition	Description
Burden	admittance (or impedance) of the secondary circuit expressed in siemens (or ohms) and power factor
capacitance tolerance	permissible difference between the actual capacitance and the rated capacitance under specified conditions
Capacitor	two terminal device characterized essentially by its capacitance
Capacitor element	device consisting essentially of two electrodes separated by a dielectric
capacitor losses	active power dissipated in the capacitor
Capacitor stack	an assembly of capacitor units connected in series
Capacitor unit	assembly of one or more capacitor elements in the same container with terminals brought out
Capacitor voltage divider	capacitor stack forming an alternating voltage divider
Capacitor voltage transformer	A voltage transformer comprising a capacitor divider unit and an electromagnetic unit so designed and interconnected that the secondary voltage of the electromagnetic unit is substantially proportional to the primary voltage, and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections.
carrier earthing switch	switch for earthing, when necessary, of the low voltage terminal

Definition	Description
carrier-frequency accessories	circuit element intended to permit the injection of carrier frequency signal and which is connected between the low voltage terminal of a capacitor divider unit and earth, having an impedance which is insignificant at power frequency, but appreciable at the carrier frequency
compensating inductance (L)	inductance which is usually connected between the intermediate terminal and the high voltage terminal of the primary winding of the intermediate transformer or between earth terminal and the earth-side terminal of the primary winding of the intermediate transformer or incorporated in the primary and secondary windings of the intermediate transformer
Coupling capacitor	Capacitor used for the transmission of signals in a power system
Creepage Distance	shortest distance, or the sum of the shortest distances, along the insulating parts of the insulator between those parts which normally have the operating voltage between them
damping device	device incorporated in the electromagnetic unit for the purposes of: • limiting overvoltages which may appear across one or more components; • and/or to prevent sustained ferro-resonance; • and or to achieve a higher performance of the transient response of the capacitor voltage transformer
dielectric of a capacitor	insulating material between the electrodes
drain coil	inductance which is connected between the low voltage terminal of a capacitor divider and earth, and whose impedance is insignificant at power frequency, but has a high value at the carrier frequency
electromagnetic unit	component of a capacitor voltage transformer, connected between the intermediate voltage terminal and the earth terminal of the capacitor divider (or possibly directly connected to earth when a carrier-frequency coupling device is used) which supplies the secondary voltage
Enclosure	housing affording the type and degree of protection suitable for the intended application
equivalent series resistance of a capacitor	virtual resistance which, if connected in series with an ideal capacitor of capacitance value equal to that of the capacitor in question, would have a power loss equal to the active power dissipated in that capacitor under specified operating conditions at a given high frequency
Ferro-resonance	Sustained resonance of a circuit consisting of a capacitance with a non-linear saturable magnetic inductance and a voltage ac-source for excitation.
high frequency capacitance (of a capacitor)	effective capacitance at a given frequency resulting from the joint effect of the intrinsic capacitance and the self-inductance of the capacitor
high voltage capacitor (of a capacitor divider) (C_1)	capacitor connected between the high voltage terminal and the intermediate voltage terminal of a capacitor divider
intermediate transformer	voltage transformer in which the secondary voltage, in normal conditions of use, is substantially proportional to the primary voltage
intermediate voltage capacitor (of a capacitor divider) (C_2)	capacitor connected between the intermediate voltage and the low voltage terminals of a capacitor divider

Definition	Description
intermediate voltage of a capacitor divider (U_2)	voltage between the intermediate voltage terminal of the capacitor divider and the low voltage terminal, when the primary voltage is applied between the high and low voltage terminals or high voltage terminal and earth terminal
Line terminal	A terminal intended for connection to a line conductor of a network
Line trap-connected CVT	CVT which supports a line trap on its top
low voltage terminal of a capacitor divider	terminal intended for connection to earth either directly or via an impedance of negligible value at network frequency
Measuring voltage transformer	A voltage transformer intended to transmit an information signal to measuring instruments, integrating meters and similar apparatus
Mechanical load (F)	forces on different parts of the instrument transformer as a function of four main forces: • forces on the terminals due to the line connections • forces due to the wind • seismic forces • electro dynamic forces due to short circuit current
Nominal voltage of a system (U_n)	highest value of the phase-to-phase operating voltage (r.m.s. value) which occurs under normal operating conditions at any time and at any point in the system
Phase displacement ($\Delta\phi$)	difference in phase between the primary voltage or current and the secondary voltage or current phasors, the direction of the phasors being so chosen that the angle is zero for an ideal transformer
Primary terminals	terminals to which the voltage or current to be transformed is applied
Protective voltage transformer	A voltage transformer intended to transmit an information signal to electrical protective and control devices
Rated burden	value of the burden on which the accuracy requirements of this specification are based
Rated capacitance of a capacitor (C_r)	The capacitance value for which the capacitor has been designed
Rated insulation level	combination of voltage values which characterizes the insulation of a capacitor voltage transformer with regard to its capability to withstand dielectric stresses.
rated primary voltage	value of the primary voltage which appears in the designation of the voltage transformer and on which its performance is based
rated secondary voltage	value of the secondary voltage which appears in the designation of the voltage transformer and on which its performance is based
Rated temperature category of a CVT	A range of temperature of the ambient air or of the cooling medium for which the capacitor voltage transformer has been designed.
rated voltage factor	multiplying factor to be applied to the rated primary voltage U_{Pr} to determine the maximum voltage at which a transformer must comply with the relevant thermal requirements for a specified time and with the relevant accuracy requirements
Ratio error (ε)	the error which an instrument transformer introduces into the measurement and which arises from the fact that the actual transformation ratio is not equal to the rated transformation ratio

Definition	Description
Secondary terminals	terminals which transmit an information signal to measuring instruments, meters and protective or control devices or similar apparatus
Secondary winding	A winding which supplies the voltage circuits of measuring instruments, meters, protective or control devices.
Section	electrically conductive part of an instrument transformer insulated from other similar parts and equipped with terminals
stray capacitance of the low voltage terminal	stray capacitance between the low voltage terminal and the earth terminal
stray conductance of the low voltage terminal	stray conductance between the low voltage terminal and the earth terminal
tangent of the loss angle (tan δ) of a capacitor	ratio between the active power P_a and the reactive power P_r: tan δ = P_a/P_r
temperature coefficient of capacitance (T_C)	fractional change of the capacitance for a given change in temperature
Transient response	Measured fidelity of the secondary-voltage waveform, compared with the voltage waveform at the high-voltage terminal under transient conditions.
Unified specific creepage distance	creepage distance of an insulator divided by the r.m.s. value of the highest operating voltage across the insulator and is expressed in mm/kV
voltage limitation element	element connected across the drain coil or between low voltage terminal of the capacitor voltage divider and earth to limit the transient overvoltages which may appear across the drain coil
voltage ratio (of a capacitor divider) (K_C)	ratio of the voltage applied to the capacitor divider to the open-circuit intermediate voltage
Voltage-connected CVT	CVT which has only one connection to the high voltage line.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
C_1	high voltage capacitor (of a capacitive divider)
C_2	intermediate voltage capacitor (of a capacitive divider)
CC	Coupling Capacitor
Cr	rated capacitance of a capacitor
CVT	Capacitive Voltage Transformer
F	mechanical load
f_R	rated frequency

Abbreviation	Description
F_V	rated voltage factor
k	actual transformation ratio
K_C	voltage ratio (of a capacitive divider)
k_r	rated transformation ratio
L	Compensating inductance
PLC	Power Line Carrier
S_r	rated output
Tan δ	tangent of loss angle of a capacitor
T_C	temperature coefficient of capacitance
Um	highest voltage for equipment
Un	system nominal voltage
VT	Voltage Transformer
Δϕ	phase displacement
ε	ratio error
ε_U	voltage ratio error

2.5 Roles and responsibilities

All the Eskom employees and/or appointed bodies involved in the procurement of capacitor voltage transformers shall ensure that the product meets the requirements of this standard. Any deviation from these requirements shall constitute a non-conformance, unless if approved in advance by a delegated Eskom instrument transformers specialist in writing and is based on sound engineering judgement.

All the Contractors supplying capacitor voltage transformers to Eskom must be conversant with the requirements of this specification and shall comply with the requirements. All the deviations shall be clearly listed in the deviation schedule as part of the tender deliverables. No deviations will be accepted unless approved by Eskom in writing.

The Eskom Instrument Transformer Care Group shall be responsible for ensuring the validity of this document.

2.6 Process for monitoring

This document and its relevance will be evaluated by the instrument transformers Care Group.

2.7 Related/supporting documents

Not applicable.

3. General requirements

The schedule A of the relevant A/B schedules shall form part of this specification and they shall take precedence over this specification in case the two documents are conflicting.

3.1 Life expectancy

The life expectancy of capacitor voltage transformers under normal service conditions shall be 25 years.

3.2 Warranty

a) Eskom only accepts capacitor voltage transformers with a minimum warranty of 5 years.

3.3 Standard service conditions

Unless otherwise specified in schedule A, the following standard conditions shall apply:

a) Outdoors

b) Ambient temperatures:

1) Minimum: -10ºC

2) Maximum: 50ºC

3) Daily average 30ºC

4) Maximum diurnal variation: 35ºC

5) Yearly daily average: 25ºC

c) Altitude: Up to 1800m above sea level

d) Solar radiation: 2500 kWh/m^2

e) Relative humidity: Not exceeding 95% (measured for a period of 24 hours)

f) Wind Pressure: 700 Pa (corresponding to a 34m/s wind speed)

g) Seismic shock: 0.3g (IEEE 693 – moderate level)

h) Lightning: Extremely severe

3.4 System earthing

For operating voltages of 132 kV or higher, the system shall be considered as effectively earthed, and for less than 132 kV to be non-effectively earthed.

3.5 Capacitor Voltage Transformers

a) All capacitor voltage transformers shall also be suitable for coupling carrier current equipment to the high voltage system.

b) The capacitor voltage divider (CVD) unit of the CVT shall comply with all the requirements of 240-146088685 and IEC 60358.

c) The electromagnetic unit (EMU) of the CVT shall be in a tank forming the base of the unit, with the connection between the intermediate voltage terminal on the capacitor stack and the primary terminal of the EMU internal to the CVT.

d) In addition to the EMU, the base of the CVT shall house the carrier auxiliary devices. The line matching equipment does not form part of the CVT and is covered in a separate specification.

e) When specified, CVTs will be used to support line traps. The electrical connections between the trap and the associated CVT shall be provided by the manufacturer. However, if the line trap supports are independent of the CVT, the high voltage terminals on the CVT shall comply with the details specified schedule A of an enquiry document.

f) When line traps are mounted on CVTs the manufacturer shall ensure that sufficient clearance exists between the line trap and CVT so that the effects of induction heating of the CVT by the line trap, and detuning of the line trap by metal components on the CVT are avoided.

g) The tank of each unit shall be fitted with a threaded earthing terminal of not less than 16 mm in diameter. Earthing terminals shall be suitable for accommodating a 50mm x 3mm copper earthing strap or, alternatively, clamps of an approved type shall be provided for this purpose.

3.6 Carrier – frequency accessories

a) The carrier-frequency accessories, comprising a drain coil and a protective device, shall be connected between the low voltage terminal of the capacitor voltage divider and the earth terminal as shown in figure 5A.2 (IEC 61869-5).

b) When a carrier-frequency accessory is connected by the manufacturer into the earth lead of the intermediate voltage capacitor, the accuracy of the capacitor voltage transformer shall remain within the specified accuracy class.

c) The requirements for the complete coupling device are specified in IEC 60481.

3.6.1 Drain Coil

The drain coil shall be so designed that:

a) The drain coil shall be permanently connected between the carrier terminal and the earth terminal of the capacitor voltage divider.

b) The drain coil shall have an inductance of 40mH and shall present an impedance of more than 10kΩ throughout the carrier frequency range of 50kHz to 500kHz.

c) The impedance at power frequency between the primary and earth terminals of the coupling device should be as low as possible and in no case exceed 20Ω.

d) the current-carrying capability at power frequency is as follows:

   i) continuous operation: 1A r.m.s.

   ii) short-time current: 50A rms for 0.2s

e) The drain coil shall have a 1.2/5μs impulse withstand insulation of 10kV.

3.6.2 Surge Arrester

a) The surge arrester shall be permanently connected across the drain coil between the carrier terminal and the earth terminal of the CC and shall be of the gapped type. (IEC 600099-1: Surge arresters, Part 1).

b) The surge arrester shall not be operated, or remain in operation following transient actuation, by the carrier frequency voltage developed across the unit by the specified carrier frequency peak envelope power (PEP).

c) The surge arrester shall have a rated voltage and impulse spark-over voltage consistent with the requirements of 3.6.2 b), and shall be capable of sustaining an impulse discharge current of wave shape 8/2μs of 5kA

3.6.3 Earthing switch

a) The earthing switch shall be permanently connected across the drain coil and surge arrester.

b) The earthing switch shall be provided with an operating lever which shall be external to the capacitor base enclosure and which shall be insulated to 2kV r.m.s. for 1s. The lever shall clearly indicate the position in which the carrier terminal is earthed and shall, when in the "Open" or "Off" position, be connected to the "earth" side of the switch.

c) The earthing switch shall have a continuous and short-time current rating as specified for the drain coil in 3.6.1 d) and shall have a 5kA 8/2 μs impulse current capability.

4. Ratings

4.1 General

The common ratings of instrument transformers, including their auxiliary equipment if applicable, should be selected from the following:

a) Highest voltage for equipment (U_m);

b) Rated insulation level;

c) Rated frequency (f_R) and

d) Rated accuracy class

The rating applies at the standardized reference atmosphere (temperature (20°C), pressure (101,3 kPa) and humidity (11 g/m^3)) specified in IEC 60071-1.

4.2 Insulation requirements

These requirements shall apply to all types of capacitor voltage transformer insulation. The rated insulation levels for capacitor voltage transformers shall comply with the requirements in Table 1.

Table 1: Rationalized Voltage Ratings

Eskom Nominal System Voltage (Un) (kV)	Equipment Nominal Voltage Rating (U_m) (kV)	Rated Lightning Impulse Withstand Voltage (kV peak at 1 000 m AMSL)	Rated Power Frequency Withstand Voltage (kV rms at 1 000 m AMSL)	Rated switching withstand voltage (peak) (kV)
66	72.5	350	140	
88	100	450	185	
132	145	650	275	
220	245	850	360	
275	300	1050	460	850
400	420	1425	630	1050
765	800	2100	975	1550

Note: The rated insulation withstand levels for lightning impulse and short time power frequency withstand are specified in Table 1. The service conditions for South Africa are rationalized for altitudes up to 1 800m. Although the insulation levels in Table 1 are specified at an altitude of 0 m to 1 000 m, the values have been selected for appropriate insulation coordination for altitudes up to 1 800 m and need not be corrected for altitude. The CVTs should be supplied with standard values as per Table 1 Test values must, however, be corrected for deviations from the standard reference atmospheric conditions.

4.3 Rated primary terminal insulation level

a) The rated primary terminal insulation level of a capacitor voltage transformer shall be based on its highest voltage for equipment U_m according to Table 1.

b) Primary terminals intended to be earthed in service have Um = 0.72 kV.

c) Primary terminals shall be made of Aluminium.

d) Primary terminals shall be of the type and orientation specified in technical schedule A.

4.4 Other requirements for primary terminals

4.4.1 Partial discharges

a) Partial discharge requirements are applicable to capacitor voltage transformers having $U_m \geq 7.2$kV and the level shall not exceed limits specified in Table 2.

Table 2: – Partial discharge test voltages and permissible levels

Type of earthing of the neutral system	PD test voltage (r.m.s.) kV	Maximum permissible PD level PC	
		Liquid or gas insulation	Solid insulation
Earthed Neutral	U_m	10	50
	$1.2\ U_m/\sqrt{3}$	5	20
Non effectively earthed	$1.2U_m$	10	50
	$1.2\ U_m/\sqrt{3}$	5	20

4.4.2 Chopped impulse

a) Capacitor voltage transformers shall be capable to withstand a chopped lighting impulse voltage applied to primary terminals having a peak value of 115% of rated lightning impulse withstand voltage.

b) In the case of CVTs, capacitor dividers and capacitor units, this test is a mandatory type test to check the design of the internal serial connections of the capacitor elements.

4.4.3 Capacitance and dielectric dissipation factor

a) The capacitance C of a unit, a stack and a capacitor voltage divider, measured at U_{Pr} and ambient temperature, shall not differ from the rated capacitance by more than −5 % to +10 %.

b) The ratio of the capacitances of any two units forming part of a capacitor stack shall not differ by more than 5 % from the reciprocal ratio of the rated voltages of the units.

c) Acceptable values of dissipation factor, expressed as tan δ measured at U_{Pr} are as follows:

1) Paper: $\leq 5 \times 10^{-3}$

2) Mixed: film-paper-film and paper-film-paper $\leq 2 \times 10^{-3}$

3) Film: $\leq 1 \times 10^{-3}$

NB: tan δ values are for dielectrics which are impregnated with mineral or synthetic oil and at 20 °C (293 K).

4.4.4 Low voltage terminal of the capacitor voltage divider

a) Capacitor voltage dividers with a low-voltage terminal shall be subjected for 1 min to a test voltage between the low-voltage and earth terminals.

b) The test voltage shall be an a.c. voltage of 4 kV (r.m.s. value).

4.4.5 Between-section insulation requirements

a) For interconnected terminal of each section, the rated power frequency withstand voltage of insulation between sections shall be 3kV.

4.4.6 Insulation requirements for secondary terminals

a) The rated power-frequency withstand voltage for secondary terminals insulation shall be 3kV.

b) The rated withstand voltage for inter-turn insulation shall be 4.5 kV peak

4.4.7 Electromagnetic unit insulation requirements

a) The rated lightning impulse withstand voltage of the electromagnetic unit shall be equal to the:

$$test\ impulse\ voltage\ of\ CVT * \frac{C_1}{C_1 + C_2}(peak)$$

b) The rated short-duration power-frequency withstand voltage of the electromagnetic unit shall be equal to:

$$U_{Pr} * 3.3 * \frac{C_1}{C_1 + C_2}(r.m.s.)$$

Notes:

The tests a) can be performed on a complete capacitor voltage transformer.

For the test b) the electromagnetic unit may be disconnected from the capacitor divider.

The factor 3.3 is fixed for all U_m values and covers the worst case.

4.5 Rated frequency

a) The standard rated frequency value is 50Hz.

b) For measuring accuracy classes, the rated frequency range is from 99 % to 101 % of the rated frequency.

c) For protective accuracy classes, the rated frequency range is from 96 % to 102 % of the rated frequency.

4.6 Rated output

a) The rated output for each secondary winding, at the rated secondary voltage and rated frequency, expressed in VA at unity power factor will be specified in the schedule A of an enquiry document.

b) The rated burden for each secondary winding is the impedance expressed in Ω with the effective resistance and reactance components. The burden is usually specified as the apparent power in VA absorbed at a specified power factor, rated secondary voltage, and rated frequency.

c) When, during testing, the voltage must vary from the rated value, the burden impedance in Ω stays the same and the apparent power in VA varies accordingly.

d) This standard requires only unity power factor i.e., the required burden is purely resistive.

e) Should damping resistors be required, these shall not form part of the burden specified.

4.7 Rated accuracy class

a) The accuracy class designation for measurement winding of capacitor voltage transformers and their respective percentage voltage (ratio) error and phase displacement is given in IEC 61869-5.

b) The accuracy class designation for protection windings of capacitor voltage transformers and their respective percentage voltage (ratio) error and phase displacement is given in IEC 61869-5.

c) The accuracy class requirements for this enquiry of the protection and metering windings will be specified in the schedule A of an enquiry document.

d) The CVT shall be supplied complete with all settings and adjustments made in the factory to meet the accuracy requirements of this specification.

e) In certain cases, Eskom may wish to use the CVT as a power transformer. Manufacturers shall indicate the maximum continuous rating in kVA and the power factor of their CVTs when they are used as a power transformer, with a maximum voltage regulation of 15% of the rated secondary voltage without exceeding the permissible temperature rise.

4.8 Rated primary voltage (U_{Pr})

a) The standard values of rated primary voltage of a capacitor voltage transformer connected between one line of a three-phase system and earth or between a system neutral point and earth shall be 1/ √3 times the values of rated system voltage.

b) Standard rated system voltage values used in Eskom are given in Table 1.

c) Should non-standard primary voltages be required, these shall be stated in technical schedule A of an enquiry document.

4.9 Rated secondary voltage (U_{Sr})

a) The standard secondary voltages of a capacitor voltage transformers connected between one phase and earth in a three-phase system is 110/√3V.

b) Should non-standard secondary voltages be required, these shall be stated in technical schedule A of an enquiry document.

4.10 Rated voltage factor

a) The CVT shall be capable of operating continuously with a rated voltage factor of 1.2.

b) The CVT shall be capable of operating for 30s with a rated voltage factor of 1.5 for effectively earthed systems.

c) The CVT shall be capable of operating for 30s with a rated voltage factor of 1.9 for non-effectively earthed systems.

4.11 Secondary Windings

a) The capacitor voltage transformer shall have three secondary output windings when used for system voltages of 220kV and above, and two windings for system voltages at 132kV and lower.

b) Where the capacitor voltage transformer has three secondary output windings, one will be used for the Main 1 protection, the second for Main 2 protection and the third for metering. These three secondary windings shall be independent of each other, and the overall design shall be such that the windings have minimal mutual effect on each other.

c) The secondary windings of the CVT shall be capable of withstanding an AC. test voltage of 2kV r.m.s. for 1 min, between all the secondary windings connected together and earth, the frame, case, core and all terminals of the primary windings.

d) In addition, each secondary winding shall be capable of withstanding the same test between it and all other windings connected together, and to the frame, case and earth.

5. Design

5.1 Requirements for liquids used in equipment

5.1.1 General

a) The manufacturer shall specify the type and the required quantity and quality of the liquid to be used in the equipment in schedule B.

b) Facilities for oil filling and draining shall be provided. These facilities shall be suitably sealed below the normal operating oil level and shall not leak oil when the transformer is tested.

c) If so specified in schedule A, oil sample valves shall be provided. Details of the oil sample valves shall be submitted for approval before manufacturing is undertaken.

5.1.2 Liquid quality

a) For oil-filled equipment, insulating oil shall comply with IEC 60296.

b) For synthetic liquid-filled equipment refer to IEC 60867.

5.1.3 Liquid level device

a) Where a dry air unit gas cushion is employed, oil gauges suitable for reading at 6m shall be provided.

b) Oil gauges shall be of the prismatic type securely attached throughout their periphery to the tank, conservator or expansion chamber. The oil chamber shall not be in communication with the outside atmosphere.

c) The device for checking the liquid level shall indicate whether the liquid level is within the operating range, during operation.

d) Where an available volume system (i.e. no gas cushion) is employed, a bellows-operated oil level indicator shall be provided. Bellows shall be of stainless steel.

5.1.4 Liquid tightness

a) No liquid loss is permitted (i.e. capacitor voltage transformers shall be hermetically sealed). Any liquid loss represents a danger of insulation contamination.

b) A capacitor unit or the complete assembled capacitor voltage divider shall be tight in the full temperature range specified for the applicable temperature category.

c) The electromagnetic unit shall be tight in the full temperature range specified for the applicable temperature category.

5.1.5 Gasket joints

a) All gasket joints shall be below oil level, unless otherwise approved.

b) Be provided with gasket material of an approved type.

c) Oil-resisting synthetic rubber gaskets are not acceptable except where synthetic rubber is used as a bonding medium for cork or similar material, or alternatively, where steel stops are provided to prevent over compression of the gaskets.

5.2 Requirements for temperature rise

a) The temperature-rise limits of the EMU and any other parts of capacitor voltage transformers are stated in IEC 61869-1.

b) The manufacturer shall clearly state in schedule B of an enquiry document the class of insulation of the EMU.

c) The temperature rise of the EMU at a rated voltage U_{pr} times rated voltage factor 1.2 at rated frequency and at total rated burden with unity power factor shall not exceed the limits stated in IEC 61869-1.

d) The temperature rise when tested under identical conditions to paragraph 3.3 with a voltage factor of 1.5 or 1.9 (as relevant) for 30 s, shall not exceed the limits given Table 5 of IEC 61869-1 by more than 10°C. If the transformer is tested starting from the cold condition, the winding temperature rise shall not exceed 10°C.

e) The lowest class of insulation used in the EMU, either of the winding itself or of the surrounding medium in which it is embedded, shall be used for specifying the class of insulation used.

5.2.1 Core, windings and connections

a) The core and windings of the EMU shall be capable of withstanding, for 1s, the mechanical and thermal effects resulting from a short circuit on any secondary terminals, with 1.2 times rated voltage Un maintained on the high voltage terminal of the CVT. The maximum permissible temperature rise of the windings under these conditions shall not exceed the temperature given in IEC 61869-1 for the type of insulation used.

b) All coils and connections shall be supported to maintain their clearance distance from each other and from earthed metal under short circuit conditions and during transport, and shall be free from vibration in normal service.

c) All winding insulation shall be treated to ensure that there will be no appreciable shrinkage after assembly.

d) The nuts and bolts of the assembly and clamping structure shall be so locked that they will not be loosened by vibration.

e) The potential of the core (or cores) shall be controlled by direct single-point connection to earth, or to the winding (or windings), or by other approved means. Normal clamping of the core for bracing will not be considered acceptable earthing.

5.3 Influence of altitude on temperature-rise

If a CVT is specified for service at an altitude in excess of 1 000m and tested at an altitude below 1 000m, the limits of temperature rise shall be reduced by the following amounts for each 100m that the altitude at the operating site exceeds 1 000 m:

a) Oil-immersed capacitor voltage transformers: 0.4%.

5.4 Electromagnetic unit carrier frequency insertion loss

a) The carrier frequency insertion loss of the CVT, produced by the addition of the electromagnetic unit, shall not exceed 0.5dB over the carrier frequency range of 50kHz to 500kHz.

5.4.1 Protective gap settings

a) Protective gaps across the intermediate voltage terminal, when fitted, shall not spark over at less than twice the intermediate voltage that occurs with the rated voltage applied to the high voltage terminal of the CVT.

b) Gaps across the series reactor, if fitted, shall withstand a voltage equivalent to the voltage drop which occurs at twice the total rated burden.

5.4.2 Electromagnetic unit primary earth switch

a) Earthing switches for earthing the primary of the EMU circuit are not required.

5.5 Requirements for earthing

a) The tank of CVT shall be provided with an earthing terminal for connection to an earthing conductor. The connecting point shall be marked with the earth symbol.

b) All metal parts which do not belong to a main or an auxiliary circuit, shall be earthed.

5.6 Requirements for external insulation

a) For outdoor capacitor voltage transformers with ceramic (porcelain) susceptible to contamination, the creepage distance of 25mm/kV or 31mm/kV shall be used. This shall be stated in schedule A.

NB: Ratio of the creepage distance between phase and earth over the r.m.s. phase-to-phase value of the highest voltage for the equipment (see IEC 60071-1). For further information and manufacturing tolerances on the creepage distance, see IEC 60815.

5.7 Main terminals

a) Equipment HV connection terminals shall be made of aluminium, to the dimensions specified in schedule A of an enquiry document. The manufacturer shall ensure that cast terminals are free from internal voids.

5.8 Mechanical requirements

The connecting terminals, mounted on the equipment as in service, shall be capable of withstanding, for a period of three minutes, each of the following forces:

a) A pull equivalent to 3000N without fail.

b) A pull equivalent to 1500N without any significant distortion measured at the extremity of the terminals.

c) In each case the pull is to be applied at right angles to the axis of the terminals in a plane 25mm beyond the free extremity of the terminal. Strength type tests shall be carried out on each type and rating of equipment.

5.9 Mechanical stress

a) All capacitor voltage transformers shall be designed to have a safety factor of 2.5 when subjected to a wind. loading of 1.2kPa (1200) on the projected area and a simultaneous force of 500N for 132kV and lower voltage equipment and 1500N for 220kV and higher voltage equipment, in the same direction as the wind pressure, at the top of the equipment, this latter force being due to the pull of the conductor attached to the equipment at this point.

b) Capacitor voltage transformers which are required to support line traps, as detailed in the schedules, shall comply with the requirements of stated above (a), with the additional force of the wind loading on the projected area of the line trap and the conductor pull on the line trap.

c) The effective area of cylindrical surfaces is 0.6 of the projected area. This factor may be used when calculating the wind loading on CVTs and line traps.

5.10 Electrical continuity

a) The continuity of the earthing circuits shall be ensured taking into account the thermal and electrical stresses caused by the current they may have to carry.

5.11 Degrees of protection by enclosures

a) The recommended minimum degree of protection for low-voltage control and/or auxiliary enclosures for outdoor capacitor voltage transformers is IP56.

5.12 Electromagnetic compatibility

5.12.1 Requirement for Radio Interference Voltage (RIV)

a) The requirement applies to CVTs having $U_m \geq 123$kV to be installed in air-insulated substations.

b) The radio interference voltage shall not exceed 2 500µV at $1.1 U_m / \sqrt{3}$.

5.12.2 Requirement for transmitted overvoltages

a) These requirements apply to capacitor voltage transformers having $U_m \geq 72.5$kV. The overvoltages transmitted from the primary to the secondary terminals shall not exceed the values given in Table 4.

Table 3: Transmitted overvoltage limits

Type of impulse	Air insulated capacitor voltage transformers
Peak value of applied voltage (U_p)	$1.6 * \frac{\sqrt{2}}{\sqrt{3}} * U_m$
Waveshape characteristics • conventional front time (T_1) • time to half (T_2)	 0.5μs ± 20% ≥ 50μs
Transmitted overvoltage peak limits (U_s)	1.6kV

5.13 Short circuit withstand capability

a) The capacitor voltage transformer shall be designed and constructed to withstand without damage, when energized at rated voltage, the mechanical, electrical and thermal effects of an external short circuit at the secondary winding(s) for the duration of 1s.

5.14 Transient response

Note: For voltage levels 220kV and above two transient response classes will be called for in schedule A of an enquiry document. One of them will be a transient response requirement as described in 5.14(a), 5.14(b) and 5.14(c).

a) Eskom wishes to use the capacitor voltage transformers for energizing high speed electronic distance protection. For such protection the transient response of the voltage transformer is of vital importance, and the time constant of any non-fundamental frequency components must be as short as possible when the CVT, energized at rated primary voltage at rated frequency, has this voltage suddenly reduced to zero by the application of a short circuit to its primary terminals at any point on the voltage wave. Under these conditions the characteristic of the transient voltage across the terminals of the secondary windings shall meet the constraints of frequency and damping specified in 5.14(b).

b) Protection windings of CVTs shall comply with the requirements of this clause at all values of external total (i.e. sum of all windings) burden, from rated metering burden (50VA) upwards to maximum total simultaneous burden and for primary short-circuits applied at zero instantaneous value and peak value of applied primary voltage. At burdens less than 50VA the CVT must produce a transient residual voltage of less than 5 % at 20ms.

1) Frequencies

All frequencies exhibited by the transient voltage shall lie outside one of the following frequency bands:

- 10Hz to 250Hz
- 5Hz to 500Hz
- 2Hz to 1000Hz

The choice of the applicable frequency band depends on the voltage rating of the CVT and will be specified in schedule A of an enquiry document.

2) Damping

The damping of the transient voltage shall be such that the instantaneous value of the transient secondary voltage shall not exceed a "declared percentage" of the peak value of rated secondary voltage, at a reference time after the instant of short-circuit and thereafter.

c) The combinations of frequency band, declared percentage and reference time are given in Annex B.

d) The frequency bands and damping requirements will be specified in schedule A of an enquiry document.

5.15 Ferro-resonance

a) The capacitor voltage transformer shall be designed and constructed to prevent sustained ferro-resonance oscillations.

b) When a CVT, energized at the continuous and at the short-time voltage factor with zero total external burden, has its external secondary terminals short circuited and the short circuit removed, the peak of the secondary voltage shall remain within the following constraints:

1) Amplitude

The amplitude shall not exceed 2.2 times the peak value of the rated voltage multiplied by the rated voltage factor as specified in schedule A of an enquiry document.

2) Damping

The damping of the transient voltage shall be such that the peak value, at a reference time and thereafter, shall not differ by more than 10% from the peak value of secondary test voltage. The reference time is 200ms. The r.m.s. value of secondary voltage shall revert to within steady-state accuracy limits within 2 s from the instant of removing the short-circuit.

5.16 Control of dynamic behaviour

a) To improve transient response and avoid ferro-resonance, damping device(s) may be employed. The loading resistors used in such a device shall not be considered part of the specified rated burden.

b) The damping device, if required, shall be an integral part of the unit.

c) Eskom prefers the use of conventional damping devices, i.e. circuits which do not contain any semiconductor elements.

d) In cases when required dynamic behaviour of the CVT can be achieved only by means of electronic device(s), the details of such device(s) containing principles of operation, construction and maintenance shall be supplied with the tender document.

e) The cost of such routine test equipment shall be given in schedule B of enquiry an document.

5.17 Adjustments

a) The provision for voltage ratio adjustments, after being set in the factory, shall be hermetically sealed to prevent tampering.

b) As the capacitor units and electromagnetic units are tested as composite units, which must be used together to achieve the specified accuracy and performance, each unit shall be clearly marked "To be used in conjunction with device No. ____".

5.18 Secondary terminal boxes

a) Each electromagnetic unit shall be fitted with a secondary terminal box, which shall be arranged in an accessible position and provided with a hinged or an easily removable, preferably slip-on, weatherproof cover with one fixing screw

b) The terminal box shall be provided with an un-drilled, removable, brass or aluminium gland plate having a minimum effective gland area of 75 mm x 150 mm. This gland plate shall be brass in the case of a steel box and aluminium in the case of an aluminium box, and shall be located at the bottom of the terminal box to permit vertical entry of the secondary control cables.

c) This gland plate shall be provided with a non-corrodible gauze-covered drain-and-vent-hole at least 10 mm in diameter.

d) The vertical centre line of the gland plate shall be at least 25mm beyond any projection on the base tank of the unit, to facilitate vertical entry of the cable.

e) The space between the bottom terminals and the gland plate shall be at least 75mm.

5.18.1 Secondary terminals

a) All terminals for connection to external circuits shall be to subject approval. Not more than two conductors shall be connected to any side of a terminal, so that the size of all terminals shall be suitable for the termination of two external cables of $4mm^2$ each.

5.18.2 Terminal Block

a) A rail mounted screw clamp/spring loaded insertion type terminal block suitable for the reception of hooked blade type wiring lugs shall be provided (Annex D).

b) The terminal blocks shall be of the type which compresses the terminations between two plates by means of terminal screws. Terminals shall also be spring loaded such that the action of the springs is independent of the action of the terminal screw.

c) Terminal screws shall be captive within the mouldings and the heads shall not project above the moulding when fully released. Each terminal shall accept up to two hooked blade type terminations.

d) Terminal entries shall be shrouded such that no current carrying metal is exposed when hooked blade terminations are fitted.

e) Springs shall be aged and shall withstand corrosion which might affect performance during their working life. Springs shall not carry current.

f) Cross connection facilities shall be provided for commoning two or more adjacent terminal blocks, without interfering with the terminal openings.

g) Provision shall be made for earthing of the secondary windings inside the terminal box.

5.19 Fuses

The provision of secondary fuses is not a requirement of this specification but, if supplied as part of the manufacturer's standard design, the following shall apply:

a) To permit grading with other fuses on the protection relay panels, the rating shall be the maximum which can be used to protect the secondary circuits against short-circuits without causing the capacitor protective gap to flash over.

b) Two spare fuses of each type and rating shall be supplied with each unit ordered.

c) The contractor shall provide full details of the time/current and all other relevant characteristics of the fuses.

5.20 Terminal Markings

a) The secondary terminal marking shall be as detailed in Annex C.

5.21 Creepage Distance

a) The equipment shall comply with the creepage distances as specified in IEC61869-1. The two levels, heavy and extra heavy pollution shall apply as specified in schedule A of an enquiry document.

6. General Information

6.1 Erection / Installation

a) The contractor responsible for installing capacitor voltage transformer shall be responsible for connecting the earth terminal of the capacitor voltage transformer to the station earth.

b) In addition, the low voltage terminal of the capacitor voltage divider shall be connected to the primary terminal of the line matching equipment by means of a solid 10 mm round copper bar.

NB: The line matching equipment is generally located at a convenient height for adjustment from ground level and can be up to 2 m from the low voltage terminal of the coupling capacitor.

6.2 Electromagnetic units (EMU)

6.2.1 Tanks

a) Corrugated tanks are not acceptable.

b) Tanks and fittings shall be of such a shape that water cannot collect at any point on the outside surface.

6.3 Finish

a) All ferrous surfaces shall be protected from corrosion in accordance with Eskom's Specification 240-75655504 as a minimum requirement.

b) The manufacturer shall ensure that the workmanship of all welded seams and joints, the class of weld material used and the gauge of metal to be welded, are suitable for galvanizing.

6.4 Welding

a) All welded seams and joints shall be welded on both sides. On tubing and thin sheet metal where this is not practical, the "through welding" technique may be employed. Light seal welding may be used on internal joints where no mechanical strength is required.

6.5 Mounting arrangements

a) All items of equipment, for which Eskom will provide mounting plinths, shall have the holes for the holding down bolts so arranged that the unit can be rotated through 90° on its plinth, if required. The spacing for the holding down bolts for both capacitor voltage transformers (CVTs) shall conform to the top cap arrangements specified in schedule A of an enquiry document.

6.6 Mounting of Equipment

a) All capacitor voltage transformers at all line voltages up to and including 400kV will be mounted on a “Medium Equipment Support” as detailed in Eskom drawings:

275kV:	0.54/302	or	0.54/309 (Support).		
	0.54/744	or	0.54/2214	or	0.54/3473 (Top Cap)
400kV:	0.54/302	or	0.54/309 (Support).		
	0.54/744	or	0.54/2214	or	0.54/3473 (Top Cap)

b) At the 765kV voltage level the structures for CVTs will be individually designed by Eskom to suit the specific requirements of the equipment supplied.

6.7 Marking

Rating plates shall be engraved, stamped, or embossed on stainless steel (any other material is subject to approval by Eskom) with the following information:

6.7.1 Individual capacitor units

a) Manufacturer

b) Serial number and year of manufacture

c) Rated capacitance Cr in picofarads and temperature in degree Celsius.

6.7.2 Complete CVTs on the base housing the EMU

a) Eskom order number

b) Manufacturer

c) Type number

d) Serial number

e) Measured capacitance of C_1 & C_2

f) Highest system voltage in kV e.g. 420 kV for 400 kV CVTs.

g) Rated primary and secondary voltage. e.g. 400/√3kV : 110/√3V for 400 kV CVTs

h) Rated frequency in Hz.

i) Temperature category i.e. –10 °C /+ 50 °C.

j) Insulation level given by means of two numbers separated by a stroke, the first number giving the r.m.s. value of power frequency withstand test voltage in kV, the second number giving the crest value of impulse test voltage in kV e.g. 630/1425 kV for a 400 kV CVT. Items (viii) and (xii) can be combined into one marking (e.g. 420/630/1425).

k) Rated output and corresponding accuracy class of each winding.

l) Rated voltage factor and corresponding rated time (e.g. 1.5/30 s)

m) Class of insulation of EMU portion

n) Serial numbers of capacitor units comprising the capacitor stack.

o) Insulation oil type

p) Year of manufacture

q) Total creepage distance in mm/kV.

6.8 Tests and test certificates

a) Type test certificates shall be submitted with tender returnable documents during tender stage.

b) Should the manufacturer be successful but still have outstanding type test report, the manufacturer shall agree with Eskom on the timeframe of the required type test reports.

c) Each CVT shall be delivered with one copy of all routine test certificate.

d) The routine test certificate shall be packed in a waterproof container and housed inside the terminal box of the CVT.

e) All tests shall be fully documented in English, signed by the relevant (competent) manufacturer's personnel and stamped.

f) Electronic copies must be stored by the manufacturer for a period not less than 10 years and be made available to Eskom upon request.

g) All routine test certificates shall give all relevant details of the test, in addition to the test results and where appropriate, include oscillograms or graphs of the equipment performance with the amplitude and time or frequency graduations clearly indicated.

6.9 Inspection and witnessing of tests

a) Eskom reserves the right to appoint a representative to inspect the equipment at any stage of manufacture or to be present at any of the specified tests. Such inspection shall not relieve the manufacturer of his responsibility for meeting all the requirements of the specification, and it shall not prevent subsequent rejection if such material or equipment is later found to be defective.

b) The manufacturer shall ascertain in writing whether inspection or witnessed tests, or both, are required. The manufacturer shall then give Eskom no less than seven (7) weeks' notice of when the equipment will be ready for inspection or the witnessing of the requested test.

c) Where Eskom has called for type testing of equipment, which Eskom intends to witness, the manufacture shall prepare a detailed programme for Eskom's approval. Eskom will, at its own discretion, select several people from Eskom's various departments and offices to witness these tests. All costs incurred for travelling, accommodation, etc. by these people, will be borne by Eskom.

d) In the event of the approved testing programme not being satisfactorily completed in the period agreed upon, which would require Eskom to undertake a return visit(s), all costs incurred by Eskom shall be to the manufacturer's account.

6.10 Numbering of test certificates

a) Each routine test and type test certificate shall clearly state the type of test being performed and cross refer to the appropriate test section number

7. Classification of tests

The tests specified in standard IEC 61869-5 shall apply to this Eskom specification and read in conjunction with the requirements below.

7.1 Testing

a) The standard ambient temperature range for testing is 15°C to 35°C. Actual measured values and the temperature at the time of testing shall be recorded. Values corrected to the reference temperature of 20 °C shall also be recorded.

b) The complete CVT (including the EMU) shall, where applicable, be tested as a single unit.

7.2 Waveform distortion

a) The total harmonic distortion of the test voltage for the test required shall not exceed 5%.

7.3 Routine tests

Each CVTs supplied in compliance with this specification shall be subjected to the routine tests detailed for capacitor voltage transformers in IEC 61869-1 and IEC 61869-5. The following routine tests shall be performed.

a) Power-frequency withstand test and measurement of capacitance, tan δ and partial discharge (Paragraph 7.3.1.501)

b) Power-frequency withstand test and measurement of C and tan δ on a capacitor voltage divider or on subsystems (Paragraph 7.3.1.502)

c) Power-frequency -withstand test on low-voltage terminal of the capacitor voltage divider (Paragraph 7.3.1.503)

d) Power-frequency withstand tests on the electromagnetic unit (Paragraph 7.3.1.504)

e) Partial discharge measurement (Paragraph 7.3.2.2)

f) Power-frequency voltage withstand tests between sections (Paragraph 7.3.3)

g) Power-frequency voltage withstand tests on secondary terminals (Paragraph 7.3.4)

h) Test for accuracy (Paragraph 7.3.5.)

i) Verification of markings (Paragraph 7.3.6)

j) Enclosure tightness test at ambient temperature (Paragraph 7.3.7)

k) Pressure test for the enclosure (Paragraph 7.3.8)

l) Ferro-resonance check (Paragraph 7.3.501)

m) Routine tests for carrier frequency accessories (Paragraph 7.3.502)

7.4 Type tests requirements

a) Type tests shall be carried out on one CVT of each type and rating.

b) If evidence is available of type tests on identical equipment, this may be accepted in place of these tests and the relevant documents shall be submitted with the tender. If type test data in accordance with the specification is not available, indication shall be given of the date on which such tests will be made.

c) Every CVT to which it is intended to apply type tests shall first have withstood satisfactorily the application of all routine tests. All type tests shall be carried out on the same CVT unless otherwise approved.

d) Each capacitor voltage divider unit of the CVTs supplied in compliance with this specification shall be subjected to the type tests detailed for coupling capacitors, in 240-146088685 or IEC 60358.

7.4.1 Type Tests

a) Temperature-rise test (Paragraph 7.2.2)

b) Chopped impulse test (Paragraph 7.4.1)

c) Impulse voltage test on primary terminals (Paragraph 7.2.3)

d) Wet test for outdoor type transformers (Paragraph 7.2.4)

e) Electromagnetic Compatibility tests (Paragraph 7.2.5) - RIV

f) Test for accuracy (Paragraph 7.2.6)

g) Verification of the degree of protection by enclosures (Paragraph 6.10)

h) Enclosure tightness test at ambient temperature (Paragraph 7.2.8)

i) Pressure test for the enclosure (Paragraph 7.2.9)

j) Capacitance and tan δ measurement at power frequency (Paragraph 7.2.501)

k) Short circuit withstand capability test (Paragraph 7.2.502)

l) Ferro-resonance test (Paragraph 7.2.503)

m) Transient response test (for protective capacitive transformers) (Paragraph 7.2.504)

n) Type tests for carrier frequency accessories (Paragraph 7.2.505)

1) Drain coil – Impulse voltage test (Paragraph 7.2.505.1.1)

2) Drain coil – Voltage withstand test (Paragraph 7.2.505.1.2)

3) Voltage limitation device – Impulse voltage test (Paragraph 7.2.505.2)

o) Mechanical test (Paragraph 7.4.5)

8. Marking, labelling and packaging

a) The marking, labelling and packaging details are to be submitted to Eskom for approval prior to manufacturing.

b) CVTs shall be packaged in robust wooden crates and suitably supported in order to protect the CVT from the stresses of normal handling that can be expected from the point of despatch to the point of construction.

c) Crates must be designed such that inspection can be effected without opening or damaging the crate. The crate must be able to be lifted by slings with lifting points clearly marked. Any special handling requirements shall be clearly specified to purchaser before delivery and shall be clearly specified on packaging.

d) Packaging shall not disintegrate due to exposure to rain and direct sunlight during outdoor storage and the construction period of 18 months in total. The manufacturer/supplier shall notify the purchaser of any special methods recommended for storage prior to delivery, and on packaging materials.

e) If CVTs are packed in crates on pallets, the gross weight of the pallets shall not exceed 1 800 kg. Pallets shall be suitable for handling by forklift trucks, capable of entry from both sides. All boxes, pallets or containers shall be clearly marked in accordance with the following example, or similar approved template:

1) Eskom Order No.:

2) Eskom SAP No.:

3) Project Name:

4) Project Number:

5) Delivery Address:

6) Supplier's Name:

7) Supplier's Serial No.

8) Technical Description of current transformers

9) Gross Weight:

8.1 User manual

a) The manufacturer must provide Eskom with an electronic user manual in pdf format specifying the following details:

1) Packaging,

2) Handling (correct handling and slinging methods),

3) Transportation,

4) Installation,

5) Storage (short and long terms) and

6) Maintenance

9. Documentation

9.1 Tender documentation

The following technical information and drawings shall be submitted as part of the tender:

1) Completed technical schedule(s),
2) Technical deviation sheet if there are deviations to Eskom's requirements,
3) CVT outline drawing(s),
4) Detailed drawing of the insulator(s),
5) Instruction / user manual(s) and
6) Type test reports

Unless otherwise specified in schedule A, one hard copy and one digital copy of all documentation pertaining to the equipment offered shall be supplied. The digital copy shall be compatible with "Adobe Acrobat pdf" format. All information shall be in English.

9.2 Contract documentation after tender award

The following drawings and technical information shall be submitted for final approval after the contract is awarded but before manufacturing can commence:

1) Outline drawing,
2) Section drawing,
3) Terminal box drawing (internal),
4) Detailed drawing of the rating plate,
5) Scheme diagram,
6) Instruction / user manual and
7) Typical routine test sheet.

10. Drawings

10.1 Details of drawings

10.1.1 Outline drawing

A outline drawing that shows the following minimum information shall be provided for each type of CVT such that the physical arrangement can be correlated with the electrical schematic arrangement:

a) Short technical description as provided by Eskom in the title block,
b) The type of insulating material,
c) Mounting details,
d) Primary terminal dimensions and markings,
e) Overall dimensions,
f) The position of the earthing terminal,
g) The height of the gland plate in the secondary terminal box above the base, and the distance of the terminal box centre-line from the centre-line of the CVT,
h) The total creepage and the arcing distance of the hollow core insulator; and
i) The mass of the complete CVT and the volume of the oil.

j) Allowance for the inclusion of:

1) Eskom SAP number and

2) Eskom drawing number

Note: The numbers shall be incorporated in the drawing upon issue.

10.1.2 Section drawing

A sectional arrangement drawing, which depicts the following details, shall be supplied:

a) The relative position of the core and windings,

b) The hollow core insulator,

c) Oil-sealing arrangement,

d) The method used to accommodate expansion of the oil and

e) Pressure-relief device, where applicable

10.1.3 Insulator drawing

A detailed drawing of the insulator showing all important dimensions shall be provided.

10.1.4 Terminal box

A detailed drawing of the terminal box showing the following:

a) Method of affixing the cover,

b) Position and dimensions of the gland plate,

c) Arrangement and clearances of the secondary terminals, creepage extension barriers, if applicable, and markings; and

d) Breathing arrangement

11. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Sibongile Maphosa	Engineer (TX-AM-SED)
Bheki Ntshangase	Senior Manager (TX-AM-SED)

12. Revisions

Date	Rev	Compiler	Remarks
April 2022	2	S. Maphosa	Change the document to align with IEC 61869-1 and IEC 61869-5 Changed RIV requirements to match IEC 61869-1
Feb 2012	1	H Boshoff	SCOWT Format – No technical contents changed

13. Development team

The following people were involved in the development of this document:

- Sibongile Maphosa

14. Acknowledgements

Not applicable.

Annex A – Capacitor Voltage Transformers

Table A.1: Standard Eskom CVT and CVD Capacitance

SAP Number	Technical Description	Rated Capacitance (pF)
9015	CVT 66kV/110V 1P1M 100/50VA (3P/0.2) 31mm/kV	10000
9017	CVT 88kV/110V 1P1M 100/50VA (3P/0.2) 31mm/kV	9000
637042	CVT 132kV/110V 1P1M 100/50VA (3P/0.2) 31mm/kV	8000
4282	CVT 220kV/110V 2P1M 150/50VA (3P/0.2) 31mm/kV	7000
8928	CVT 220kV/110V 2P1M 150/50VA (3P/0.2) 25mm/kV	7000
8546	CVT 275kV/110V 2P1M 150/50VA (3P/0.2) 31mm/kV	6000
8545	CVT 275kV/110V 2P1M 150/50VA (3P/0.2) 25mm/kV	6000
8544	CVT 400kV/110V 2P1M 150/50VA (3P/0.2) 31mm/kV	4400
8525	CVT 400kV/110V 2P1M 150/50VA (3P/0.2) 25mm/kV	4400
637043	CVT 765kV/110V 2P1M 150/50VA (3P/0.2) 31mm/kV	4400
637044	CVT 765kV/110V 2P1M 150/50VA (3P/0.2) 25mm/kV	4400
637045	CVT 765kV/110V 2P1M 150/50VA (3PT1) 31mm/kV	4400
637046	CVT 765kV/110V 2P1M 150/50VA (3PT1) 25mm/kV	4400

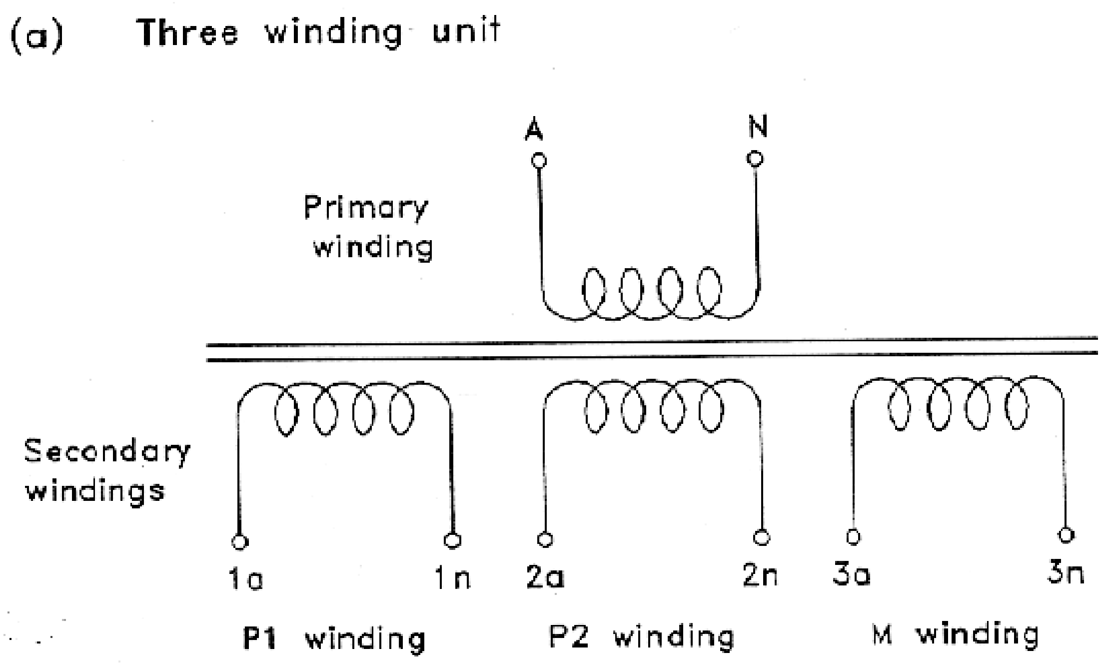
Annex B – CVT requirements for damping of transient voltage

(Normative)

Table B.1: CVT requirements for damping of transient voltage

1	2	3
Frequency band **Hz**	**Declared percentage**	**Reference time** **(ms)**
10 to 250	10	20
	10	10
	10	20
5 to 500	10	10
	5	20
2.5 to 100	10	10
	5	10
Not associated with any particular values	1	40

Annex C – Terminal markings



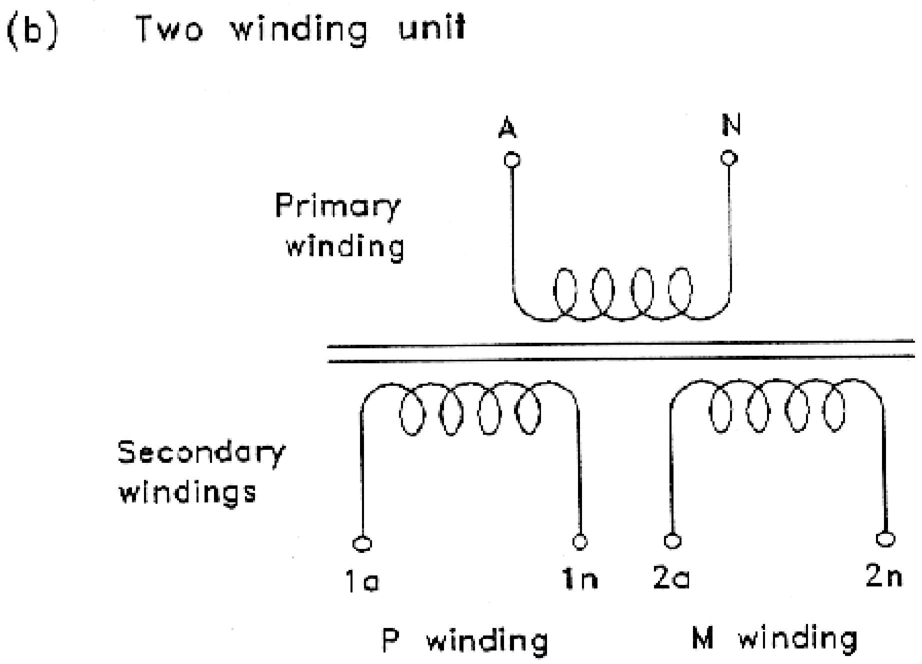


Figure C.1: CVT secondary terminal markings

Annex D – General Arrangement of Terminal Block

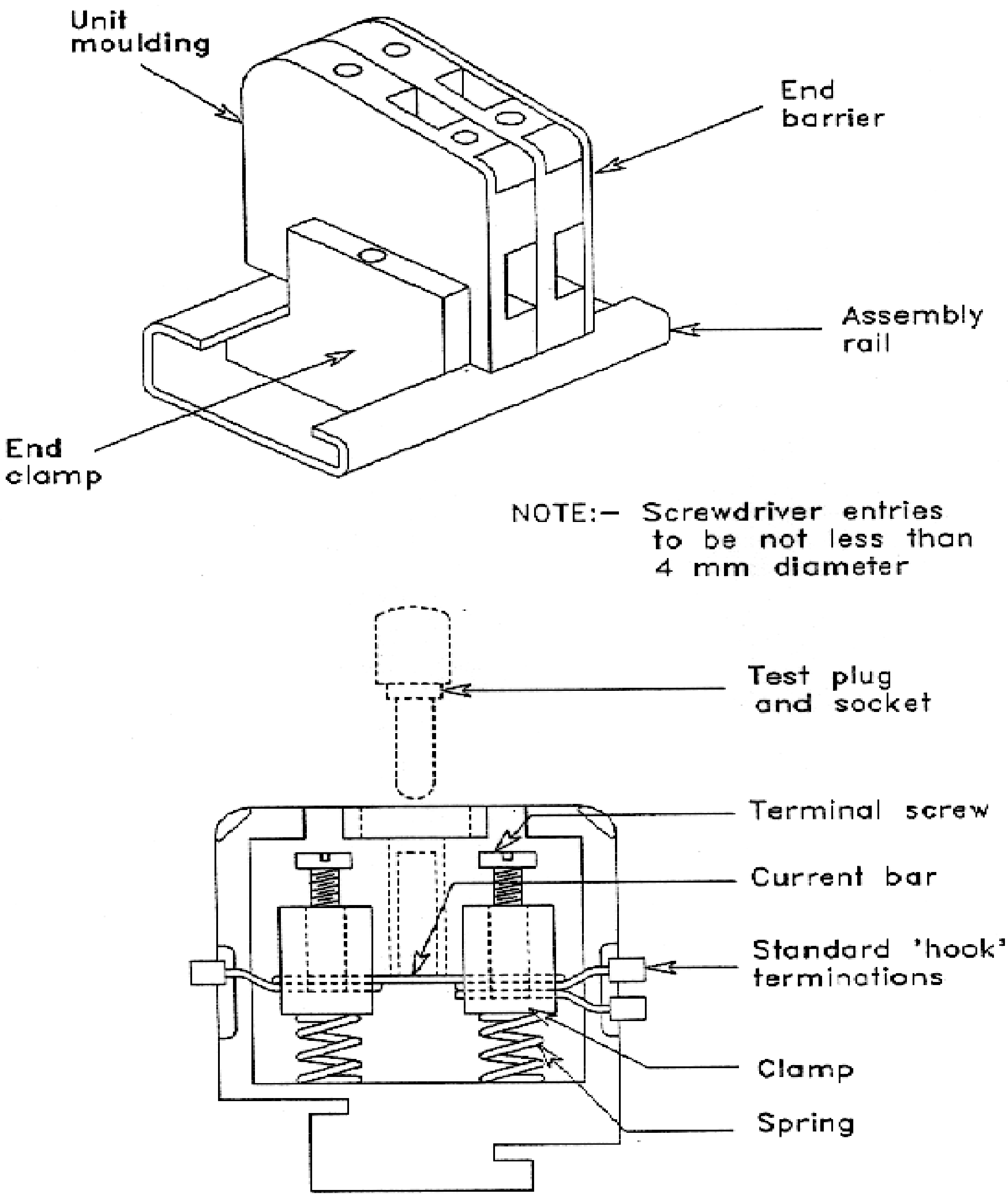


Figure D.1: General arrangement of terminal block

Annex E – Test Arrangement for Carrier Frequency Insertion Loss of CVT

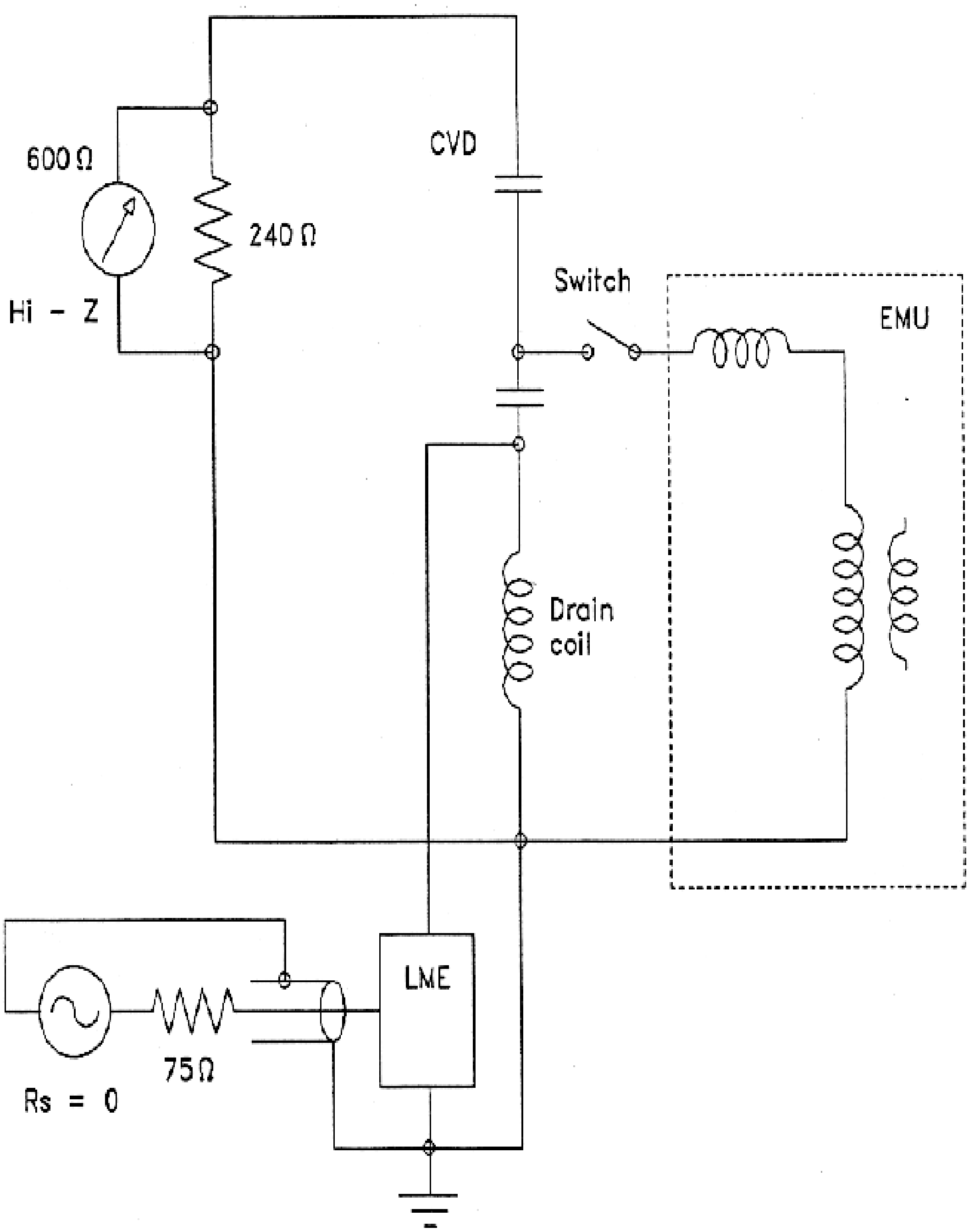


Figure E.1: Test arrangement for carrier frequency insertion loss of CVT

SECTION 5: PARTICULARS & GUARRANTEES

PART 5.1: 132KV VOLTAGE TRANSFORMERS (OUTDOOR)

SPECIFICATION:

ITEM	DESCRIPTION	UNITS	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
1	**132kV OUTDDOR VOLTAGE TRANSFORMERS**			
	Manufacturer			
	Type number			
5.1				
5.1.1	General requirements			
	a) indoor or outdoor use		outdoor	
	b) measuring core			
	Measuring			
	1. rated burden per phase	VA	100	
	2. accuracy class	VA	0,2	
	c) protection core			
	1. rated burden per phase	VA	100	
	2. accuracy class	VA	3P	
	d) 3-phase voltage transformers		no	
	1. HV neutral earthed		yes	
	or			
	e) single-phase voltage transformers		yes	
	f) symmetrical 3-phase fault current (only applies when HV fuses are	kA	NA	
	g) fault current phase-to-earth (only applies when HV fuses are required)	kV	NA	
	h) basic insulation level	kV	650	
	I) Ratio	kV	[132/sqrt3]/[11/sqrt3]	
5.1.2	Is a power winding required ? If yes,		no	
	a) rated secondary voltage	V		
	b) rated continious current of secondary winding	A	-	
5.1.3	Creepage distance			
	Minimum creepage distance for other than medium pollution level	mm		
5.1.4	Outdoor-type voltage transformers			
	1) primary insulation medium			
	2) secondary insulation medium			
	3) core insulation medium			
	4) main insulation (oil, gas or resin)			

ITEM	DESCRIPTION	UNITS	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
5.1.5	Oil-insulated voltage transformers quantity of oil			
	Details to be supplied for approval			
	a) sealing arrangement		yes	
	b) oil-level indicators		yes	
5.1.6	Dry-type insulation			
	Is this core included in the encapsulation ?			
5.1.7	Gas-insulted voltrage transformers			
	Method of sealing		NA	
	Type of densing meter			
	Number of contacts			
	Operating densities			
5.1.8	Voltage factor		2.0	
	Time for voltage factor	s		
5.1.9	Short circuit protection			
	Are primary fuses required ?		NO	
	if YES,			
	a) rating	A		
	b) location			
5.1.10	If secondary protection required ?		YES	
	If YES,			
	a) by means of fuses/MCCBs ?		fuses	
	b) current rating	A		
	c) make and type of protection			
5.1.11	Short-circuit currents			
	a) calculated secondary short circuit current	A		
	b) maximum permissible duration of secondary short-circuit current	s	1	
	c) operating time for secondary short circuit	s		
	d) calculated primary current for a secondary short-circuit assuming zero source impedance	A		
	e) drawing showing method of mounting secondary fuses/MCCBs			
5.1.12	Windings and connections			

ITEM	DESCRIPTION	UNITS	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
	Is a residual voltage winding required ?		NO	
	If YES,			
	a) rated burden	V.A.	100	
	b) rated secondary voltage	V	110/sqrt3	
	c) are tapped windings for providing both rated secondary residual voltages required?		no	
5.1.13	Details of primary winding neutral (earth) terminal			
5.1.14	Cores			
	Number of core limbs for for 3-phase voltage transformer with residual voltage output		N.A.	
	a) drawing number of magnetization curve showing voltage/magnetizing current for built-up core			
	b) core steel details required			
	1) B/H curve			
	2) core steel thickness	mm		
5.1.15	Secondary terminal box			
	Number of fuses/MCCBs			
	Manufacturer of fuses/MCCBs			
	Type of fuses/MCCBs			
	Current rating of fuses/MCCBs	A		
	Diameter of secondary earthing terminal	mm		
	HV winding earth end to be brought out, with link to earth terminal		yes	
	Dimension of terminal box			
	length	mm		
	height	mm		
	depth	mm		
5.1.16	Mounting arrangement (outdoor type voltage transformer)			
	a) holding-down bolts to be arranged to fall within a square of maximum dimensions	mm		
	b) mass of transformer (including oil)	kg		
5.1.17	Is electrogalvanizing, sherardizing or metal spraying of ferrous parts acceptable ?		Hot dipped galvanised	

ITEM	DESCRIPTION	UNITS	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
	Finish offered on ferrous parts			
	Finish offered on non-ferrous parts			
5.1.18	a) type of primary terminal material of primary terminal			
	b) overall dimensions of primary terminal			
	stem : length	mm	120	
	diameter	mm	26	
	pad : hole arrangement	mm		NA
	hole spacing	mm		
	length	mm		
	thickness	mm		
	c) diameter of tank earthing terminal	mm		
5.1..19	Spare fuses			
	Primary fuses quantity required		NA	
	Secondary fuses quantity required		2 per VT	
5.1.20	Type tests			
	Are type test results available ?			yes/no
	If no, are type tests to be performed ?		yes	
	If required, where are type tests to be carried out ?			
5.1.21	Routine tests			
	Is a tangent delta test required ?		yes	
	Partial discharge test		yes	
5.1.22	Test procedure for cast resin-encapsulated voltage transformers		NA	
5.1.23	Marking/labelling/documentation			
	a) materials used for rating plates			
	b) material used for diagram plates			
	c) method of fixing plates			
5.1.24	Core material details and B/H curve required with tender		yes	

ITEM	DESCRIPTION	UNITS	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED
5.1.25	Drawing numbers for post-type voltage transformers			
	a) outline dimension			
	b) assembly			
	c) terminal box			
	d) terminal marking			
	e) rating plate			
	f) diagram plate			
	Quantity required for tender		1	
	Quantity required for contract		3	
5.1.26	Drawing numbers for voltage transformers built into switchgear			
	a) rating plate			
	b) diagram plate			
	Quantity required			
5.1.27	Number of instruction books for voltage transformers if other than three		3	
5.1.28	Number of copies of routine test certificates			
5.1.29	Storage for outdoor-type voltage transformers			
	Guides on a) storage			
	b) transportation			
	c) handling and slinging			

Capacitive Voltage Transformer and Coupling Capacito

Note: Eskom Standard 240-56030645 must be read in conjuction with IEC 61869-5

CONTENTS PAGE

Item	Short Description	Rated Capacitance
Item 5	CVT 275kV/110V 2P1M 150/50VA (3P/0.2) 31mm/kV	6000

›rs

: 61869-1 and IEC

SAP Number

Note: Eskom Standard 240-56030645 must be read in conjuction

Items 5

Item 5	275 kV Capacitor Voltage Transformer (CVT)	Unit
1	Manufacturer	
2	Manufacturer's type number	
3	Rated Capacitance	pF
	a) Value of upper capacitance (C_1)	pF
	b) Lower Capacitance (C_2)	pF
4	System conditions for which the	
	capacitor shall be suitable	
	a) Rated frequency	Hz
	b) System neutral	
	c) Rated r.m.s. line-to-line voltage	kV
	d) Maximum continuous r.m.s. line-to-line Voltage	kV
5	Insulation	
	a) Minimum crest value of full wave	
	lightning impulse type test withstand	
	voltage to earth at sea level on HV terminal	kV
	b) Characteristic of impulse wave	µs
	c) Minimum crest value of full wave	
	switching impulse type test withstand	
	voltage to earth at sea level on HV terminal	kV
	d) Characteristic of impulse wave	µs
	e) Minimum 60 s power frequency wet	
	withstand type test voltage to earth at	
	sea level on HV terminal	kV r.m.s.
	f) Minimum 60 s power frequency dry	
	withstand routine test voltage at sea level	
	on HV terminal	kV r.m.s.
	g) Partial discharge type test in accordance with	
	IEC 61869-1	
	h) Polution level	
	1) Extra heavy - creepage distances	mm
	arcing distances	mm
6	Equipment suitable for carrier injection	
7	High frequency capacitance and	%
	equivalent series resistance	Ωmax
8	Stray capacitance and stray conductance	pF max
	of low voltage terminals	µs max
9	Radio influence	
	a) Test voltage kV	kV

	b) Maximum radio influence voltage	μV
10	Self resonant frequency of complete capacitor stack	MHz
11	LV terminals	
	Minimum 60 s power frequency dry	
	withstand routine test voltage on low	
	voltage terminal	kV r.m.s.
12	Capacitor suitable for supporting a line trap	
13	VT Secondary windings	
	a) Protection (P1)	
	b) Protection (P2)	
	c) Metering (M)	
	d) Total	
14	VT mounted in base of CVD (Single unit)	
15	Rated CVT transformation ratios	
	a) Protection winding (P1)	
	b) Protection winding (P2)	
	c) Metering winding	
16	16 Rated burden of secondary windings	
	a) P1 winding	VA
	b) P2 winding	VA
	c) M winding	VA
	d) Total burden	VA
17	Accuracy class of CVT	
	a) P1 winding	
	b) P2 winding	
	c) M winding (within burden range 40 VA to 50 VA)	
18	Transient response Class	
19	Ferroresonance (Ref 5.15 of 240-56030645)	
	a) Amplitude	
	b) Damping	
20	Secondary short circuit current	A
	a) P1 winding	
	b) P2 winding	
	c) M winding	
21	Maximum CVT rating as a power transformer	kVA
		Cos φ
22	Recommended maximum rating of fuses	
	protecting the voltage transformer secondary windings	A
23	Class of insulation of VT	
24	Rated voltage factor	
	a) Continuous	
	b) 30	s
25	Temperature category of CVT	°C
26	Maximum carrier frequency insertion loss of VT	dB
27	Minimum 60 s power frequency withstand routine	
	test voltage on secondary windings	kV r.m.s.
28	CVT equipment with carrier earthing switch	
29	Carrier drain coil	
	a) i) Maximum insertion loss	dB

	or	
	ii) Minimum impedance at carrier frequency	kΩ
	b) i) Maximum volt drop at rated frequency with	
	associated CC energized at rated voltage	V
	or	
	ii) Maximum 50 Hz impedance	Ω
	c) Minimum 50 Hz current carrying capacity	
	i) Continuous	A r.m.s.
	ii) Short time for 0.2s	A r.m.s.
	d) Minimum impulse withstand voltage	kV
30	Low voltage terminal arrester	
	Non linear arrester	
	a) Rated voltage	kV
	b) Impulse sparkover voltage	kV
	c) Minimum 8/20 μs impulse discharge current	kA
31	Type of mounting	
32	High-voltage terminal	
	a) Terminal material and finish	
	b) Dimensions	mm
	c) Arrangement of terminals	
	d) Number of terminals	
	e)Spacing between conductors	mm
	f) Withstand force without failure	kN
	g) Withstand force without distortion	kN
33	Secondary terminals	
	a) Separate terminal box for secondary terminals	
	with gland plate facilities	
	b) Separate insulated bushing for connection to	
	carrier equipment	
34	Mass of complete CVT	kg
35	Outline Drawings showing:	
	a) dimensions, fixing details and mounting arrangements	
	b) Details of HV connecting terminals	
	c) Earth terminal	
	d) Details of secondary terminal	
	e) Details of earth switch and carrier connection	
	f) Nameplate	
36	Type test reports (Capacitor Voltage Transformer)	
	a) Temperature-rise test	
	b) Chopped impulse test	
	c) Lighning impulse test	
	d) Wet test for outdoor type transformers	
	e) Radio influence voltage test (RIV)	
	f) Transmitted overvoltage test	
	g) Test for accuracy	
	h) Verification of the degree of protection by enclosures	
	i) Enclosure tightness test at ambient temperature	
	j) Capacitance and tan δ measurement at power frequency	

	k) Short circuit withstand capability test	
	l) Ferro-resonance test	
	m) Transient response test	
	n) Mechanical test	
37	Type test reports (Carrier frequency accessories)	
	a) Drain coil – Impulse voltage test	
	b) Drain coil – Voltage withstand test	
	c) Voltage limitation device – Impulse voltage test	

with IEC 16869-1 and IEC 60044-5

SCHEDULE A	SCHEDULE B
Eskom requirements	**Technical guarantees for equipment offered**
6 000	
50	
Effectively earthed	
275	
300	
1050	
1.2/50	
850	
250/2 500	
460	
460	
Complies	
Extra heavy	
Yes	
–20 to +50 of rated C	
40	
200	
20	
190	

2500	
>1	
10	
No	
1	
1	
1	
3	
Yes	
275/√3 kV to 110/√3 V	
275/√3 kV to 110/√3 V	
275/√3 kV to 110/√3 V	
50	
50	
50	
150	
3P	
3P	
0.2M	
T1	
xxxxxxxxxxxxxxxxxxxx	
xxxxxxxxxxxxxxxxxxxx	
1,2	
1,5	
–10 to +40	
0,5	
2	
Yes	
0,5	

10	
30	
20	
1	
50	
10	
Yes	
5	
Upright on pedestal with	
integral VT as base unit	
38 dia x 125 long	
Vertical	
2	
330	
3	
1,5	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	

Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	

NOI

The equipment to be supplied co
Specification and Schedule A, w

1.2 Specification

Page	Paragraph

1.3 Schedule A

Page	Paragraph

Any deviations offered to this spec
evidence shall be provided that th
specified by Eskom.

Item	Clause

N- COMPLIANCE SCHEDULES

omplies in all respects with the requirements of the
ith the exception of the following points:

Deviation or Non-compliance

Deviation or Non-compliance

Deviation schedule

ification shall be listed below with reasons for deviation. In addition, e proposed deviation will at least be more cost-effective than that

Proposed deviation

Eskom	Standard	Technology

Title: **ESKOM STANDARD FOR TOP CORE CURRENT TRANSFORMERS RATED FROM 132KV UP TO 765KV**

Unique Identifier:	**240-170000559**
Alternative Reference Number:	**n/a**
Area of Applicability:	**Engineering**
Documentation Type:	**Standard**
Revision:	**2**
Total Pages:	**41**
Next Review Date:	**November 2026**
Disclosure Classification:	**Controlled Disclosure**

Compiled by	**Approved by**	**Authorized by**
Sibongile Maphosa	**Sibongile Maphosa**	**Bheki Ntshangase**
Engineer	**Engineer**	**Senior Manager TX AME – SE&D**
Date: 17 November 2021	Date: 17 November 2021	Date: 17 November 2021

Supported by SCOT/SC

Bheki Ntshangase

SCOT/SC Chairperson

Date: 17 November 2021

PCM Reference: **SC 07-04-W-01**

SCOT Study Committee Number/Name: **Plant Equipment**

Content

Figures

Tables

1. Introduction

This standard stipulates Eskom's requirements for designing, manufacturing and testing of top core current transformers rated from 132kV up to 765kV. The requirements stipulated in this document are based on international practices combined with Eskom's experiences. The requirements are specified in order to ensure the integrity of the products thereby minimising the risk of failure of equipment.

2. Supporting clauses

2.1 Scope

This standard details the requirements applicable to top core current transformers used in Eskom from nominal voltage of 132kV up to 765kV.

2.1.1 Purpose

The document is written to capture and standardise Eskom top core current transformer requirements.

2.1.2 Applicability

This document shall apply to Eskom Transmission.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] IEC 60060-1: High voltage test techniques – Part 1: General definitions and test requirements

[2] IEC 60071-1: Insulation co-ordination – Part 1: Definitions, principles and rules

[3] IEC 60085: Electrical insulation – Thermal classification

[4] IEC 60270: High voltage test techniques – Partial discharge measurements

[5] IEC 60296: Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear

[6] IEC 60455 (all parts): Resin based reactive compounds used for electrical insulation

[7] IEC 60529: Degrees of protection provided by enclosures (IP code)

[8] IEC 60694: Common specifications for high-voltage switchgear and controlgear standards

[9] IEC 60815: Guide for the selection of insulators in respect of polluted conditions

[10] IEC 61869-1: Instrument Transformers – Part 1: General

[11] IEC 61869-2: Instrument Transformers – Part 2: Additional requirements for current transformers

[12] IEC 62271-2: High-voltage switchgear and controlgear – Part 2: Seismic qualification for rated voltages of 72.5 kV and above.

[13] IEC TR 62271-301: High Voltage Switchgear and Controlgear – Part 301: Dimensional Standardisation of High Voltage Terminals

[14] CISPR 18-2: Radio interference characteristics of overhead power lines and high-voltage equipment – Part 2: Methods of measurement and procedure for determining limits

[15] Note: Some IEC documents mentioned above are available from SABS with the same number preceded by SANS.

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

Definition	Description
Accuracy class	a designation assigned to an instrument transformer, the ratio error and phase displacement of which remain within specified limits under prescribed conditions of use
Accuracy limit factor (ALF)	ratio of the rated accuracy limit primary current to the rated primary current
Burden	admittance (or impedance) of the secondary circuit expressed in siemens (or ohms) and power factor
Class P protective current transformer	protective current transformer without remanent flux limit, for which the saturation behaviour in the case of a symmetrical short-circuit is specified
Class PX protective current transformer	protective current transformer of low-leakage reactance without remanent flux limit for which knowledge of the excitation characteristic and of the secondary winding resistance, secondary burden resistance and turns ratio, is sufficient to assess its performance in relation to the protective relay system with which it is to be used
Class TPY protective current transformer	protective current transformer with remanent flux limit, for which the saturation behaviour in case of a transient short-circuit current is specified by the peak value of the instantaneous error
Composite error (ε_c)	under steady-state conditions, the r.m.s. value of the difference between the instantaneous values of the primary current, and the instantaneous values of the actual secondary current multiplied by the rated transformation ratio with the positive signs of the primary and secondary currents corresponding to the convention for terminal markings
Creepage Distance	shortest distance, or the sum of the shortest distances, along the insulating parts of the insulator between those parts which normally have the operating voltage between them
Current transformer	instrument transformer in which the secondary current, under normal conditions of use, is substantially proportional to the primary current and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections
Duration of first fault (t')	duration of the fault in a C-O duty cycle, or of the first fault in a C-O-C-O duty cycle
Duration of second fault (t'')	duration of the second fault in a C-O-C-O duty cycle
Enclosure	housing affording the type and degree of protection suitable for the intended application
Exciting current (I_e)	r.m.s. value of the current taken by the secondary winding of a current transformer, when a sinusoidal voltage of rated frequency is applied to the secondary terminals, the primary and any other windings being open-circuited

Definition	Description
Fault repetition time (t_{fr})	time interval between interruption and re-application of the primary short-circuit current during a circuit breaker auto-reclosing duty cycle in case of a non-successful fault clearance
Highest voltage for equipment (U_m)	the highest r.m.s. value of phase-to-phase voltage for which the equipment is designed in respect of its insulation as well as other characteristics which relate to this voltage in the relevant equipment standards
Instrument security factor (FS)	ratio of rated instrument limit primary current to the rated primary current
Knee point e.m.f.	e.m.f. of a current transformer at rated frequency, which, when increased by 10%, causes the r.m.s. value of the exciting current to increase by 50%
Measuring current transformer	current transformer intended to transmit an information signal to measuring instruments and meters
Mechanical load (F)	forces on different parts of the instrument transformer as a function of four main forces: • forces on the terminals due to the line connections • forces due to the wind • seismic forces • electro dynamic forces due to short circuit current
Nominal voltage of a system (U_n)	highest value of the phase-to-phase operating voltage (r.m.s. value) which occurs under normal operating conditions at any time and at any point in the system
Peak value of exciting secondary current at Eal (I_{al})	peak value of the exciting current when a voltage corresponding to E_{al} is applied to the secondary terminals while the primary winding is open
Phase displacement ($\Delta\phi$)	difference in phase between the primary voltage or current and the secondary voltage or current phasors, the direction of the phasors being so chosen that the angle is zero for an ideal transformer
Primary terminals	terminals to which the voltage or current to be transformed is applied
Protective current transformer	a current transformer intended to transmit an information signal to protective and control devices
Rated burden	value of the burden on which the accuracy requirements of this specification are based
Rated dynamic current (I_{dyn})	maximum peak value of the primary current which a transformer will withstand, without being damaged electrically or mechanically by the resulting electromagnetic forces, the secondary winding being short-circuited
Rated equivalent limiting secondary e.m.f. (E_{al})	that r.m.s. value of the equivalent secondary circuit e.m.f. at rated frequency necessary to meet the requirements of the specified duty cycle.
Rated frequency (f_R)	value of the frequency on which the requirements of this standard are based
Rated insulation level	combination of voltage values which characterizes the insulation of a current transformer with regard to its capability to withstand dielectric stresses
Rated knee-point e.m.f (E_k)	lower limit of the knee point e.m.f.

Definition	Description
Rated primary current (I_{pr})	value of the primary current on which the performance of the transformer is based
Rated primary short-circuit current (I_{psc})	r.m.s. value of the a.c. component of a transient primary short-circuit current on which the accuracy performance of a current transformer is based
Rated resistive burden (R_b)	rated value of the secondary connected resistive burden in ohms
Rated secondary current (I_{sr})	value of the secondary current on which the performance of the transformer is based
Rated short-time thermal current (I_{th})	maximum value of the primary current which a transformer will withstand for a specified short time without suffering harmful effects, the secondary winding being short-circuited
Rated symmetrical short-circuit current factor (K_{ssc})	ratio of the rated primary short circuit current to the rated primary current
Rated turns ratio	specified ratio of the number of primary turns to the number of secondary turns
Ratio error (ε)	the error which an instrument transformer introduces into the measurement and which arises from the fact that the actual transformation ratio is not equal to the rated transformation ratio
Secondary terminals	terminals which transmit an information signal to measuring instruments, meters and protective or control devices or similar apparatus
Secondary winding resistance (R_{ct})	actual secondary winding d.c. resistance in ohms corrected to 75ºC or such other temperature as may be specified
Section	electrically conductive part of an instrument transformer insulated from other similar parts and equipped with terminals
Specified duty cycle (C-O and / or C-O-C-O)	duty cycle in which, during each specified energization, the primary short circuit current is assumed to have the worst-case inception angle
Specified primary time constant (T_p)	that specified value of the time constant of the d.c. component of the primary short-circuit current on which the transient performance of the current transformer is based
Specified time to accuracy limit in the first fault t'_{al}	time in a C-O duty cycle, or in the first energization of a C-O-C-O duty cycle, during which the specified accuracy has to be maintained
Specified time to accuracy limit in the second fault t''_{al}	time in the second energization of a C-O-C-O duty cycle during which the specified accuracy has to be maintained
Transient dimensioning factor (K_{td})	dimensioning factor to consider the increase of the secondary linked flux due to a d.c. component of the primary short circuit current
Unified specific creepage distance	creepage distance of an insulator divided by the r.m.s. value of the highest operating voltage across the insulator and is expressed in mm/kV

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
ALF	Accuracy Limit Factor
CT	current Transformer
Eal	rated equivalent limiting secondary e.m.f.
E_k	rated knee-point e.m.f.
F	mechanical load
f_R	rated frequency
I_{al}	peak value of the exciting secondary current at E_{al}
I_{dyn}	rated dynamic current
I_e	exciting current
I_{pr}	rated primary current
I_{psc}	rated primary short-circuit current
I_{sr}	rated secondary current
I_{th}	rated short-time thermal current
K_{ssc}	rated symmetrical short-circuit current factor
K_{td}	transient dimensioning factor
R_b	resistive burden
R_{ct}	secondary winding resistance
T	turns
t’	duration of first fault
t’’	duration of second fault
t''_{al}	specified time to accuracy limit in the second fault
t'_{al}	specified time to accuracy limit in the first fault
t_{fr}	fault repetition time
T_p	specified primary time constant
U_n	system nominal voltage
$\Delta\phi$	phase displacement
ε	ratio error
ε_c	composite error

2.5 Roles and responsibilities

All Eskom employees and/or appointed bodies involved in the procurement of top core current transformers of nominal voltages from 132kV up to 765kV shall ensure that the product meets the requirements of this standard. Any deviation from these requirements shall constitute a non-conformance, unless if approved in advance by a delegated Eskom current transformer specialist in writing and is based on sound engineering judgement.

All the Contractors supplying current transformers to Eskom must be conversant with the requirements of this standard, and shall comply with the requirements. All the deviations shall be clearly listed in the deviation schedule as part of the tender deliverables. No deviations will be accepted unless approved by Eskom in writing.

The Eskom Instrument Transformer Care Group shall be responsible for ensuring the validity of this document.

2.6 Process for monitoring

This document and its relevance will be evaluated by the relevant instrument transformers Care Group.

2.7 Related/supporting documents

Not applicable.

3. General requirements

Schedule A of the relevant A/B schedules shall form part of this specification and shall take precedence over this standard in case the two documents are conflicting.

3.1 Life expectancy

The life expectancy of current transformers under normal service conditions shall be 25 years.

3.2 Standard service conditions

Unless otherwise specified in schedule A, the following standard conditions shall apply:

a) Ambient temperatures:

1) Minimum: -10^{o}C

2) Maximum: 40^{o}C

3) Maximum diurnal variation: 35^{o}C

4) Yearly daily average: 25^{o}C

b) Altitude: Up to 1800m

c) Solar radiation: 2500 kWh/m^2

d) Relative humidity: Not exceeding 95% (measured for a period of 24 hours)

e) Wind Pressure: 700 Pa (corresponding to a 34m/s wind speed)

f) Seismic shock: 0.3g

4. Ratings

4.1 General

The common ratings of instrument transformers, including their auxiliary equipment if applicable, should be selected from the following:

a) Highest voltage for equipment (U_m);

b) Rated insulation level;

c) Rated frequency (f_R) and

d) Rated accuracy class

The rating applies at the standardized reference atmosphere (temperature (20°C), pressure (101.3 kPa) and humidity (11 g/m3)) specified in IEC 60071-1.

4.2 Insulation requirements

These requirements shall apply to all types of current transformer insulation. The rated insulation levels for current transformers shall comply with the requirements in Table 1.

Table 1: Rationalized Voltage Ratings

Equipment Nominal Voltage Rating (U_n) (kV)	Highest Voltage for Equipment (U_m) (kV)	Rated Lightning Impulse Withstand Voltage (kV peak) at 1 000 m AMSL)	Rated Power Frequency Withstand Voltage (kV rms) at 1 000 m AMSL)	Rated Switching Withstand Voltage (kV peak) at 1 000 m AMSL)
132	145	650	275	N/A
275	300	1050	460	850
400	420	1425	630	1050
765	800	2100	975	1550

Note: The rated insulation withstand levels for lightning impulse and short time power frequency withstand are specified in Table 1. The service conditions for South Africa are rationalized for altitudes up to 1 800m. Although the insulation levels in Table 1 are specified at an altitude of 0 m to 1 000 m, the values have been selected for appropriate insulation coordination for altitudes up to 1 800 m and need not be corrected for altitude. The CTs should be supplied with standard values as per Table 1 Test values must, however, be corrected for deviations from the standard reference atmospheric conditions.

4.3 Rated primary terminal insulation level

a) Primary terminals shall be of the type and orientation specified in technical schedule A.

b) Primary terminals shall be made Aluminium and shall be specified in technical schedule A. The commonly used terminals for this type of current transformers in Eskom are listed in Table 2.

Table 2: Aluminium terminals for current transformers

Terminal type	Diameter (mm)	Length (mm)
Aluminium Stem	60	125
8 – bolt pad to IEC 60518	-	100 x 200

c) Primary terminals shall be marked P1 and P2 with the following additional requirements:

1) P1 is the terminal which is insulated from the CT head and
2) P2 is the terminal connected to the CT head.
3) The connection between the terminal P2 and CT's head shall be of the same (or of compatible) material as that of the terminals and shall not be of braided construction. It shall be able to carry the rated short circuit current specified in technical schedule A.

Note: The intention of this requirement is to ensure that any flashover from the CT head to earth, or to other phases, will fall within the protected zone of the feeder circuit and will therefore be cleared selectively. To achieve this, the CT is mounted with the P1 terminal (insulated terminal) connected towards (facing) the circuit breaker.

4.4 Other requirements for primary terminals

4.4.1 Partial discharges

a) Partial discharge requirements are applicable to current transformers having $U_m \geq 7.2kV$ and the level shall not exceed limits specified in Table 3.

Table 3: – Partial discharge test voltages and permissible levels

Type of earthing of the neutral system	PD test voltage (r.m.s.) kV	Maximum permissible PD level PC	
		Liquid or gas insulation	Solid insulation
Earthed Neutral	U_m	10	50
	$1.2\ U_m/\sqrt{3}$	5	20
Non effectively earthed	$1.2U_m$	10	50
	$1.2\ U_m/\sqrt{3}$	5	20

4.4.2 Chopped impulse

a) Current transformers shall be capable to withstand a chopped lighting impulse voltage applied to primary terminals having a peak value of 115% of rated lightning impulse withstand voltage.

4.4.3 Capacitance and dielectric dissipation factor

a) A capacitive test tap is required for dielectric dissipation factor (DDF = tangent-delta) testing and should be brought through a separate terminal (for all current transformers having $U_m \geq 24kV$).

b) The special test requirements apply only to current transformers having $U_m \geq 72.2kV$ with liquid immersed primary insulation or gas insulated current transformers with capacitance grading insulation system.

4.4.4 Between-section insulation requirements

a) For interconnected terminal of each section, the rated power frequency withstand voltage of insulation between sections shall be 3kV.

4.4.5 Insulation requirements for secondary terminals

a) The rated power-frequency withstand voltage for secondary terminals insulation shall be 3kV.

b) The rated withstand voltage for inter-turn insulation shall be 4.5 kV peak

4.5 Rated frequency

a) The standard frequency value is 50Hz.

4.6 Rated output

a) Standard values for measuring classes and class P current transformers are: 2.5, 5, 10, 15 and 30VA. The required output shall be specified in technical schedule A.

4.7 Description of standard current transformers used in Eskom

a) Standard current transformers used in Eskom are listed in Annexure A.

4.8 Core and winding design details

4.8.1 Cores, ratios and special characteristics

a) Where multi-ratio CTs are required, the various ratios shall be provided by means of tapping that can be obtained by changing the effective number of turns on the secondary winding.

4.8.1.1 Core Layout

Figures 1 – 3 show the core layouts for Protection (P), Measurements (M) and Bus zone (B). It is important to note the primary terminal polarity markings (i.e. P1, P2) with respect to the core layout.

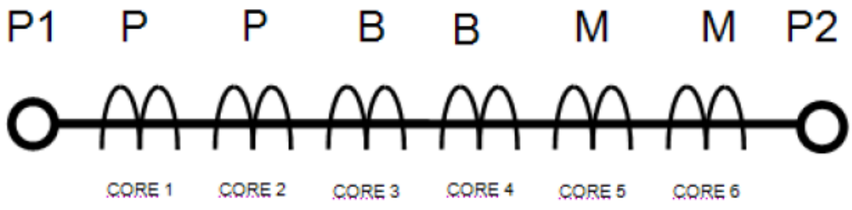


Figure 1: Core Layout – Six Core Current Transformer (2P2M2B)

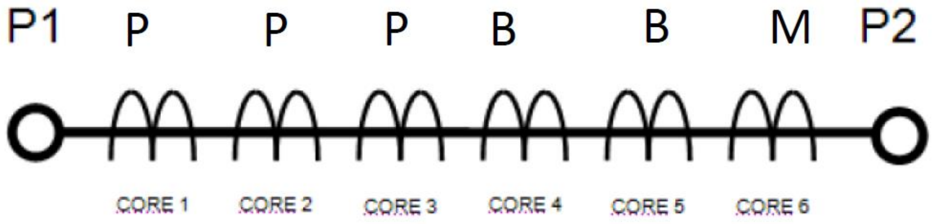


Figure 2: Core Layout – Six Core Current Transformer (3P1M2B)

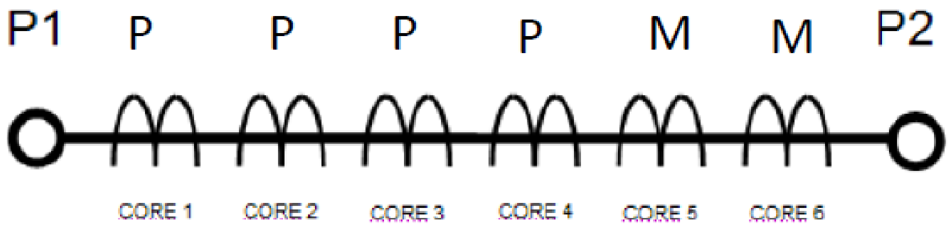


Figure 3: Core Layout – Six Core Current Transformer (4P2M)

4.8.1.2 Tapping arrangements

The secondary core tapping arrangements shall be as indicated in Figure 4 to Figure 6:

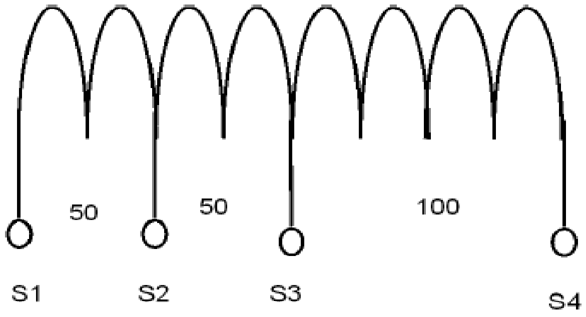


Figure 4: Tapping Arrangements for Multi-ratio 1/200 Measuring Cores

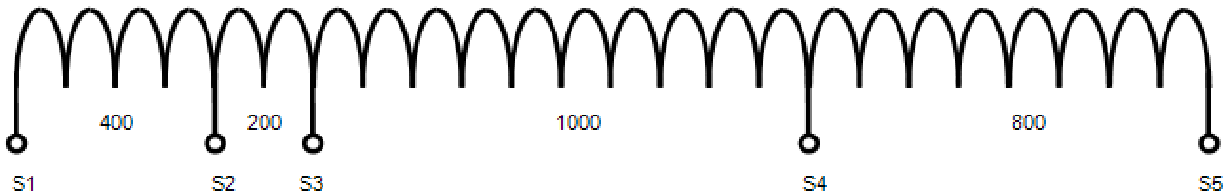


Figure 5: Tapping Arrangements for Multi-ratio 1/2400

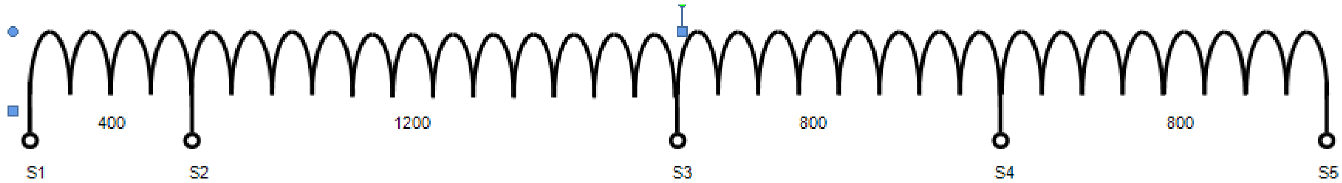


Figure 6: Tapping Arrangements for Multi-ratio 1/3200

4.9 Rated accuracy class

4.9.1 Measuring current transformers

a) For measuring current transformers, the accuracy classes used in Eskom are class 0.2 and in special cases class 0.2S.

b) However Eskom has special requirements for standard measuring current transformers and these are stated in Table 4.

Table 4: Measuring Core Specifications

Maximum Core Ratio	Tapping	Ratio	Class	Burden	Security Factor
MR 1/200	S1 - S2	50/1	0.2	5VA	FS 20
	S3 - S4	100/1		10VA	—
	S1 - S4	200/1		10VA	—
MR 1/2400	S2 - S3	200/1	0.2	2.5VA	—
	S1 - S2	400/1		5VA	FS 20
	S1 - S3	600/1		10VA	—
	S4 - S5	800/1		10VA	—
	S3 - S4	1000/1		10VA	—
	S2 - S4	1200/1		10VA	—

Maximum Core Ratio	Tapping	Ratio	Class	Burden	Security Factor
	S1 - S4	1600/1		10VA	—
	S3 - S5	1800/1		10VA	—
	S2 - S5	2000/1		10VA	—
	S1 - S5	2400/1		10VA	—
MR 1/3200	S1 - S2	400/1	0.2	5VA	FS 20
	S3 - S4	800/1		10VA	—
	S2 - S3	1200/1		10VA	—
	S1 - S3	1600/1		10VA	—
	S2 - S4	2000/1		10VA	—
	S1 - S4	2400/1		10VA	—
	S2 - S5	2800/1		10VA	—
	S1 - S5	3200/1		10VA	—

In cases where Class 0.2S measuring cores are required, the requirements shall be specified in technical schedule A.

4.9.2 Protective current transformers

a) The standard protective current transformers used in Eskom are class PX and class P but there are exceptional cases where TPY is utilized.

4.9.2.1 Class PX Protective Current Transformers

The performance of class PX protective current transformers shall be specified in terms of the following:

a) Rated primary current (I_{pr});

b) Rated secondary current (I_{sr});

c) Rated turns ratio;

d) Rated knee point e.m.f. (E_k);

e) Upper limit of exciting current (I_e) at the rated knee point e.m.f. and

f) Upper limit of the secondary winding resistance (R_{ct}).

4.9.2.2 Class PX protection core specifications

a) Table 5 gives the specifications for class PX protection cores specifications

Table 5: Class PX Protection Core Specifications

Maximum Core Ratio	Tapping	Ratio	Class	E_k min (V)	I_e max (mA)	R_{ct} (Ω) @ 75°C
MR 1/2400	S2 - S3	1/200T	PX	200	504	0.8
	S1 - S2	1/400T		400	252	1.6
	S1 - S3	1/600T		600	168	2.4
	S4 - S5	1/800T		800	126	3.2
	S3 - S4	1/1000T		1000	100	4
	S2 - S4	1/1200T		1200	84	4.8

Maximum Core Ratio	Tapping	Ratio	Class	E_k min (V)	I_e max (mA)	R_{ct} (Ω) @ 75°C
	S1 - S4	1/1600T		1600	63	6.4
	S3 - S5	1/1800T		1800	56	7.2
	S2 - S5	1/2000T		2000	50	8
	S1 - S5	1/2400T		2400	42	9.6
MR 1/3200	S1 - S2	1/400T	PX	400	256	1.6
	S3 - S4	1/800T		800	128	3.2
	S2 - S3	1/1200T		1200	85	4.8
	S1 - S3	1/1600T		1600	64	6.4
	S2 - S4	1/2000T		2000	51	8.0
	S1 - S4	1/2400T		2400	42	9.6
	S2 - S5	1/2800T		2800	36	11.2
	S1 - S5	1/3200T		3200	32	12.8

4.9.2.3 Class PX buszone protection core specifications

Table 6 give the specifications for class PX buszone protection cores specifications.

Table 6: Buszone Core Specifications

Maximum Core Ratio	Tapping	Ratio	Class	E_k min (V)	I_e max (mA)	R_{ct} (Ω) @ 75°C
FR 1/500	S1 - S2	1/500T	PX	550	50	2
FR 1/1200	S1 - S2	1/1200T	PX	550	50	2
FR 1/1600	S1 - S2	1/600T	PX	550	50	2
MR 1/1600/1200/1000	S1 - S2	1/1000T	PX	550	50	2
	S1 - S3	1/1200T		660	42	2.4
	S1 - S4	1/1600T		880	31	3.2
MR 1/1600/1200	S1 – S2	1/1200T	PX	550	50	2
	S1 – S3	1/1600T		733	38	2.7
MR 1/2400/1600	S1 – S2	1/1600T	PX	550	50	2
	S1 – S3	1/2400T		825	33	3
FR 1/2400	S1 - S2	1/2400	PX	550	50	2

Note: The CT's name plate shall reflect the manufacturer's design values for the core excitation current, i.e. rather than the maximum allowable values specified above.

4.9.2.4 Class P protective current transformers

a) The standard accuracy limit factor (ALF) values are 5, 10, 15, 20 and 30.

b) The accuracy class is designated using the highest permissible percentage of the composite error, followed by the letter "P" (standing for "protection") and the *ALF* value.

c) The standard accuracy classes for protective current transformers are 5P and 10P.

d) At rated frequency and with rated burden connected, the ratio error, phase displacement and composite error shall not exceed the limits given in Table 7.

Table 7: Error limits for class P current transformers

Accuracy class	**Ratio error at rated primary current ± %**	**phase displacement at rated primary current**		**Composite error at rated accuracy limit primary current %**
		± Minutes	± Centiradians	
5P	1	60	1.8	5
10P	3	—	—	10

Note: Class P protection current transformers are non-standard and will be specified in technical schedule A when required.

4.9.2.5 Class P unbalance current transformers

Table 8 give the specifications for class P protection cores specifications.

Table 8: Unbalance CT Core specifications

Maximum Core Ratio	**Tapping**	**Ratio**	**Class**	**ALF**	**Burden**
1/1	S1 - S2	1/1	5P	10	10VA
1/2	S1 - S2	1/2	5P	10	10VA
1/5	S1 - S2	1/5	5P	10	10VA
1/10	S1 - S2	1/10	5P	10	10VA
1/20	S1 - S2	1/20	5P	10	10VA

4.9.2.6 Class TPY protective current transformers

a) The error limits for class TPY current transformer at the rated frequency and burden are given in Table 9.

Table 9: Error limits for TPY current transformers

Class	**At rated primary current**			**Transient error limits under specified duty cycle conditions**
	Ratio error	**Phase displacement**		
	±%	**minutes**	**Centiradians**	
TPY	1.0	±60	±1.8	ε = 10%

b) The performance of class TPY protective current transformers shall be specified in terms of the following:

1) Class designation (i.e. TPY),
2) Rated symmetrical short circuit current factor (Kssc),
3) Duty cycle consisting of C-O-CO cycle: t'_{al}, t', t_{fr} and t''_{al},
4) Rated primary time constant (T_p)
5) Rated resistive burden (R_b)

Note: For current transformers with tapped secondary windings, the given accuracy requirements can be fulfilled with only one ratio.

4.10 Standard values of rated primary current

a) The standard values for rated primary current for top current transformers used in Eskom are 2A, 4A, 10A, 20A, 40A, 200A, 2500A, 3150A and 4000A.

b) Should a non-standard rated primary current for a current transformer be required, it shall be stated in technical schedule A.

4.11 Standard values of rated secondary current

a) The standard value for rated secondary current for current transformers used in Eskom is 1A.

4.12 Short-time current rating (I_{th})

a) The standard values for short-time current (I_{th}) for top current transformers used in Eskom are 0.6kA, 10kA, 40kA, 50kA and 63kA

4.13 Rated dynamic current (I_{dyn})

a) The standard value of the rated dynamic current (I_{dyn}) is 2.5 times the rated short-time thermal current (I_{th}).

5. Design and construction

5.1 Requirements for liquids used in equipment

5.1.1 General

a) The manufacturer shall specify the type and the required quantity and quality of the liquid to be used in the equipment in schedule B.

b) Facilities for oil filling and draining shall be provided. These facilities shall be suitably sealed below the normal operating oil level and shall not leak oil when the transformer is tested.

c) The method used to allow for the expansion of the insulating oil shall be stainless steel bellows.

d) If so specified in schedule A, oil sample valves shall be provided. Details of the oil sample valves shall be submitted for approval before manufacturing is undertaken.

5.1.2 Liquid quality

For oil-filled equipment, insulating oil shall comply with IEC 60296.

5.1.3 Liquid level device

The device for checking the liquid level shall indicate whether the liquid level is within the operating range, during operation.

5.1.4 Liquid tightness

a) No liquid loss is permitted (i.e. current transformers shall be hermetically sealed). Any liquid loss represents a danger of insulation contamination.

b) Details of the sealing arrangement shall be submitted for approval if requested in schedule A.

c) Where the manufacturer’s design requires specially designed gasketted joints to be above the oil level, machined surfaces and O-rings shall be used. Details of such joints shall be submitted for approval if requested in schedule A.

5.2 Requirements for gases used in equipment

5.2.1 General

a) The manufacturer shall specify the type and the required quantity and quality of the gas to be in equipment.

5.2.2 Gas quality

a) New SF_6 (sulphur hexafluoride) shall comply with IEC 60376.

b) New green (g^3) gases shall comply with their respective standards.

c) The maximum allowed moisture content within instrument transformers filled with gas at rated filling density for insulation shall be such that the dew-point is not higher than – 5 °C for a measurement at 20 °C.

d) Adequate correction shall be applied for measurement at other temperatures. For the measurement and determination of the dew point, refer to IEC 60376 and IEC 60480.

5.2.3 Gas monitoring device

a) Gas-insulated instrument transformers having a minimum functional pressure above 0.2 MPa shall be provided with pressure or density monitoring device.

b) Gas monitoring devices may be provided alone or together with the associated equipment.

5.2.4 Gas tightness

a) The tightness characteristic of a closed pressure system stated by the manufacturer shall be consistent with a minimum maintenance and inspection philosophy.

b) The tightness of closed pressure systems for gas is specified by the relative leakage rate F_{rel} of each compartment.

c) Standardized leakage rate value is 0.5 % per year, for SF_6 and SF_6-mixtures.

d) The standardized leakage rate value should be less or equal to 0.5% for new green (g^3) gases.

e) Means shall be provided to enable gas systems to be safely replenished whilst the equipment is in service.

f) An increased leakage rate at extreme temperatures is acceptable, provided that this rate resets to a value not higher than the maximum permissible value at normal ambient air temperature. The increased temporary leakage rate shall not exceed the values given in Table 10.

Table 10: Permissible temporary leakage rate for gas systems

Temperature Class (°C)	Permissible temporary leakage rate
+40	$3F_p$
Ambient temperature	F_p
-10	$3F_p$

5.2.5 Pressure relief device

a) Gas insulated current transformers shall be provided with a pressure relief device.

b) The device shall be protected against any accidental damage.

5.3 Requirements for solid materials used in equipment

a) Specifications for organic material used for instrument transformers (i.e. epoxy resin, polyurethane resin, epoxy-cycloaliphatic resin, composite material, etc.) either for indoor or outdoor installations are given in the IEC 60455 series.

b) Dry type CTs shall have resin-encapsulated cores and windings.

5.4 Requirements for temperature rise

5.4.1 General

a) The temperature rise in a current transformer when carrying a primary current equal to the rated continuous thermal current, with a unity power-factor and burden corresponding to the rated output, shall not exceed the appropriate value given in Table 11, when operating under service conditions specified in paragraph 3.2.

Table 11: limits for temperature rise

Part of instrument transformers	Temperature-rise limit K
1. Oil-immersed instrument transformers	
– top oil	50
– top oil, hermetically sealed	55
– winding average	60
– winding average, hermetically sealed	65
– other metallic parts in contact with oil	as for winding
2. Solid or gas insulated instrument transformers	
– winding (average) in contact with insulating materials of the following classes[a]:	
• Y	45
• A	60
• E	75
• B	85
• F	110
• H	135
– other metallic parts in contact with the above insulating material classes	as for windings
3. Connection, bolted or the equivalent	
– Bare-copper, bare-copper alloy or bare-aluminium alloy	
• in air	50
• in SF_6	75
• in oil	60
– Silver-coated or nickel-coated	
• in air	75
• in SF_6	75
• in oil	60
– Tin-coated	
• in air	65
• in SF_6	65
• in oil	60
[a] Insulating class definitions according to IEC 60085.	

5.4.2 Influence of altitude on temperature

If a current transformer is specified for service at an altitude in excess of 1 000m and tested at an altitude below 1 000m, the limits of temperature rise ΔT given in Table 11 shall be reduced by the following amounts for each 100m that the altitude at the operating site exceeds 1 000 m:

a) Oil-immersed current transformers: 0.4% and

b) Dry-type and gas insulated current transformers: 0.5%.

5.5 Requirements for earthing

a) The frame of current transformers shall be provided with a reliable earthing terminal for connection to an earthing conductor suitable for specified fault conditions.

b) The connecting point shall be marked with the “earth” symbol as indicated by symbol number 5019 of IEC 60417.

5.5.1 Electrical continuity

a) The continuity of the earthing circuits shall be ensured taking into account the thermal and electrical stresses caused by the current they may have to carry.

b) For the interconnection of enclosures, frames, etc., fastening (e.g. bolting or welding) is acceptable for providing electrical continuity.

5.6 Requirements for external insulation

a) For outdoor current transformers with ceramic (porcelain) or composite insulators susceptible to contamination, the creepage distance of 25mm/kV and 31mm/kV shall be used.

NB: Ratio of the creepage distance between phase and earth over the r.m.s. phase-to-phase value of the highest voltage for the equipment (see IEC 60071-1). For further information and manufacturing tolerances on the creepage distance, see IEC 60815.

5.7 Mechanical requirements

a) The requirements apply to current transformers rated for highest voltage of 72.5kV and above. Current transformers must be able to withstand static loads given in Table 12 applied in any direction to the primary terminals.

Table 12: Static withstand test loads

Highest Voltage for Equipment Um kV	Static withstand test load FR N	
	Load Class 1	**Load Class 2**
123 - 170	2000	3000
245 - 362	2500	4000
≥ 420	4000	5000

5.8 Internal arc fault protection

a) The requirements apply to oil immersed and gas insulated free-standing current transformers with U_m ≥ 72.5kV for which arc fault protection is additionally specified.

b) If the requirements are specified, the current transformer must be able to withstand internal arc of the specified current and duration specified in Table 13.

Table 13: Arc fault duration and protection criteria

Internal arc fault current r.m.s. value kA	Protection stage	Arc fault duration s	Internal arc fault protection class I	Internal arc fault protection class II
<40	1	0.2	Fracture of housing and fire permitted, but all projected part to be within the containment area	No external effect other than the operation of pressure relief device
	2	0.5		No fragmentation (burn-through or fire acceptable)
≥40	1	0.1		No external effect other than the operation of pressure relief device
	2	0.3		No fragmentation (burn-through or fire acceptable)

NB: This test is not a guarantee against containment under all short-circuit conditions, but a test to demonstrate conformance to an agreed level of safety.

c) If required in schedule A, the CTs' construction shall comply with the fail-safe design, yielding a low explosion risk. The supplier is to provide details of the fail-safe design features in the tender.

5.9 Degrees of protection by enclosures

a) The recommended minimum degree of protection for low-voltage control and/or auxiliary enclosures for outdoor current transformers is IP56.

5.10 Electromagnetic compatibility

5.10.1 Requirement for Radio Interference Voltage (RIV)

a) The requirement applies to current transformers having $U_m \geq 123$kV to be installed in air-insulated substations. The radio interference voltage shall not exceed 2 500μV at $1.1U_m/\sqrt{3}$.

5.10.2 Requirement for transmitted overvoltages

a) These requirements apply to instruments transformers having $U_m \geq 72.5$ kV. The overvoltages transmitted from the primary to the secondary terminals shall not exceed the values given in Table 14.

Table 14: Transmitted overvoltage limits

Type of impulse	Air insulated current transformers
Peak value of applied voltage (U_p)	$1.6 * \frac{\sqrt{2}}{\sqrt{3}} * U_m$
Waveshape characteristics conventional front time (T_1) time to half (T_2)	 0.5μs ± 20% ≥ 50μs
Transmitted overvoltage peak limits (U_s)	1.6kV

6. Construction

6.1 Secondary terminals

a) The secondary terminals shall be rail-mounted, and shall be the spring-loaded screw clamp type of 10 mm width in accordance with IEC 60947-7-1. The terminals shall accept two back-to-back hook blade lugs.

6.2 Secondary terminal boxes

a) Each CT shall be fitted with a secondary terminal box that shall be located in an accessible position and shall be provided with an easily removable (preferably slip-on) weather-proof cover. When in place, the cover shall be secured to the corresponding terminal box by means of a minimum M8 stainless steel set screw or an otherwise approved method.

b) The type of terminal box shall be stated in schedule B and, subject to approval, shall be either:

c) Integrally cast with the CT case;

d) The terminal box with the cover fixed in place shall have a degree of protection of at least IP56 in accordance with IEC 60529.

e) The secondary terminal box shall have an opening, at the bottom of the box, for vertical entry of the secondary control cables. The opening shall be covered externally by an undrilled, removable gland plate of brass (of minimum thickness 2mm), aluminium alloy (of minimum thickness 3mm) or stainless steel (of minimum thickness 2mm) for a steel or aluminium box. Unless otherwise specified in schedule A, this gland plate and the opening shall have an effective area of at least 75mm × 50mm. This area shall be stated in schedule B. Access to the gland-plate opening shall not be obstructed for cables that enter the terminal box vertically from below.

f) The distance between the bottom terminals and the gland plate shall be at least 75 mm.

g) The terminal box shall be fitted with a breathing vent of diameter at least 10 mm. This vent shall be situated in the bottom of the box, shall be made of non-corroding material and shall be designed to prevent the entry of insects.

h) The beginning and the end of each secondary winding with all secondary taps, if any, shall be wired to suitable terminals accommodated in the terminal box.

i) An earth terminal shall be provided for earthing of the secondary windings inside the terminal box and shall have an external connection to the main earthing system.

6.3 Capacitive test tap

a) The capacitive tap connection shall be provided for dielectric dissipation factor (tan delta) testing purposes. This terminal shall be clearly labelled.

6.4 Current transformer base

a) The base shall have an earthing flag of 5 mm × 50 mm × 100 mm (minimum), with two 14 mm holes at 50 mm centres arranged vertically. The flag shall be situated in close proximity to mounting bolt hole on the same side as the terminal box.

6.5 Hollow core insulators

a) Insulators shall comply with IEC 60815-2 and IEC 61462.

b) The name of the manufacturer and the country of origin of the HV insulators shall be stated in schedule B, and detailed drawings of the insulator shall be supplied with the tender. Permission shall be obtained from the purchaser before a change of insulator supplier during the course of a contract.

6.6 Mounting arrangement

a) The base mounting arrangement for the CTs shall be such that it can be bolted to a support structure, with mounting holes arranged on the corners of a square of dimensions not exceeding those specified in schedule A.

6.7 Corrosion

Unless otherwise approved, all ferrous parts associated with current transformers shall either be:

a) Hot-dip galvanized in accordance with SANS 121, of minimum coating thickness not less than 90µm; or

b) Zinc metal sprayed in accordance with SANS 2063, of minimum coating thickness not less than 80µm.

Metallization shall be followed by a base coat and top coat in accordance with SANS 12944-5. Metallization shall be followed by a base coat and top coat in accordance with SANS 12944-5.

All materials shall be inherently corrosion-resistant or treated against corrosion for the design lifetime of the equipment.

6.8 Markings

6.8.1 Terminal Markings

The terminal markings shall identify:

a) The primary and secondary windings,

b) The winding sections, if any,

c) The relative polarities of windings and winding sections and

d) The intermediate taps, if any.

NB: Further clarity on terminal markings is provided in Table 208 of IEC 61869-2.

6.9 Rating and diagram plates

The plate(s) shall be mechanically affixed e.g. screwed or riveted, to the equipment. Mounting by means of adhesives is not acceptable.

The plate(s) shall be manufactured from anodized aluminium or stainless steel and the material, and the method of mounting the plates, shall be stated in technical schedule B.

The plate(s) shall be externally fixed on a vertical surface of the main body of the CT, in close proximity to the terminal box and not to any removable part. The size of the characters shall be not less than 4mm.

The following information shall be engraved or stamped into the rating plate:

1) Manufacturer's name

2) Year of manufacture, serial number and type designation

3) Rated primary and secondary current

4) The rated continuous thermal current if it is different from the rated primary current.

5) Rated short-time thermal current (I_{th})

6) Rated dynamic current (I_{dyn})

7) Rated frequency

8) Highest voltage of equipment

9) Rated insulation level

10) Mass in kg

11) Class of mechanical requirements (for $U_m \geq 72$kV)

12) On current transformers with two or more secondary windings, the use of each winding and its corresponding terminals

NB: Some items can be combined e.g. 145/275/650kV

6.10 Warranty

Eskom only accepts current transformers with a minimum warranty of 5 years.

7. Tests

7.1 General

7.1.1 Classification of tests

The tests specified in this standard are classified as follows:

a) Type test: a test made on equipment to demonstrate that all equipment made to the same specification complies with the requirements not covered by routine tests.

b) Routine test: a test to which each individual piece of equipment is subjected. Routine tests are for the purpose of revealing manufacturing defects. They do not impair the properties and reliability of the test object.

c) Special test: a test other than a type test or a routine test, agreed on by manufacturer and Eskom.

7.2 Type tests

Unless valid and approved type test certificates specified in IEC 61869-1, IEC 61869-2 and in Schedule A are available, type tests must be carried out on one fully assembled current transformer of each type and rating at an IEC approved test facility. The certificates of the tests shall be included in the test reports. Type tests shall be followed by routine tests. Type tests are listed in (a) to (k):

a) Short-time current test

b) Temperature rise test

c) Lightning impulse test on primary terminals

d) Switching impulse voltage test (for current transformers with $U_m \geq 300$kV)

e) Wet test for outdoor type transformers (for current transformers with $U_m < 300$kV)

f) Radio interference voltage (for current transformers with $U_m \geq 123$kV)

g) Transmitted overvoltage test (for current transformers with $U_m \geq 72.5$kV)

h) Test for accuracy

i) Verification of the degree of protection by enclosures

j) Enclosure tightness test at ambient temperature (for gas insulated current transformers)

k) Pressure test for enclosure (for gas insulated current transformers)

7.3 Routine tests

7.3.1 General

Each fully assembled current transformer shall be subjected to the routine tests mentioned below at the manufacturer's works to prove compliance to this specification.

a) Verification of terminal markings

b) Power-frequency withstand test on primary winding

c) Partial discharge measurement

d) Power-frequency withstand test on secondary terminals

e) Power-frequency withstand tests between sections

f) Test for accuracy

g) Enclosure tightness test at ambient temperature (for gas insulated current transformers)

h) Pressure test for enclosure (for gas insulated current transformers)

i) Determination of the secondary winding resistance

j) Test for rated knee point e.m.f. and exciting current at rated knee point e.m.f.

k) Inter-turn overvoltage test

7.3.2 Capacitance and dielectric dissipation factor (tan delta) tests

7.3.2.1 General

The main purpose is to check the uniformity of the production. Conduct this test after the power-frequency withstand test; this test is applicable to all oil-immersed paper-insulated current transformers with *U*m ≥ 24 kV. Record the tangent delta and the capacitance (*C*) readings at 10 kV on the information plate mounted on the tank for the purposes of condition monitoring.

7.3.2.2 Current Transformers with Um ≥ 52kV

Raise the voltage applied between primary terminals bonded together and the earth screen terminal to 120% of U_m /√3. While the voltage is being raised, record the tangent delta measurements at voltages of 10kV, 66.6%, 100%, and 120% of U_m /√3. Thereafter, take the measurements in the reverse order back to 10kV, i.e. 100%, 66.6% and 10kV.

The current transformer is deemed to have passed the test when it meets the following two conditions:

a) The absolute value of tangent delta readings at each step, during both excursions, is not more than 0.5% (i.e. 0.005) and

b) The difference in absolute value between the readings at the maximum test voltage (120% of U_m /√3) and that at the minimum test voltage (10kV) is not more than 0,001.

7.4 Special tests

When specified in schedule A, special tests shall be performed and may be specified as type tests. The following special tests which are listed and described in detail in IEC 61869-1 and IEC 61869-2 are required by Eskom:

a) Chopped impulse voltage withstand test on primary windings

b) Capacitance and dielectric dissipation factor (tan delta) tests

c) Mechanical tests (applicable to current transformers with U_m ≥ 72.5kV)

d) Internal arc fault test (applicable to current transformers with U_m ≥ 72.5kV)

e) Corrosion test

7.4.1 Mechanical tests

When the mechanical tests on primary terminals are specified in schedule A, the applied design factor of safety shall be at least 2.

7.5 Test certificates (Routine tests certificates)

a) Each CT shall be delivered with one copy of all routine test certificates together with a copy of the excitation curve showing clearly where the knee-point occurs for each protective core and, in the case of multi-ratio windings, stating to which ratio the curve applies.

b) These certificates and curves shall be packed in a waterproof container and housed inside the terminal box of each respective current transformer.

c) All tests shall be fully documented in English, signed by the relevant (competent) manufacturer's personnel and stamped.

d) Electronic copies must be stored by the manufacturer for a period not less than 10 years and be made available to Eskom upon request.

7.6 Works inspections and witnessing of tests

a) Eskom reserves the right to appoint a representative to inspect the current transformers at any stage of manufacture, or to be present at any of the tests specified.

8. Marking, labelling and packaging

a) The marking, labelling and packaging details are to be submitted to Eskom for approval prior to manufacturing.

b) Imported CTs shall be packaged in robust wooden crates and suitably supported in order to protect the CT from the stresses of normal handling that can be expected from the point of despatch to the point of construction.

c) Crates must be designed such that inspection can be effected without opening or damaging the crate. The crate must be able to be lifted by slings with lifting points clearly marked. Any special handling requirements shall be clearly specified to purchaser before delivery and shall be clearly specified on packaging.

d) Packaging shall not disintegrate due to exposure to rain and direct sunlight during outdoor storage and the construction period of 18 months in total. The manufacturer/supplier shall notify the purchaser of any special methods recommended for storage prior to delivery, and on packaging materials.

e) If CTs are packed in crates on pallets, the gross weight of the pallets shall not exceed 1 800 kg. Pallets shall be suitable for handling by forklift trucks, capable of entry from both sides. All boxes, pallets or containers shall be clearly marked in accordance with the following example, or similar approved template:

   1) Eskom Order No.:
   2) Eskom SAP No.:
   3) Project Name:
   4) Project Number:
   5) Delivery Address:
   6) Supplier's Name:
   7) Supplier's Serial No.

8) Technical Description of current transformers

9) Gross Weight:

8.1 User manual

a) The manufacturer must provide Eskom with an electronic user manual in pdf format specifying the following details:

1) Packaging,
2) Handling (correct handling and slinging methods),
3) Transportation,
4) Installation,
5) Storage (short and long terms) and
6) Maintenance

9. Documentation

9.1 Tender documentation

a) The following technical information and drawings shall be submitted as part of the tender:

1) Completed technical schedule,
2) Technical deviation sheet (in case there are deviations)
3) Current transformer outline drawing,
4) Detailed drawing of the insulator
5) Instruction / user manual
6) Type test reports

Unless otherwise specified in schedule A, one hard copy and one digital copy of all documentation pertaining to the equipment offered shall be supplied. The digital copy shall be shall be compatible with “Adobe Acrobat pdf” format. All information shall be in English.

9.2 Contract documentation after tender award

a) The following drawings and technical information shall be submitted for final approval after the contract is awarded but before manufacturing can commence:

1) Outline drawing
2) Terminal box drawing internal
3) Detailed drawing of the rating plate
4) Scheme diagram
5) Section drawing
6) Instruction / user manual
7) Typical routine test sheet

10. Drawings

10.1 Details of drawings

10.1.1 Outline drawing

A outline drawing that shows the following minimum information shall be provided for each type of CT such that the physical arrangement can be correlated with the electrical schematic arrangement:

a) Nominal voltage, normal current, short-circuit withstand current and durations in the title block,

b) The type of insulating material,

c) Mounting details,

d) Primary terminal dimensions and markings,

e) Overall dimensions,

f) The position of the earthing terminal,

g) The height of the gland plate in the secondary terminal box above the base, and the distance of the terminal box centre-line from the centre-line of the CT,

h) The total creepage and the arcing distance of the hollow core insulator; and

i) The mass of the complete CT and the volume of the oil

j) Allowance for the inclusion of:

  1) Eskom SAP number; and

  2) Eskom drawing number

Note: The numbers shall be incorporated in the drawing upon issue.

10.1.2 Section drawing

A sectional arrangement drawing, which depicts the following details, shall be supplied:

a) The relative position of the core and windings,

b) The hollow core insulator,

c) Oil-sealing arrangement,

d) The method used to accommodate expansion of the oil and

e) Pressure-relief device, where applicable

10.1.3 Insulator drawing

A detailed drawing of the insulator showing all important dimensions shall be provided.

10.1.4 Terminal box

A detailed drawing of the terminal box showing the following:

a) Method of affixing the cover,

b) Position and dimensions of the gland plate

c) Arrangement and clearances of the secondary terminals, creepage extension barriers, if applicable, and markings; and

d) Breathing arrangement

11. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Sibongile Maphosa	Engineer (TX AME – Substation Equipment & Diagnostics)
Bheki Ntshangase	Senior Manager (TX AME – Substation Equipment & Diagnostics)

12. Revisions

Date	Rev	Compiler	Remarks
Nov 2021	2	S Maphosa	• Changed protective and measurement CTs technical parameters. • Included requirements for new (g^3) gases
Aug 2021	1	S Maphosa	New document

13. Development team

The following people were involved in the development of this document:

- Sibongile Maphosa
- Mantsie Hlakudi
- Patrick Van Der Colff
- Henri Groenewald
- Japhta Makgotlho

14. Acknowledgements

The development team would like to acknowledge all members of the Instrument Transformers Care Group who contributed to this standard.

Annex A – Current Transformers List

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
132kV Porcelain Current Transformers					
180031	CT 132kV 2500A 40kA 2P 2M 2B5 31mm/kV	PPBBMM	1/2400T MR	1/500T FR	2400/1 MR
180034	CT 132kV 2500A 40kA 2P 2M 2B16-12-10 31mm/kV	PPBBMM	1/2400T MR	1/1600T MR	2400/1 MR
257374	CT 132kV 2500A 40kA 2P 2M 2B24 31mm/kV	PPBBMM	1/2400T MR	1/2400T FR	2400/1 MR
216835	CT 132kV 2500A 40kA 3P 1M 2B24 31mm/kV	PPPBBM	1/2400T MR	1/2400T FR	2400/1 MR
243900	CT 132kV 2500A 40kA 2P 2M 2B16 31mm/kV	PPBBMM	1/2400T MR	1/1600T FR	2400/1 MR
217028	CT 132kV 2500A 40kA 3P 1M 2B16 31mm/kV	PPPBBM	1/2400T MR	1/1600T FR	2400/1 MR
243902	CT 132kV 2500A 40kA 2P 2M 2B12 31mm/kV	PPBBMM	1/2400T MR	1/1200T FR	2400/1 MR
630597	CT 132kV 2500A 40kA 3P 1M 2B12 31mm/kV	PPPBBM	1/2400T MR	1/1200T FR	2400/1 MR
675463	CT 132kV 3150A 40kA 2P 2M 2B24031mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
275kV Porcelain Current Transformers					
639033	CT 275kV 3150A 50KA 2P 2M 2B24 25mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
639037	CT 275kV 3150A 50KA 3P 1M32 2B24 25mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
639038	CT 275kV 3150A 50KA 2P 2M32 2B16 25mm/kV	PPBBMM	1/3200T MR	1/1600T FR	3200/1 MR
639039	CT 275kV 3150A 50KA 3P 1M32 2B16 25mm/kV	PPPBBM	1/3200T MR	1/1600T FR	3200/1 MR
639040	CT 275kV 3150A 50KA 2P 2M32 2B12 25mm/kV	PPBBMM	1/3200T MR	1/1200T FR	3200/1 MR
639041	CT 275kV 3150A 50KA 3P 1M32 2B12	PPPBBM	1/3200T MR	1/1200T FR	3200/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
	25mm/kV				
639042	CT 275kV 3150A 50KA 2P 2M32 2B24-16 25mm/kV	PPBBMM	1/3200T MR	1/2400T MT	3200/1 MR
639043	CT 275kV 3150A 50KA 3P 1M32 2B24-16 25mm/kV	PPPBBM	1/3200T MR	1/2400T MT	3200/1 MR
639044	CT 275kV 3150A 50KA 2P 2M32 2B16-12 25mm/kV	PPBBMM	1/3200T MR	1/1600T MR	3200/1 MR
639045	CT 275kV 3150A 50KA 3P 1M32 2B16-12 25mm/kV	PPPBBM	1/3200T MR	1/1600T MR	3200/1 MR
639032	CT 275kV 3150A 50KA 2P 2M32 2B24 31mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
8575	CT 275kV 3150A 50KA 3P 1M32 2B24 31mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
186669	CT 275kV 3150A 50KA 2P 2M32 2B16 31mm/kV	PPBBMM	1/3200T MR	1/1600T FR	3200/1 MR
186670	CT 275kV 3150A 50kA 3P 1M32 2B16 31mm/kV	PPPBBM	1/3200T MR	1/1600T FR	3200/1 MR
639064	CT 275kV 3150A 50KA 2P 2M32 2B12 31mm/kV	PPBBMM	1/3200T MR	1/1200T FR	3200/1 MR
639065	CT 275kV 3150A 50KA 3P 1M32 2B12 31mm/kV	PPPBBM	1/3200T MR	1/1200T FR	3200/1 MR
639066	CT 275kV 3150A 50KA 2P 2M32 2B24-16 31mm/kV	PPBBMM	1/3200T MR	1/2400T MT	3200/1 MR
639067	CT 275kV 3150A 50KA 3P 1M32 2B24-16 31mm/kV	PPPBBM	1/3200T MR	1/2400T MT	3200/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
639068	CT 275kV 3150A 50KA 2P 2M32 2B16-12 31mm/kV	PPBBMM	1/3200T MR	1/1600T MR	3200/1 MR
639069	CT 275kV 3150A 50KA 3P 1M32 2B16-12 31mm/kV	PPPBBM	1/3200T MR	1/1600T MR	3200/1 MR
639046	CT 275kV 2500A 50KA 2P 2M24 2B24 25mm/kV	PPBBMM	1/2400T MR	1/2400T FR	1/2400 MR
639047	CT 275kV 2500A 50KA 3P 1M24 2B24 25mm/kV	PPPBBM	1/2400T MR	1/2400T FR	1/2400 MR
639048	CT 275kV 2500A 50KA 2P 2M24 2B16 25mm/kV	PPBBMM	1/2400T MR	1/1600T FR	1/2400 MR
639049	CT 275kV 2500A 50KA 3P 1M24 2B16 25mm/kV	PPPBBM	1/2400T MR	1/1600T FR	1/2400 MR
639050	CT 275kV 2500A 50KA 2P 2M24 2B12 25mm/kV	PPBBMM	1/2400T MR	1/1200T FR	1/2400 MR
639051	CT 275kV 2500A 50KA 3P 1M24 2B12 25mm/kV	PPPBBM	1/2400T MR	1/1200T FR	1/2400 MR
639052	CT 275kV 2500A 50KA 2P 2M24 2B24-16 25mm/kV	PPBBMM	1/2400T MR	1/2400T MR	1/2400 MR
639053	CT 275kV 2500A 50KA 3P 1M24 2B24-16 25mm/kV	PPPBBM	1/2400T MR	1/2400T MR	1/2400 MR
639054	CT 275kV 2500A 50KA 2P 2M24 2B16-12 25mm/kV	PPBBMM	1/2400T MR	1/1600T MR	1/2400 MR
639055	CT 275kV 2500A 50KA 3P 1M24 2B16-12 25mm/kV	PPPBBM	1/2400T MR	1/1600T MR	1/2400 MR
639056	CT 275kV 2500A 50KA 2P 2M24 2B24 31mm/kV	PPBBMM	1/2400T MR	1/2400T FR	1/2400 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
639057	CT 275kV 2500A 50KA 3P 1M24 2B24 31mm/kV	PPPBBM	1/2400T MR	1/2400T FR	2400/1 MR
186671	CT 275kV 2500A 50kA 2P 2M24 2B16 31mm/kV	PPBBMM	1/2400T MR	1/1600T FR	2400/1 MR
639058	CT 275kV 2500A 50KA 3P 1M24 2B16 31mm/kV	PPPBBM	1/2400T MR	1/1600T FR	2400/1 MR
186673	CT 275kV 2500A 50kA 2P 2M24 2B12 31mm/kV	PPBBMM	1/2400T MR	1/1200T FR	2400/1 MR
186674	CT 275kV 2500A 50kA 3P 1M24 2B12 31mm/kV	PPPBBM	1/2400T MR	1/1200T FR	2400/1 MR
186667	CT 275kV 2500A 50kA 2P 2M24 2B5 31mm/kV	PPBBMM	1/2400T MR	1/500T FR	2400/1 MR
639059	CT 275kV 2500A 50KA 2P 2M24 2B24-16 31mm/kV	PPBBMM	1/2400T MR	1/2400T MR	2400/1 MR
639060	CT 275kV 2500A 50KA 3P 1M24 2B24-16 31mm/kV	PPPBBM	1/2400T MR	1/2400T MR	2400/1 MR
639061	CT 275kV 2500A 50KA 2P 2M24 2B16-12 31mm/kV	PPBBMM	1/2400T MR	1/1600T MR	2400/1 MR
639062	CT 275kV 2500A 50KA 3P 1M24 2B16-12 31mm/kV	PPPBBM	1/2400T MR	1/1600T MR	2400/1 MR
640324	CT 275kV 3150A 50kA 4P2M 25mm/kV	PPPPMM	1/3200T MR	—	3200/1 MR
640325	CT 275kV 3150A 50kA 4P2M 31mm/kV	PPPPMM	1/3200T MR	—	3200/1 MR
640326	CT 275kV 200A 10kA 2M 31mm/kV	2M	—	—	200/1 MR
275kV Composite Current Transformers					
639609	CT 275kV 3150A 50kA 2P 2M 2B24 31mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
639612	CT 275kV 3150A 50kA 3P 1M 2B24 31mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
639610	CT 275kV 3150A 50kA 2P2M2B24-16 31mm/kV	PPBBMM	1/3200T MR	1/2400T MR	3200/1 MR
639613	CT 275kV 3150A 50kA 3P1M2B24-16 31mm/kV	PPPBBM	1/3200T MR	1/2400T MR	3200/1 MR
639611	CT 275kV 3150A 50kA 2P2M2B16-12 31mm/kV	PPBBMM	1/3200T MR	1/1600T MR	3200/1 MR
639614	CT 275kV 3150A 50kA 3P1M2B16-12 31mm/kV	PPPBBM	1/3200T MR	1/1600T MR	3200/1 MR
400kV Porcelain Current Transformers					
639164	CT 400kV 4000A 63KA 2P 2M B24 25mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
639070	CT 400kV 3150A 50KA 2P 2M 2B24 25mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
639071	CT 400kV 3150A 50KA 3P 1M32 2B24 25mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
639072	CT 400kV 3150A 50KA 2P 2M32 2B16 25mm/kV	PPBBMM	1/3200T MR	1/1600T FR	3200/1 MR
639073	CT 400kV 3150A 50KA 3P 1M32 2B16 25mm/kV	PPPBBM	1/3200T MR	1/1600T FR	3200/1 MR
639074	CT 400kV 3150A 50KA 2P 2M32 2B12 25mm/kV	PPBBMM	1/3200T MR	1/1200T FR	3200/1 MR
639075	CT 400kV 3150A 50KA 3P 1M32 2B12 25mm/kV	PPPBBM	1/3200T MR	1/1200T FR	3200/1 MR
639076	CT 400kV 3150A 50KA 2P 2M32 2B24-16 25mm/kV	PPBBMM	1/3200T MR	1/2400T MR	3200/1 MR
639077	CT 400kV 3150A 50KA 3P 1M32 2B24-16	PPPBBM	1/3200T MR	1/2400T MR	3200/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
	25mm/kV				
639078	CT 400kV 3150A 50KA 2P 2M32 2B16-12 25mm/kV	PPBBMM	1/3200T MR	1/1600T MR	3200/1 MR
639079	CT 400kV 3150A 50KA 3P 1M32 2B16-12 25mm/kV	PPPBBM	1/3200T MR	1/1600T MR	3200/1 MR
639112	CT 400kV 4000A 63KA 2P 2M32 2B24 31mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
186755	CT 400kV 3150A 50kA 2P 2M32 2B24 31mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
186754	CT 400kV 3150A 50KA 3P 1M32 2B24 31mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
186662	CT 400kV 3150A 50KA 2P 2M32 2B16 31mm/kV	PPBBMM	1/3200T MR	1/1600T FR	3200/1 MR
186663	CT 400kV 3150A 50KA 3P 1M32 2B16 31mm/kV	PPPBBM	1/3200T MR	1/1600T FR	3200/1 MR
639090	CT 400kV 3150A 50KA 2P 2M32 2B12 31mm/kV	PPBBMM	1/3200T MR	1/1200T FR	3200/1 MR
639091	CT 400kV 3150A 50KA 3P 1M32 2B12 31mm/kV	PPPBBM	1/3200T MR	1/1200T FR	3200/1 MR
639092	CT 400kV 3150A 50KA 2P 2M32 2B24-16 31mm/kV	PPBBMM	1/3200T MR	1/2400T MR	3200/1 MR
639093	CT 400kV 3150A 50KA 3P 1M32 2B24-16 31mm/kV	PPPBBM	1/3200T MR	1/2400T MR	3200/1 MR
639094	CT 400kV 3150A 50KA 2P 2M32 2B16-12 31mm/kV	PPBBMM	1/3200T MR	1/1600T MR	3200/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
639095	CT 400kV 3150A 50KA 3P 1M32 2B16-12 31mm/kV	PPPBBM	1/3200T MR	1/1600T MR	3200/1 MR
639080	CT 400kV 2500A 50KA 2P 2M24 2B24 25mm/kV	PPBBMM	1/2400T MR	1/2400T FR	2400/1 MR
639081	CT 400kV 2500A 50KA 3P 1M24 2B24 25mm/kV	PPPBBM	1/2400T MR	1/2400T FR	2400/1 MR
639082	CT 400kV 2500A 50KA 2P 2M24 2B16 25mm/kV	PPBBMM	1/2400T MR	1/1600T FR	2400/1 MR
639083	CT 400kV 2500A 50KA 3P 1M24 2B16 25mm/kV	PPPBBM	1/2400T MR	1/1600T FR	2400/1 MR
639084	CT 400kV 2500A 50KA 2P 2M24 2B12 25mm/kV	PPBBMM	1/2400T MR	1/1200T FR	2400/1 MR
639085	CT 400kV 2500A 50KA 3P 1M24 2B12 25mm/kV	PPPBBM	1/2400T MR	1/1200T FR	2400/1 MR
639086	CT 400kV 2500A 50KA 2P 2M24 2B24-16 25mm/kV	PPBBMM	1/2400T MR	1/2400T MR	2400/1 MR
639087	CT 400kV 2500A 50KA 3P 1M24 2B24-16 25mm/kV	PPPBBM	1/2400T MR	1/2400T MR	2400/1 MR
639088	CT 400kV 2500A 50KA 2P 2M24 2B16-12 25mm/kV	PPBBMM	1/2400T MR	1/1600T MR	2400/1 MR
639089	CT 400kV 2500A 50KA 3P 1M24 2B16-12 25mm/kV	PPPBBM	1/2400T MR	1/1600T MR	2400/1 MR
639096	CT 400kV 2500A 50KA 2P 2M24 2B24 31mm/kV	PPBBMM	1/2400T MR	1/2400T FR	2400/1 MR
639097	CT 400kV 2500A 50KA 3P 1M24 2B24 31mm/kV	PPPBBM	1/2400T MR	1/2400T FR	2400/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
676124	CT 400kV 2500A 50KA 3P 1M24 2B20 31mm/kV	PPPBBM	1/2400T MR	1/2000T FR	2400/1 MR
186664	CT 400kV 2500A 50KA 2P 2M24 2B16 31mm/kV	PPBBMM	1/2400T MR	1/1600T FR	2400/1 MR
186665	CT 400kV 2500A 50KA 3P 1M24 2B16 31mm/kV	PPPBBM	1/2400T MR	1/1600T FR	2400/1 MR
186666	CT 400kV 2500A 50KA 2P 2M24 2B12 31mm/kV	PPBBMM	1/2400T MR	1/1200T FR	2400/1 MR
186668	CT 400kV 2500A 50KA 3P 1M24 2B12 31mm/kV	PPPBBM	1/2400T MR	1/1200T FR	2400/1 MR
639098	CT 400kV 2500A 50KA 2P 2M24 2B24-16 31mm/kV	PPBBMM	1/2400T MR	1/2400T MR	2400/1 MR
639099	CT 400kV 2500A 50KA 3P 1M24 2B24-16 31mm/kV	PPPBBM	1/2400T MR	1/2400T MR	2400/1 MR
639100	CT 400kV 2500A 50KA 2P 2M24 2B16-12 31mm/kV	PPBBMM	1/2400T MR	1/1600T MR	2400/1 MR
639101	CT 400kV 2500A 50KA 3P 1M24 2B16-12 31mm/kV	PPPBBM	1/2400T MR	1/1600T MR	2400/1 MR
8388	CT 400kV 3150A 50KA 2PTPY 2M32 2B24 31mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
639106	CT 400kV 3150A 63KA 2P 2M32 2B24 31mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
639107	CT 400kV 3150A 63KA 3P 1M32 2B24 31mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
639104	CT 400kV 3150A 63KA 2P 2M32 2B16 31mm/kV	PPBBMM	1/3200T MR	1/1600T FR	3200/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
639105	CT 400kV 3150A 63KA 3P 1M32 2B16 31mm/kV	PPPBBM	1/3200T MR	1/1600T FR	3200/1 MR
639110	CT 400kV 3150A 63KA 2P 2M32 2B24 25mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
639111	CT 400kV 3150A 63KA 3P 1M32 2B24 25mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
639108	CT 400kV 3150A 63KA 2P 2M32 2B16 25mm/kV	PPBBMM	1/3200T MR	1/1600T FR	3200/1 MR
639109	CT 400kV 3150A 63KA 3P 1M32 2B16 25mm/kV	PPPBBM	1/3200T MR	1/1600T FR	3200/1 MR
639102	CT 400kV 4000A 63kA 4P 2M 25mm/kV	PPPPMM	1/3200T MR	—	3200/1 MR
639103	CT 400kV 4000A 63kA 4P 2M 31mm/kV	PPPPMM	1/3200T MR	—	3200/1 MR
400kV Composite Current Transformers					
639740	CT 400kV 4000A 50kA 4P2M 38mm/kV	PPPPMM	1/3200T MR	—	3200/1 MR
639744	CT 400kV 3150A 50kA 4P2M 38mm/kV	PPPPMM	1/3200T MR	—	3200/1 MR
639709	CT 400kV 3150A 50kA 2P2M2B24 31mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
639730	CT 400kV 3150A 50kA 3P1M2B24 31mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
639725	CT 400kV 3150A 50kA 2P2M2B24-16 31mm/kV	PPBBMM	1/3200T MR	1/2400T MR	3200/1 MR
639732	CT 400kV 3150A 50kA 3P1M2B24-16 31mm/kV	PPPBBM	1/3200T MR	1/2400T MR	3200/1 MR
639729	CT 400kV 3150A 50kA 2P2M2B16-12 31mm/kV	PPBBMM	1/3200T MR	1/1600 MR	3200/1 MR
639733	CT 400kV 3150A 50kA 3P1M2B16-12	PPPBBM	1/3200T MR	1/1600 MR	3200/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
	31mm/kV				
765kV Composite Current Transformers					
639168	CT 765KV 800A 50KA 2P1M 25MM/KV	PPM	1/800T FR	—	800/1 FR
400484	CT 765KV 800A 50KA 2P1M 31MM/KV	PPM	1/800T FR	—	800/1 FR
639170	CT 765KV 3150A 50KA 4P2M 25MM	PPPPMM	1/3200T MR	—	3200/1 MR
403346	CT 765KV 3150A 50KA 4P2M 31	PPPPMM	1/3200T MR	—	3200/1 MR
1kV Toroidal Current Transformer					
639174	CT 1kV 800A 2P (TPY) Dry type toroidal	PP	1/800T FR	—	—

Notes:

1) There are current transformers used in Eskom which are regarded as non-standard due to low utilisation, when they are require, their special requirements shall be stated in technical schedule A.

2) Current transformers with 3 * Protection cores, 1 * Metering core and 2 * Bus zone cores are used for capacitor banks application. The core layout thereof shall be PPPBBM.

SECTION 5: PARTICULARS & GUARRANTEES

PART 5.2: 132KV CURRENT TRANSFORMER

SPECIFICATION NO:

ITEM	DESCRIPTION	UNIT	SPECIFIED REQUIREMENT	OFFERED AND GUARANTEED
5,2	**132kV Outdoor Current**			
	Manufacturer			
	Type number			
5.2.1	*Electrical parameters*			
5.2.1.1	Total creepage distance to earth	mm	3625	
5.2.1.2	Rated short-duration primary current / time	kA/S	31.5/3	
5.2.1.3	Voltage described in NRS 029 clause 4.2.1.2	kV		
5.2.1.4	Voltage described in NRS 029 clause 4.2.1.3	kV		
5.2.1.5	Is a capacitive tap terminal required?			
5.2.1.6	Ratio on which routine tests shall be carried out			
5.2.1.7	Is a tangent delta test required		Yes	
5.2.1.8	Method of earthing system neutral		Solid	
5.2.2	*Mechanical requirements*			
5.2.2.1	Primary terminals stem diameter	mm	38	
5.2.2.2	Type of bushing			
5.2.2.3	Quantity of oil in CT	lt.		
5.2.2.4	Type of cable box			
5.2.2.5	Minimum area of gland plate	mm	75 x 50	
5.2.2.6	Foundation bolt diameter	mm		
5.2.2.7	Foundation bolt plan	mm		
5.2.2.8	Sets of tender drawings		1	
5.2.2.9	Sets of contract drawings		3	

ITEM	DESCRIPTION	UNIT	SPECIFIED REQUIREMENT	OFFERED AND GUARANTEED
5.2.3.	*Current transformer particulars:*			
5.2.3.1	**current transformer**			
	Cores 1 & 2			
	a) Ratio (S1-S2 & S1-S3)		1200/1600/1A	
	b) Accuracy class		T	
	c) Knee point		1000V at 1200/1	
	d) Magnetising current at knee point		<50mA	
	e) Secondary resistance		<3 Ohms	
	Core 3			
	a) Ratio (S1-S2 & S1-S3)		1200/1600/1A	
	b) Accuracy class		5P15	
	c) Burden	VA	15	
	d) Resistance		3	
	Core 4 & 5			
	a) Ratio (S1-S2 & S1-S3)		1200/1600/1	
	b) Accuracy class		T	
	c) Knee point		1000 V	
	d) Magnetising current at knee point		50mA	
	e) Secondary resistance		3 Ohms	
5.2.4.1	Oil level indicator of prismatic or other approved type, where applicable		Yes	
5.2.4.2	Oil sampling device of approved type located at bottom of tank, where applicable		Yes	
5.2.4.3	Two valves, one at the top and one at the bottom of tank with a coupling for a flexible hose for connecting to the oil filtering plant, when applicable			
5.2.4.4	Lifting and jacking lugs which shall be welded or riveted to the tank		Yes	
	Robust underbase of the skid type.			
5.2.4.5	Rollers are not required		Yes	
5.2.4.6	Details of gas pressure instrumentation, where applicable			
5.2.4.7	Gas pressure indicator. where applicable		Yes	

ITEM	DESCRIPTION	UNIT	SPECIFIED REQUIREMENT	OFFERED AND GUARANTEED
5.2.4.8	Insulation medium (gas), where applicable		Yes	
5.2.4.9	Mass of gas per voltage transformer, where applicable		Yes	
5.2.4.10	Insulation material (outer body), where applicable		Porcelain	

Item

(I)
(II)
(III)
(IV)
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18
C19
C20
C21
C22

SCHEDULES A AND B

SUMMARY OF REQUIREMENTS FOR

275kV POST TYPE CURRENT TRANSFORMER TOP CORE DESIGN

Contents

275kV POST TYPE CURRENT TRANSFC
TOP CORE DESIGN

(I) Multi ratio (MR) Metering current transformers (Cores 1 & 2)

Nominal ratio	Tapping points on secondary windings	Ratios available
2400	1600/600/400/1	2400/2000/1800/1600/1200/1000/800/600/400/200/1

(II) Multi ratio (MR) Protection current transformers Cores 3 & 6

Nominal ratio	Tapping points on secondary windings	Ratios available
2400	1600/600/400/1	2400/2000/1800/1600/1200/1000/800/600/400/200/1

(III) Multi ratio Bus-zone protection current transformers (cores 4

As per Table 5 and 6 of NRS 029 - Ratios for multi ratio (BZ) protection (

Highest (nominal) ratio	Tapping points	Magnetization parameters at lowe
		Minimum excitation voltage V
1600/1	Fixed	**550**

꞉RMER

Burden capability VA	Accuracy class	Ratio
10	0,2	400/1

꞉ & 5)

꞉current transformers

꞉st ratio (in bold)	
Maximum magnetization current mA	**Maximum total winding resistance at 75 °C** Ω
50	**2**

275kV POST TYPE CURRENT TRANSFORMER
TOP CORE DESIGN

(IV) Summary of item requirements

Nominal system voltage	kV
Maximum system voltage	kV
Rated Switching impulse	kV
Rated Lightning impulse	kV
Nominal short-time thermal current	
a) Item 10 to 37	kA
Nominal primary current	
a) Item 1	A

Item	Short Description	Material Number
Item 1	CT 275kV 2500A 50kA 2P 2M 2B16 31mm/kV	

Legend:
1x, 2x, 3x, ….. = Number of secondary cores
Protective core: P24 = (2400/1)
Bus Zone core: B16 = (1600/1)
Metering core: M24 = (2400/1)

275
300
850
1050
50
2500

Summary of core requirements		
Protection	**Metering**	**Bus zone**
2 x P24	2 x M24	2 x B16

275kV POST TYPE CURRENT TRANSFORMER
TOP CORE DESIGN

Schedule A and B

Schedule A: Purchaser's specific requirements

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

Item	240-170000559 Sub-clause	Description	
C.1	**3**	**General requirements:**	
	3,2	**Service conditions** (if non-standard)	
		Ambient air temperature (average)	°C
		Altitude	m
		Average humidity	%
		Wind pressure	Pa
		Pollution level (heavy or very heavy)	
	5,6	1) Heavy - creepage distances (25mm/kV)	mm
		arcing distances	mm
	5,6	2) Very heavy - creepage distances (31mm/kV)	mm
		arcing distances	mm
C.2	4,1	**Application Details**	
		Nominal r.m.s. voltage (U_n)	kV
	4,10	Nominal primary current	
		a) Item 1	A
	4,10	Rated primary current	
		a) Item 1	A
	Table 1	Rated insulation level (switching impulse)	kV
		Basic insulation level (lightning impulse)	kV
	4,12	Nominal short-time current	
		a) thermal rating (r.m.s.)	kA
		b) time applicable to thermal rating	s
	4,13	c) dynamic rating	kA
	4,5	Frequency	Hz
	5,10	Maximum radio noise influence voltage	µV
C.3	6,9	**Type of current transformer offered**	
		Provide Manufacturer name	
		Provide Manufacturer's type designation	
C.4	6,5	**Details of high voltage insulator**	
		Manufacturer of HV porcelain insulators	
		Provide detailed drawing of HV insulator	
		Compliance with Specification: IEC 60815.	
C.5	5,1	**Details of oil-insulated current transformers**	
		Provide Type of oil	
		Is the oil certified free from polychlorinated biphenyls (Zero count)?	
		Quantity of oil required	kg
		Sealing arrangements required	

		Provide expansion accommodation method	
		Provide oil-level indicator	
		Provide oil sample valve and drawing	
C.6	5,2	**Gas-insulated current transformers**	
		Provide Type of gas (name)	
		Provide details of filling/evacuation valves	
		Provide details of density meter	
		Provide weight of gas	kg
		Provide certificate of gas compliance	
		Method of sealing	
C.7	4,3	**Primary terminals (pad type)**	
		Materials:	
		a) aluminium	
		Details of pad type terminal (IEC 60518)	
		a) number of holes	
		b) hole centres	mm
		c) hole size	dia
		d) orientation	
C.8	6	**Constructional requirements**	
	6,1	Seconary terminals (Spring-loaded screw clamp type: size 10mm)	
	6,2	Provide drawing of terminal box	
		Minimum effective gland area of secondary terminal box/gland plate: lengh x width	mm
	6,3	Provide capacitive tap	
C.9	6,6	**Mounting arrangement**	
		Holding down bolts to be arranged to fall within a square of maximum dimensions	mm
C10	6,7	**Metal finish**	
		Finish offered on ferrous parts	
		Finish offered on non-ferrous parts	
C.11	6,9	**Rating plates and diagram plates**	
		Provide details of materials used for rating plates	
		Provide details of material used for diagram plates	
		Provide details of method of fixing diagram and rating plates	
C.12	9	**Drawings and instruction manuals in English and in PDF format**	
		Quantity of drawings and literature required with tender	
		Provide Outline drawing	
	5.3.5	Number of instruction books required with tender	
		Number of descriptive pamphlets required with tender	
C.13	5,8	**Safety Design Features**	
		Provide details of compliance of safety design features: Proof of Internal arc withstand capability test	
C.14	4.9.1	**Details of measuring current transformers**	
		a) purpose	
	4.8.1.1	b) relative position of the core	
		c) nominal current ratio (Page 2 of Schedules A&B)	
		d) number of cores (Page 3 of Schedules A&B)	
		e) tap points at (Page 2 of Schedules A&B)	
	4.8.1.2	f) ratio selection on secondary	
		g) nominal continuous current	
		1) primary	A
		2) secondary	A
		h) short-time thermal r.m.s. current	
		1) primary	kA

		2) secondary (highest value)	A
		3) ratio for which (i)(2) applies	
		4) time	s
	Table 6	j) burden	VA
		k) accuracy class	
		l) ratio for which (j) and (k) apply	
		m) maximum secondary winding resistance at 75 °C	Ω
		Instrument security factor (FS)	
		Provide core steel details	
		a) grade	
		b) thickness of lamina	mm
		c) annealed?	
		d) B/H curve	
	7,6	Test certificates of individual routine tests are required and copies shall be placed in the terminal box	
C.15	4.9.2	**Details of protective current transformers**	
		a) purpose	
		b) accuracy class:	
	4.8.1.1	c) relative position of the core	
		d) nominal turns ratio (Page 2 of Schedules A&B)	
		e) number of cores (Page 3 of Schedules A&B)	
		f) tap points (Page 2 of Schedules A&B)	
	4.8.1.2	g) ratio selection on	
		h) nominal continuous thermal r.m.s. current	
		1) primary	A
		2) secondary	A
		j) short-time thermal r.m.s. current	
		1) primary	kA
		2) secondary (highest value)	A
		3) ratio for which (j)(2) applies	
		4) time	s
		k) burden	VA
		l) accuracy limit factor (class P cores)	
		m) E_{al} or knee-point r.m.s. voltage	V
		n) maximum magnetization current at E_{al} or knee-point	mA
		p) ratio for which (b), (m) and (n) apply	
		q) maximum secondary winding resistance at 75 °C	Ω
		r) maximum voltage on terminals of windings(s) not connected to the burden	
		Provide drawing number of magnetization curve	
		Provide core steel details	
		a) grade	
		b) thickness of lamina	mm
		c) annealed?	
		d) B/H curve	
	7,6	Test certificates of individual routine tests are required and copies shall be placed in the terminal box	
C.16	4.9.2.3	**Details of bus zone cores (Fixed)**	
		a) purpose	
		b) accuracy class: (note that (l) apply)	
	4.8.1.1	c) relative position of the core	
		d) nominal turns ratio	

		e) number of cores (Summary of item requirements)	
		f) tap points	
	4.8.1.2	g) ratio selection on secondary	
		h) nominal continuous thermal r.m.s. current	
		1) primary (item 22 - 23)	A
		2) secondary	A
		j) nominal short-time thermal r.m.s. current	
		1) primary	kA
		2) secondary (highest value)	A
		3) ratio for which (j)(2) applies	
		4) time	s
		k) E_{al} or knee-point r.m.s. voltage	V
		l) maximum magnetization r.m.s. current	mA
		m) ratio at which (k) and (l) apply	
		n) maximum secondary winding resistance at 75 °C	Ω
		Provide drawing number of magnetization curve	
		Provide core steel details	
		a) grade	
		b) thickness of lamina	mm
		c) annealed?	
		d) B/H curve	
	7,6	Test certificates of individual routine tests are required and copies shall be placed in the terminal box	
C.17	7	**Tests**	
		Provide valid type test certificates on the design offered	
C.18	7,2	**Impulse tests on primary winding**	
		a) minimum crest value of full-wave impulse type	
		test voltage at sea level	kV
		b) Indicate the test impulse wave shape used	μs
C.19	7,3	**High-voltage power-frequency withstand tests**	
		Minimum 60 s power-frequency wet withstand type	
		test voltage at sea level	kV
		Minimum 60 s power-frequency dry withstand	
		routine test voltage at sea level	kV
C.20	7,2	**Short-time current test** (see C.2)	
		a) short-time withstand current	kA
		b) time	s
C.21	7,2	**Type Test requirements**	
		Short-time current test	
		Temperature rise test	
		lightning Impulse Withstand	
		Swtching impulse voltage test	
		Radio interference voltage	
		Transmitted overvoltage test	
		Determination or errors (Test for Accuracy)	
		Verification of the degree of protection by enclosures	
		Enclosure tightness test at ambient temperature (gas insulated CTs)	
		Pressure test for enclosure (gas insulated CTs)	
C.22	7,4	**Special test requirements**	
		Chopped impulse voltage withstand test	
		Mechanical test on primary terminals	

		Capacitance and dielectric dissipation factor test
		Internal arc fault test
		Corrosion test

Schedule A	Schedule B
–10 to +40	xxxxxxxxxx
1800	xxxxxxxxxx
95	xxxxxxxxxx
700	xxxxxxxxxx
Heavy	
Heavy	
Very heavy	
Very heavy	
275	
2500	
2500	
850	
1050	
50	____________
1	____________
127,5	____________
50	xxxxxxxxxx
2500	
Yes	____________
Yes	____________
Yes	____________
Yes	____________
Yes	
Yes	____________
Yes	____________
Yes	____________
Yes	____________

Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
-	
8	
50	
14	
Horizontal	
Yes	
Yes	
130 x 75	
Yes	
706	
xxxxxxxxxx	
xxxxxxxxxx	
Yes	
Yes	
Yes	
1	
Yes	
1	
1	
Yes	
M24	
Metering	
Comply	
2400/1	
Comply	
Comply	
Comply	
2500	
1	
50	

-	
-	
1	
10	
0,2	
400/1	
-	
20	
On request	
On request	
On request	
Yes	
Comply	
P24	
Protection	
PX	
Comply	
2400/1	
Comply	
Comply	
Secondary	
2500	
1	
50	
-	
-	
1	
xxxxxxxxxx	xxxxxxxxxx
xxxxxxxxxx	xxxxxxxxxx
2400	
42	
2400/1	
9,6	
-	
Yes	
On request	
On request	
On request	
Yes	
Comply	
B16	
Bus zone	
PX	
Comply	
1600/1	

Comply	
1600/1	
Yes	
2500	
1	
50	
31,25	
1600/1	
1	
550	
50	
1600/1	
2	
Yes	
On request	
On request	
On request	
Yes	
Comply	
Yes	
1050	
1/50 or 1.2/50 or 1,5/40	
460	
460	
50	
1	
	Report Name/No.
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
Yes	
	Report Name/No.
Yes	
Yes	

Yes	
Yes	
Yes	

NON

The equipment to be supplied c
Specification and Schedule A, v

1.2 Specification

Page	Paragraph

1.3 Schedule A

Page	Paragraph

Any deviations offered to this spec
evidence shall be provided that th
specified by Eskom.

Item	Clause

N- COMPLIANCE SCHEDULES

omplies in all respects with the requirements of the
vith the exception of the following points:

Deviation or Non-compliance

Deviation or Non-compliance

Deviation schedule

ification shall be listed below with reasons for deviation. In addition,
e proposed deviation will at least be more cost-effective than that

Proposed deviation

SECTION 5: PARTICULAR & GUARRANTEES

PART 6.1: BUSBARS, CONNECTIONS & CLAMPS

SPECIFICATION NO:

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
1	**Conductor tube**			
1,1	Type		Aluminium tube	
1,2	Place of application		Main & Reserve Bar	
1,3	Maximum current carrying capacity (continuous)	A	2370 at 65deg C	
1,4	Short circuit rating (3 s)	kA		
1.4.1	Max dynamic forces exerted in short circuit	N		
1.4.2	Maximum deflection of busbar and support insulators under short circuit conditions	mm		
1,5	Material		Aluminium	
1,6	Diameter	mm	120	
1,7	Wall thickness	mm	6	
1,8	Max span	m	12 (max.)	
1,9	Sag under gravity	mm		
1,10	Other	mm		
2	**Stranded conductor**			
2,1	Place of application			
2,2	Size of conductor			
2,3	Material			
2,4	Maximum current carrying capacity (continuous)	A		
2,5	Short circuit rating (3 s)	A		
3	**Clamps** (with potensial clips)			
3,1	Types being offered :			
3.1.1	Drawings numbers			
3.1.2	Current rating - continuous	A	2370 (min.)	
3.1.3	Manufacturer			
3,2	Types being offered :			
3.2.1	Drawings numbers			
3.2.2	Current rating - continuous	A	2370 (min.)	
3.2.3	Manufacturer			
3,3	Types being offered :			
3.3.1	Drawings numbers			

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
3.3.2	Current rating - continuous	A	2370 (min.)	
3.3.3	Manufacturer			

Eskom	**Standard**	**Technology**

Title: **OUTDOOR CERAMIC STATION POST INSULATORS FOR SYSTEMS WITH NOMINAL VOLTAGES UP TO 765KV SPECIFICATION**

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HV Plant SC Chairperson

Date: 23/10/2015

PCM Reference: **<xxxxxx>**

SCOT Study Committee Number/Name: **<Number or name>**

Content

Tables

1. Introduction

The specification for station post insulators was previously included in the station disconnector specification, but was found not to adequately specify the requirements.

Certain electrical and mechanical characteristics are rationalised in order to achieve standardization. For those parameters, which can be varied, the preferred values are specified.

It is intended that the insulators specified in this document be used for the construction of all new or refurbished substations. The insulator lengths and end fittings specified are critical and deviation from these outside of the allowable tolerances will result in a tender offer being rejected.

Insulators for maintenance may not have standard connecting lengths or standard end fittings as specified in this specification. In these cases this specification must be used as a basis for the majority of the requirements, whilst specifying the particular connecting lengths or end fittings for the application in the technical schedule of an enquiry document.

2. Supporting clauses

2.1 Scope

This specification covers the Eskom specific technical requirements for station post insulators for use in substations with nominal system voltages up to 765kV. The insulator ratings have been rationalised for application at the following nominal system voltages: 22kV, 33kV, 66kV, 132kV 220kV, 275kV, 400kV and 765kV (See Table 1).

2.1.1 Purpose

To document, have on record and refer to as required, Eskom's specific technical requirements for station post insulators for use in substations with nominal system voltages up to 765kV.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001 Quality Management Systems.

[2] SANS/IEC 60815, Selection and dimensioning of high voltage insulators for use in polluted conditions, Part 1: Definitions, information and general principles & Part 2: Ceramic and glass insulators for a.c. systems.

[3] SANS/IEC 60273, Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.

[4] SANS/IEC 60168, Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000V.

[5] SANS/IEC 60060-1, High-voltage test techniques – Part 1: General definitions and test requirements.

[6] SANS 121 [Equivalent to ISO 1461], Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods.

[7] ISO/IEC 17011, Conformity assessment — General requirements for accreditation bodies accrediting conformity assessment bodies.

[8] 240-56062328 KIPTS Natural Ageing and Pollution Performance Test Procedure for Outdoor Insulator Products Section 0 - General Requirements Work Instruction.

[9] 240-56030420 KIPTS Natural Ageing Test Procedure for Outdoor Insulator Products Section 1 - Particular Requirements for Post, Long Rod and Stand-Off Insulators Work Instruction.

[10] IEC 60437, Radio interference test on high-voltage insulators.

[11] IEC 60507, Artificial pollution tests on high-voltage insulators to be used on a.c. systems.

[12] ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories.

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

Definition	Description
Accredited testing laboratory/authority	A laboratory which is ISO/IEC 17025 accredited and/or that which holds valid certification issued by ILAC (International Laboratory Accreditation Corporation) or one of its members
Certified test report	A certificate of tests performed as specified within the specification, and carried out by an accredited authority or by the manufacturer and witnessed by an accredited authority that has been accredited in accordance with ISO/IEC 17011.
Crack	A surface fracture greater than 0,1 mm deep
Metal fittings of an insulator	Devices that form part of an insulator and intended to connect it to a supporting structure or to a conductor. The two fittings referred to in this specification are the earth end and a line or live end.

Note: All other definitions are as described in the relevant normative references listed above.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
AMSL	Above Mean Sea Level
g	Acceleration due to gravity
KIPTS	Koeberg Insulator Pollution Test Station
MCFL	Minimum Cantilever Failing Load
PCD	Pitch Circle Diameter
r.m.s	Root mean square

2.5 Roles and responsibilities

The Air Insulation Care Group leader must ensure that this document is updated, renewed and current at all times.

2.6 Process for monitoring

Not applicable

2.7 Related/supporting documents

Not applicable

3. Specification for Outdoor Ceramic Station Post Insulators for Systems with Nominal Voltages up to 765kV

3.1 Requirements

3.1.1 General

No conditions in this specification shall lessen the obligations of the supplier as detailed in any other documents forming part of a contract. The insulators shall be designed, manufactured and tested as specified herein, as per the normative references listed and as per the requirement of the technical schedule of an enquiry document.

All evaluation submissions shall be supplied electronically as well as in printed format. All information must be supplied in English. Details of the format and structure of the submission shall be made available at the time of issuing the enquiry document.

3.1.2 Manufacturer/supplier Credentials

The manufacturer/supplier shall have access to the engineering facilities necessary to provide technical service and information, advice and after-sales service related to the products under consideration. The manufacturer/supplier must have adequate local technical competency to deal with technical and quality issues related to their products.

The manufacturer/supplier is requested to provide a list of references indicating the country, name of the customer, system voltage, quantity and year of delivery for substantial previous orders. Eskom will perform a comparison of these details with the type of insulator being offered against the enquiry.

3.1.3 Product Acceptance

Only insulators that have been evaluated and accepted by Eskom will be procured for use on the Eskom system.

The manufacturer/supplier shall be fully responsible for his designs and their satisfactory performance in service. Acceptance by Eskom shall not absolve the supplier of the responsibility for the adequacy of the design, dimensions and other details.

Manufacturers'/supplier's catalogues shall not refer to any product as "Eskom approved" or "Eskom accepted".

3.1.4 Quality System Assessment

Quality assessment will be done in conjunction with the technical acceptance. This assessment shall not override any quality requirements that are specified in a contract document.

3.1.5 Samples

Samples of insulators may be requested as part of the technical evaluation process.

3.1.6 Drawings and Manuals

Each acceptance package shall include one copy of the general arrangement drawings of the insulator and components offered. In addition it should contain detailed assembly, handling and transport instructions

The drawings shall clearly show the following information:

a) Eskom drawing number and applicable revision (Eskom will allocate the number after the drawing has been approved.

b) All dimensions and associated tolerances of the insulator housing and top and bottom end fittings (mounting hole details, PCD etc.)

c) Minimum nominal total creepage distance and specific creepage distance

d) Detailed dimensioned profile of shed pair.

e) Material description and fabrication details (e.g. “fabrication method and materials used)

f) Electrical properties: The lightning impulse withstand level (basic insulation level), switching impulse withstand level, power frequency withstand level, etc, as defined in the normative standards listed.

g) Mechanical properties: The minimum cantilever and torsion failing loads as defined in the normative standards listed.

h) Detail of end fitting flange mounting holes, corona rings, material and corrosion treatment if applicable.

i) Mass of complete insulator assembly.

j) Colour of the glaze.

k) Supplier’s product code numbers.

l) Location and description of identification markings on the insulator body.

m) All dimensions and associated tolerances of all fasteners and associated fittings

Notes:

- All parameters shall be in metric units and dimensions in millimetres.
- Drawings must be supplied in both scale PDF and acceptable CAD format.
- Indicate on drawings whether SCD or USCD is utilized.
- Maintenance and operating manuals shall be supplied with a tender.
- All information submitted must be in English.

3.1.7 Insulator Type and Material

Post insulators and post insulator units shall be of the cylindrical, solid-core type with cemented external metal fittings. The insulating material shall be of glazed porcelain. The colour of the glaze shall be dark brown in colour, unless otherwise approved. The use of alternative material may be offered as an option, but shall be subject to Eskom approval.

The ceramic body shall be sound, thoroughly vitrified and free of defects and blemishes that could adversely affect the performance or durability of the post insulator. The insulators shall be capable of withstanding seismic events of up to 0,3g. The exposed parts of the ceramic body shall be smoothly glazed and free of surface defects, inclusions etc. that could detrimentally affect the performance of the post insulator.

3.1.8 Electrical Insulation Withstand Levels

The rated insulation withstand levels for lightning and switching impulse, as well as short time power frequency withstand are specified in Table 1, and are in accordance with standard values in SANS 60273. The service conditions for South Africa are rationalised for altitudes up to 1800m. Although the insulation levels in Table 1 are specified at an altitude of 0 - 1000m, the values have been selected for appropriate insulation coordination for altitudes up to 1800m and need not be corrected for altitude. The insulators should be supplied with standard values as per Table 1. Test values must however be corrected for deviations from the standard reference atmospheric conditions in accordance with SANS 60060-1.

Table 1: Insulation Withstand Levels at 1000m AMSL

1	2	3	4	5
Nominal system voltage	**Maximum system voltage**	**Rated lightning impulse withstand voltage**	**Rated switching impulse withstand (wet) voltage**	**Rated short duration wet power frequency withstand voltage**
kV r.m.s.	kV r.m.s.	kV (peak)	kV (peak)	kV r.m.s.
22	24	150	-	50
33	36	200	-	70
66	72,5	350	-	140
132	145	550	-	230
220	245	1050[1]	750	460
275	300	1175[2]	850	-
400	420	1425[3]	950	-
		1550[4]	1050	-
765	800	2100	1300	-

Notes:

1) 1050 kV rated insulators may be required for extensions at existing 220kV substations

2) 1175kV rated insulators is the standard for all new build 220 and 275kV substations

3) 1425kV rated insulators may be required for extensions at existing 400kV substations

4) 1550kV rated insulators is the standard for all new build 400kV substations

3.1.9 Dimensional characteristics

3.1.9.1 Insulation Creepage

Eskom has rationalised on three site pollution severity classes as defined in SANS 60815 Part 1, as follows:

a) For all nominal voltages >132 kV, class “d - Heavy” and “e - Very heavy” are specified.

b) For all nominal voltages ≤132 kV, class “c-Medium”, class “d - Heavy” and “e - Very heavy” is specified.

The minimum specific and unified specific creepage distances at the maximum continuous system voltage (Um) for these site pollution severity classes are given in Table 2.

Table 2: Creepage requirements

1	2	3	4
Pollution zone	**Voltage application range**	**SCD**	**USCD**
		mm/kV	mm/kV
c- Medium (M)	≤ 132 kV	20	34,7
d - Heavy (H)	All voltages	25	43,3
e - Very heavy (VH)	All voltages	31	53,7

Notes: Depending on the insulator design, the specific creepage distance required to successfully complete the KIPTS test requirement (see 3.2.2.3), might be higher than that listed in the table above. Items 14C, 15C, 16C & 17C listed in the Annex, require a minimum SCD of 38 mm/kV.

3.1.9.2 Insulator shed profile

Insulator shed profiles shall be designed in accordance with SANS 60815. Alternating sheds with an "open" or "aerodynamic" profile are preferred. Designs utilising "Under-ribs", in order to increase the creepage distance, shall not be accepted. The following parameters apply to the shed profile and are the recommended minimum values in SANS 60815 for full compliance:

a) The shed spacing-projection (s/p) ratio shall be at least 0,65.

b) The minimum distance between sheds:

- For insulator lengths greater than 550mm shall be 30mm
- For insulator lengths less than or equal to 550mm shall be 25mm

c) The creepage to clearance ratio (l/d) shall not exceed 5.

d) The shed angle shall be between 5º and 22,5º

e) The creepage factor shall be not exceed:

- 3,75 for SPS Class "c" ("Medium" pollution class)
- 3,875 for SPS Class "d" ("Heavy" pollution class)
- 4,0 for SPS Class "e" ("Extra heavy" pollution class)

Above the dimensional constraints of the shed profile, the sheds shall be sufficiently robust to withstand reasonable handling and transportation stresses.

3.1.9.3 Overall dimensions

The height of the post insulator is a critical dimension from the electrical performance and mechanical design perspectives, and cannot be deviated from. Two heights are specified in some cases for a given voltage, as there are different specifications for some existing installations, and for new installations. The height of the insulator is specified in Table 2.

The diameter of the insulating part is also stated in Table 3 below.

3.1.10 Mechanical characteristics

3.1.10.1 Cantilever strength

Post insulators shall be standardised in mechanical strength classes based on the values of the specified minimum cantilever failing load in the bending test according to the classification in SANS 60273 and are tabulated in Table 3.

3.1.10.2 Torsional strength

Torsional failing load is critical for application in disconnector switches. The minimum values are as per SANS 600273 and are tabulated in Table 3.

Table 3: Post Insulator Dimensions and Mechanical Characteristics

1	2	3	4	5	6
Item	**IEC classification**	**Height**	**Max nominal diameter of insulating part**	**Cantilever failing load**	**Torsion failing load**
		mm	**mm**	**N**	**Nm**
1	C4-150	355 ± 1	195	4000	1000
2	C4-200	475 ± 1	210	4000	1200
3	C4-325[1]	770 ± 1	225	4000	2000
4	C4-550	1220 ± 1	300	4000	3000
5	C6-550		300	6000	4000
6	C10-550		350	10000	4000
7	C12.5-550		350	12500	6000
8	C10-1050	2300±3,5	450	10000	4000
9	C4-1175	2650±4,5		4000	3000
10	C6-1175			6000	3000
11	C10-1175			10000	4000
12	C12.5-1175			12500	6000
13	C10-1425	3150±4,5		10000	4000
14	C6-1550	3350±4,5		6000	3000
15	C10-1550			10000	4000
16	C12.5-1550			12500	6000
17	C16-1550			16000	6000
18	C8-2100	4700±5,5		8000	4000

Notes:

1) As per Table 1, the required **Rated lightning impulse withstand voltage** is 350 kV (peak)

3.1.11 Fixing Arrangements

The end fittings shall comply with the dimensional characteristics stated in SANS 60273. The end fittings shall be manufactured from cast iron. The mechanical strength of the end fittings shall be demonstrated with the appropriate mechanical tests. Portland and alumina cements are preferred for metal end fitting attachment. The use of sulphur cement is not acceptable.

Corona rings shall be supplied with the insulators as part of the supply contract, for installation on the live end for applications at both live and dead end as necessary to meet the RIV limits. The dimensions of the corona ring shall be such that adequate dry arcing distance is maintained to meet impulse withstand levels.If corona rings are required, these must be supplied with each unit and details on dimensions, mounting and finish must be provided in the submission.

Galvanised fasteners shall be supplied to assemble a complete post insulator unit.

In addition, fasteners that are required for mounting the post insulator base flange to the supporting structure must be provided and packaged appropriately with each supplied post insulator, meeting the following minimum criteria:

- Bolt length: The bolt length shall be equivalent to the sum of the width of the post insulator base flange, supplied nut, supplied washers and an additional 15mm.
- Bolt Type: Grade 8.8 or superior shall be supplied.
- Bolt Size: This is to be determined by the manufacturer. The integrity of the fastening arrangement supplied shall be able to withstand all forces placed on the post insulator up to and including the maximum failing load ratings. Detailed confirmation or suitable calculation showing that this requirement is met must be supplied.
- All ferrous fasteners and associated fittings shall be hot dip galvanised in accordance with SANS 121 to a minimum coating thickness of 100 µm.
- Detailed drawings, specification and ratings of the supplied fasteners, associated components and fastening arrangement must be submitted and shall be subject to Eskom acceptance.
- Fasteners and its associated fittings must be individually packaged for each post insulator supplied i.e. fasteners and associated fittings for more than one post insulators cannot be supplied in the same package.

The top and bottom flanges of the end fittings shall have PCDs, holes and thread sizes as listed in Table 4. “Plain” indicates that the holes are not tapped.

Table 4: Post Insulator PCD Requirements

1	2	3	4	5	6
Item	**IEC classification**	**Top fitting PCD**	**Hole detail**	**Bottom fitting PCD**	**Hole detail**
		mm		mm	
1	C4-150	76	4 X M12 (Tapped)	76	4 X M12 (Tapped)
2	C4-200	76	4 X M12 (Tapped)	76	4 X M12 (Tapped)
3	C4-325	127	4 X M16 (Tapped)	127	4 X M16 (Tapped)
4	C4-550	127	4 X M16 (Tapped)	127	4 X M16 (Tapped)
5	C6-550	127	4 X M16 (Tapped)	127	4 X M16 (Tapped)
6	C10-550	127	4 X M16 (Tapped)	225	4 X 18mm (Plain)
7	C12.5-550	127	4 X M16 (Tapped)	254	8 X 18mm (Plain)
8	C10-1050	225	4 X 18mm (Plain)	275	8 X 18mm (Plain)
9	C4-1175	127	4 X M16 (Tapped)	225	4 X 18mm (Plain)
10	C6-1175	127	4 X M16 (Tapped)	254	8 X 18mm (Plain)
11	C10-1175	225	4 X 18mm (Plain)	275	8 X 18mm (Plain)
12	C12.5-1175	225	4 X 18mm (Plain)	300	8 X 18mm (Plain)
13	C10-1425	225	4 X 18mm (Plain)	300	8 X 18mm (Plain)
14	C6-1550	127	4 X M16 (Tapped)	254	8 X 18mm (Plain)
15	C10-1550	225	4 X 18mm (Plain)	300	8 X 18mm (Plain)
16	C12.5-1550	225	4 X 18mm (Plain)	325	8 X 18mm (Plain)
17	C16-1550	225	4 X 18mm (Plain)	356	8 X 18mm (Plain)
18	C8-2100	225	4 X 18mm (Plain)	325	8 X 18mm (Plain)

3.1.12 Metal Finish

All ferrous fittings shall be hot dip galvanised in accordance with SANS 121 to a minimum coating thickness of 100 µm. Threaded holes shall be suitable for standard metric sized bolts, after the galvanising process. The thread of tapped holes shall not be re-tapped after galvanising.

3.1.13 Insulator Identification

The insulator shall be indelibly marked with the following information:

a) “IEC classification” according to SANS 60273

b) Minimum nominal total creepage distance in mm

c) Manufacturer’s name or trademark;

d) Manufacturer’s type or model number, batch number and year of manufacture

The markings shall be clearly legible and in English. Markings on the insulating unit shall remain legible during the lifetime of the insulator.

For porcelain insulators, the markings shall be a transfer that is fired into the glaze of the top shed.

3.1.14 Packaging

Details of the proposed packaging method shall accompany a tender offer, and shall be subject to Eskom acceptance.

The insulators shall be packaged in robust wooden crates, individually protected and suitably supported in order to protect the insulators from the stresses of normal handling that can be expected from the point of despatch to the point of construction. The crates must be designed such that inspection can be affected without opening or damaging the crate. The crate must be able to be lifted by slings with lifting points clearly marked. Any special handling requirements shall be clearly specified to purchaser before delivery and shall be clearly specified on packaging.

The packaging shall not disintegrate due to exposure to rain and direct sunlight during outdoor storage and the construction period of 18 months in total. The manufacturer/supplier shall notify the purchaser of any special methods recommended for storage prior to delivery, and on packaging materials.

If insulators are packed in boxes or crates on pallets, the gross weight of the pallets shall not exceed 1800kg. Pallets shall be suitable for handling by forklift trucks, capable of entry from both sides. Each pallet shall be fitted with a shock indicator to indicate if the pallet was subjected to high impacts during transit. All boxes, pallets or containers shall be clearly marked in accordance with the following template or similar approved:

Eskom Order No.:
Eskom SAP No.:
Project Name:
Project Number:
Delivery Address:
Suppliers Name:
Supplier’s Serial No.:
Description of Material:
Gross Weight:

3.1.15 Delivery

Eskom shall only accept delivery to the destination specified in the contract. Arrangements for acceptance, off-loading and trans-shipping including off-loading at the final destination shall be pre-arranged and will be the responsibility of the supplier.

3.2 Testing and inspection

a) Single copies of type test reports, in English, shall be submitted with a tender to prove that the station post insulators offered comply fully with the provisions of the standards stipulated in the normative references as well as for any further requirements as stipulated in this specification and in the relevant Technical Schedule and Annexes. Should such evidence not be available, the relevant type tests will be performed and the costs thereof paid by the manufacturer or supplier. If all the required type test reports are not submitted, the tender will be rated incomplete and shall not be considered. If required, any special test reports will be submitted as soon as possible and at least three months before dispatch.

b) All test reports shall be an accredited testing laboratory. An accredited testing laboratory is defined as that which is ISO/IEC 17025 accredited and/or that which holds valid certification issued by ILAC (International Laboratory Accreditation Corporation) or one of its members.

c) Eskom reserves the right to appoint a representative to inspect the products offered at any stage of manufacture and to witness and sanction any tests. If inspection or witnessing of tests is required, Eskom will advise the contractor who will then give eight weeks' notice of the date on which impending inspection or testing will take place.

d) Any design change must be verified by tests wherever applicable and will be subject to Eskom's approval.

3.2.1 General

Insulators manufactured from glazed porcelain shall comply with the testing requirements of SANS 60168.

Eskom reserves the right to subject randomly selected insulators that have been delivered, to qualifying design or type tests. The costs of such testing shall be for Eskom's account only for those insulators that pass the tests. However, for the insulators that fail these tests and for any subsequent testing, the cost shall be for the supplier's account. Failure to pass qualifying design tests will result in rejection of all insulators from the supplier, until the problem is satisfactorily resolved.

In addition to the test requirements of SANS 60168, the following test requirements shall apply:

3.2.2 Type Tests

3.2.2.1 Standard Tests

Post insulators shall be subject to the following standard type tests for outdoor applications as specified in SANS 60168:

a) Verification of dimensions

b) Dry lightning impulse withstand voltage test

c) Wet switching impulse withstand voltage test

d) Wet power-frequency withstand voltage test

e) Mechanical failing load test carried out in bending

Note 1: Additional mechanical load failing tests may be required depending on the insulator application as agreed between the Eskom and the manufacturer

3.2.2.2 Special Tests according to IEC

Where indicated in the technical schedules, the following special tests are required:

a) Radio interference test (see IEC 60437). For ceramic post insulators, the RIV test shall be performed as in service with the relevant fittings installed for applications at nominal system voltages of 132kV and above. The test shall be compensated for relative air density consistent with an altitude of 1800m above sea level. The limit for RIV shall be 65dB at 0.5MHz under dry conditions at the service altitude of 1800m.

b) Details of tests undertaken and the test setup used must be supplied with the tender submission and will be evaluated by Eskom for its conformity to field service conditions. If required, additional tests may be stipulated, for the cost of the supplier, to better represent field service conditions.

c) Artificial pollution test (see IEC 60507). Details of artificial pollution tests conducted in accordance with IEC 60507 and pollution levels evaluated must be must be supplied with the tender submission. This will be evaluated for its acceptability in relation to the creepage levels offered and their intended application in the different pollution environments as stipulated in section 3.1.9.1. If required, additional tests may be stipulated, for the cost of the supplier, to better represent field service conditions.

3.2.2.3 Special Test: Eskom KIPTS Natural Ageing and Pollution Performance Test

Only for items in which it is requested in the technical schedules, KIPTS certificates must be supplied for Light-Medium (LM) and Heavy- Very Heavy (HVH) pollution cycles. The KIPTS test facility limitation is currently (2014) up to 132kV. Therefore the test requirement is split according to nominal system voltage level as follows:

a) $U_n \leq$ 132kV: For insulators for applications up to nominal system voltages of 132kV (i.e. lightning Impulse withstand up to and including 550kV), the Eskom KIPTS “Natural aging and pollution performance test” is to be conducted in place of the IEC 60507 artificial pollution test. The test shall be according to Eskom procedures 240-56062328 and 240-56030420. The test commencement date and test duration shall be as defined in 240-56030420.

b) $U_n >$ 132kV: For insulators for applications with nominal voltages greater than 132kV (i.e. lightning impulse withstand greater than 550kV), the results from the test on 132kV insulator will be extrapolated to longer insulators having the same design in addition to performing the IEC 60507 artificial pollution test.

3.2.3 Sample Tests

The following sample tests shall be performed, as applicable on the number of post insulators selected at random from the lot, in accordance with SANS 60168:

a) Verification of the dimensions

b) Temperature cycle test

c) Mechanical failing load test carried out in bending

d) Porosity test

e) Galvanizing test

Note: Samples that are subjected to tests that may affect their mechanical and/or electrical characteristics shall not be used in service that is b, c and d.

3.2.4 Routine Tests

Routine tests shall be performed in accordance with SANS 60168 on all post insulators units prior to despatch from the manufacturer's works.

Test certificates of the results of production routine tests shall be retained by the supplier and shall be available for Eskom's inspection. The following tests are to be carried out on all insulator units:

Visual examination

Mechanical test (50 % of the specified mechanical failing load, shall be applied in four mutually perpendicular directions, each for a minimum time of 3 s)

Note: The routine mechanical test should be a bending test, unless otherwise indicated by the duty required of the post insulator (e.g. Switch disconnector application). The method for the routine test shall be agreed between Eskom and the manufacturer.

3.2.5 Test Certificates

Single copies of all certificates and full reports of type tests performed by an accredited test authority shall be submitted with a tender offer, unless Eskom waives this requirement due to a previous evaluation of the product. The test certificate for any insulator shall be easily traceable by reference to the insulator markings. The test certificates shall be in English.

Although routine test certificates are not required for submission and approval, Eskom reserves the right to call for copies of routine test certificates for a period of one year after the date of delivery.

3.2.6 Works Inspections and Witnessing of Tests

Eskom reserves the right to appoint a representative to inspect the post insulators at any stage of manufacture, or to be present at any of the tests specified.

Eskom requests to be notified at least sixty days prior to any tests or quality control hold point activities related to production of the post insulators as agreed with the supplier.

4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Kevin Kleinhans	Chief Engineer
Gavin Strelec	Chief Engineer
Nishal Mahatho	Senior Consultant
Raphael Swinny	Middle Manager

Name and surname	Designation
Fernando Witbooi	Chief Technologist
Jason Blaauw	Senior Engineer
Krishna Naidoo	Senior Engineer
Noor Adam	Engineer
Lester Geldenhuis	Chief Engineer
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5. Revisions

Date	Rev	Compiler	Remarks
Oct 2015	4	T Govender Chief Engineer	Minor corrections, inclusion of summary sheets for type tests, drawing details and deviations.
June 2014	3	T Govender Chief Engineer	Changes undertaken to comply with new procurement policy. Non-KIPTS items included.
May 2014	2	T Govender Chief Engineer	25 mm/kV for $U_n \leq$ 132kV is introduced. The supply of mounting bolts and fittings are incorporated. Additional items for Weskesfleur substation is included.
May 2013	1	K. Kleinhans Chief Engineer	Final Document for Publication
Nov 2012	0	K. Kleinhans Chief Engineer	Draft document for Review created from DSP 34-2202

6. Development team

The following people were involved in the development of this document:

- T Govender
- K Kleinhans

7. Acknowledgements

The Air Insulation Care Group members are acknowledged for their input in compiling this document.

Annex A – Technical Schedules

Item	Title	Offered (Y/N)
1A	INSUL POST C4-150 20mm/kV (KIPTS)	
1B	INSUL POST C4-150 25mm/kV (KIPTS)	
1C	INSUL POST C4-150 31mm/kV (KIPTS)	
1D	INSUL POST C4-150 20mm/kV (Non- KIPTS)	
1E	INSUL POST C4-150 25mm/kV (Non- KIPTS)	
1F	INSUL POST C4-150 31mm/kV (Non- KIPTS)	
2A	INSUL POST C4-200 20mm/kV (KIPTS)	
2B	INSUL POST C4-200 25mm/Kv (KIPTS)	
2C	INSUL POST C4-200 31mm/kV (KIPTS)	
2D	INSUL POST C4-200 20mm/kV (Non- KIPTS)	
2E	INSUL POST C4-200 25mm/kV (Non- KIPTS)	
2F	INSUL POST C4-200 31mm/kV (Non- KIPTS)	
3A	INSUL POST C4-325 20mm/Kv (KIPTS)	
3B	INSUL POST C4-325 25mm/kV (KIPTS)	
3C	INSUL POST C4-325 31mm/kV (KIPTS)	
3D	INSUL POST C4-325 20mm/kV (Non- KIPTS)	
3E	INSUL POST C4-325 25mm/kV (Non- KIPTS)	
3F	INSUL POST C4-325 31mm/kV (Non- KIPTS)	
4A	INSUL POST C4-550 20mm/Kv (KIPTS)	
4B	INSUL POST C4-550 25mm/kV (KIPTS)	
4C	INSUL POST C4-550 31mm/kV (KIPTS)	
4D	INSUL POST C4-550 20mm/kV (Non- KIPTS)	
4E	INSUL POST C4-550 25mm/kV (Non- KIPTS)	
4F	INSUL POST C4-550 31mm/kV (Non- KIPTS)	
5A	INSUL POST C6-550	

Item	Title	Offered (Y/N)
7A	INSUL POST C12.5-550 20mm/Kv (KIPTS)	
7B	INSUL POST C12.5-550 25mm/kV (KIPTS)	
7C	INSUL POST C12.5-550 31mm/kV (KIPTS)	
7D	INSUL POST C12.5-550 20mm/kV (Non-KIPTS)	
7E	INSUL POST C12.5-550 25mm/kV (Non-KIPTS)	
7F	INSUL POST C12.5-550 31mm/kV (Non-KIPTS)	
8A	INSUL POST C10-1050 25mm/kV	
8B	INSUL POST C10-1050 31mm/kV	
9A	INSUL POST C4-1175 25mm/kV	
9B	INSUL POST C4-1175 31mm/kV	
10A	INSUL POST C6-1175 25mm/kV	
10B	INSUL POST C6-1175 31mm/kV	
11A	INSUL POST C10-1175 25mm/kV	
11B	INSUL POST C10-1175 31mm/kV	
12A	INSUL POST C12.5-1175 25mm/kV	
12B	INSUL POST C12.5-1175 31mm/kV	
13A	INSUL POST C10-1425 25mm/kV	
13B	INSUL POST C10-1425 31mm/kV	
14A	INSUL POST C6-1550 25mm/kV	
14B	INSUL POST C6-1550 31mm/kV	
14C	INSUL POST C6-1550 38mm/kV	
15A	INSUL POST C10-1550 25mm/kV	
15B	INSUL POST C10-1550 31mm/kV	
15C	INSUL POST C10-1550 38mm/kV	
16A	INSUL POST C12.5-1550	

Item	Title	Offered (Y/N)
	20mm/kV (KIPTS)	
5B	INSUL POST C6-550 25mm/kV (KIPTS)	
5C	INSUL POST C6-550 31mm/kV (KIPTS)	
5D	INSUL POST C6-550 20mm/kV (Non-KIPTS)	
5E	INSUL POST C6-550 25mm/kV (Non-KIPTS)	
5F	INSUL POST C6-550 31mm/kV (Non-KIPTS)	
6A	INSUL POST C10-550 20mm/kV (KIPTS)	
6B	INSUL POST C10-550 25mm/kV (KIPTS)	
6C	INSUL POST C10-550 31mm/kV (KIPTS)	
6D	INSUL POST C10-550 20mm/kV (Non-KIPTS)	
6E	INSUL POST C10-550 25mm/kV (Non-KIPTS)	
6F	INSUL POST C10-550 31mm/kV (Non-KIPTS)	

Item	Title	Offered (Y/N)
	25mm/kV	
16B	INSUL POST C12.5-1550 31mm/kV	
16C	INSUL POST C12.5-1550 38mm/kV	
17A	INSUL POST C16-1550 25mm/kV	
17B	INSUL POST C16-1550 31mm/kV	
17C	INSUL POST C16-1550 38mm/kV	
18A	INSUL POST C8-2100 25mm/kV	
18B	INSUL POST C8-2100 31mm/kV	

Annex B – C4-150 (ITEMS 1A-1F)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

		INSUL POST C4-150 (ITEMS 1A-1F)				
Item	**Clause**	**Description**	**Units**	**Schedule A**		**Schedule B**
1		**General**				
1.1		**Item description**	Select/Tick applicable item. Only one item per sheet.	1A		
				1B		
				1C		
				1D		
				1E		
				1F		
		"IEC 60273" Classification	-	C4-150		
		Specific creepage distance	mm/kV	1A	20	
				1B	25	
				1C	31	
				1D	20	
				1E	25	
				1F	31	
1.2		**Purchasing details**				
		SAP Number	-	-		
		Supplier	-	-		
		Manufacturer	-	-		
		Manufacturer product type designation/code	-	-		
1.3		**Site conditions of service**				
		Maximum ambient temperature	Degrees Celcius	45		
		Minimum ambient temperature		-10		
		Maximum daily average		35		
		Maximum daily variation		35		
2		**Technical requirements**				
2.1		**Insulator details**				
		Insulator type	-	Solid core		
		Number of insulating units	-	-		
		Mass of complete insulator	kg	-		
		Insulator material	-	Porcelain		
		Colour of glaze	-	Dark Brown		

2.2		**Electrical insulation levels**				
		Rated lightning impulse withstand voltage (peak)	kV	150		
		Rated switching impulse withstand voltage, wet (peak)	kV	-		
		Rated short time power freq. withstand voltage, wet	kV r.m.s	50		
2.3		**Dimensional characteristics**				
		Minimum nominal total creepage distance (l)	mm	-		
		Arcing distance (S)	mm	-		
		Creepage factor (l/S)	-	20 mm/kV	3.75	
				25 mm/kV	3.875	
				31 mm/kV	4	
		Shed profile: Plain or Alternating	-	Alternating		
		Minimum shed spacing to projection (s/p) ratio	-	0.65		
		Minimum distance between sheds of the same diameter	mm	25		
		Maximum creepage distance vs. clearance	-	5		
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-		
		Insulator height (across mounting flanges)	mm	355 ± 1		
		Maximum nominal diameter of insulating part	mm	195		
2.4		**Mechanical characteristics**				
		Bending (cantilever) failing load	N	4000		
		Torsion failing load	Nm	1000		
2.5		**Fixing arrangements**				
		Top fitting pitch circle diameter	mm	76		
		Top fitting - number of holes	-	4		
		Top fitting - diameter of holes	-	M12		
		Bottom fitting pitch circle diameter	mm	76		
		Bottom fitting - number of holes	-	4		
		Bottom fitting - diameter of holes	-	M12		
		Flange material	-	Cast iron		
		Metal finish - minimum hot dip galvanizing thickness	µm	100		
		Cementing material	-	Portland cement		
		Mounting bolt: Length	mm	-		
		Mounting bolt: Type	Grade	8.8		

		Mounting bolt: Size	mm	-		
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes		
3		**Packaging**				
		Number of post insulators per pallet	-	-		
		Maximum mass per pallet	kg	1800		
4.		**Test requirements**				
4.1		**Type tests - Standard**				
		a) Verification of dimensions		Yes		
		b) Dry lightning impulse withstand voltage test		Yes		
		c) Wet switching impulse withstand voltage test		No		
		d) Wet power-frequency withstand voltage test		Yes		
		e) Mechanical failing load test carried out in bending		Yes		
		f) Mechanical failing load test carried out in torsion		Yes		
4.2		**Type tests - Special**				
		a) Radio interference test (see IEC 60437);		No		
		b) Artificial pollution test (see IEC 60507)		1A	No	
				1B	No	
				1C	No	
				1D	Yes	
				1E	Yes	
				1F	Yes	
		c) KIPTS pollution test		1A	Yes (LM)	
				1B	Yes (LM)	
				1C	Yes (HVH)	
				1D	No	
				1E	No	
				1F	No	
4.3		**Sample tests**				
		a) Verification of the dimensions		Yes		
		b) Temperature cycle test		Yes		
		c) Mechanical failing load test carried out in bending		Yes		
		d) Porosity test		Yes		
		e) Galvanizing test		Yes		
4.4		**Routine tests**				
		a) Visual examination		Yes		
		b) Mechanical test		Yes		

Annex C – C4-200 (ITEMS 2A- 2F)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

		INSUL POST C4-200 (ITEMS 2A- 2F)				
Item	**Clause**	**Description**	**Units**	**Schedule A**		**Schedule B**
1		**General**				
1.1		**Item description**	Select/ Tick applicable item. Only one item per sheet	2A		
				2B		
				2C		
				2D		
				2E		
				2F		
		"IEC 60273" Classification	-	C4-200		
		Specific creepage distance	mm/kV	2A	20	
				2B	25	
				2C	31	
				2D	20	
				2E	25	
				2F	31	
1.2		**Purchasing details**				
		SAP Number	-	-		
		Supplier	-	-		
		Manufacturer	-	-		
		Manufacturer product type designation/code	-	-		
1.3		**Site conditions of service**				
		Maximum ambient temperature	Degrees Celcius	45		
		Minimum ambient temperature		-10		
		Maximum daily average		35		
		Maximum daily variation		35		
2		**Technical requirements**				
2.1		**Insulator details**				
		Insulator type	-	Solid core		
		Number of insulating units	-	-		
		Mass of complete insulator	kg	-		
		Insulator material	-	Porcelain		
		Colour of glaze	-	Dark Brown		

2.2		**Electrical insulation levels**				
		Rated lightning impulse withstand voltage (peak)	kV	200		
		Rated switching impulse withstand voltage, wet (peak)	kV	-		
		Rated short time power freq. withstand voltage, wet	kV r.m.s	70		
2.3		**Dimensional characteristics**				
		Minimum nominal total creepage distance (l)	mm	-		
		Arcing distance (S)	mm	-		
		Creepage factor (l/S)	-	20 mm/kV	3.75	
				25 mm/kV	3.875	
				31 mm/kV	4	
		Shed profile: Plain or Alternating	-	Alternating		
		Minimum shed spacing to projection (s/p) ratio	-	0.65		
		Minimum distance between sheds of the same diameter	mm	25		
		Maximum creepage distance vs. clearance	-	5		
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-		
		Insulator height (across mounting flanges)	mm	475 ± 1		
		Maximum nominal diameter of insulating part	mm	210		
2.4		**Mechanical characteristics**				
		Bending (cantilever) failing load	N	4000		
		Torsion failing load	Nm	1200		
2.5		**Fixing arrangements**				
		Top fitting pitch circle diameter	mm	76		
		Top fitting - number of holes	-	4		
		Top fitting - diameter of holes	-	M12		
		Bottom fitting pitch circle diameter	mm	76		
		Bottom fitting - number of holes	-	4		
		Bottom fitting - diameter of holes	-	M12		
		Flange material	-	Cast iron		
		Metal finish - minimum hot dip galvanizing thickness	µm	100		
		Cementing material	-	Portland cement		
		Mounting bolt: Length	mm	-		
		Mounting bolt: Type	Grade	8.8		
		Mounting bolt: Size	mm	-		

		Confirmation of the integrity of the supplied fastening arrangement	-		Yes	
3		**Packaging**				
		Number of post insulators per pallet	-		-	
		Maximum mass per pallet	kg		1800	
4.		**Test requirements**				
4.1		**Type tests - Standard**				
		a) Verification of dimensions			Yes	
		b) Dry lightning impulse withstand voltage test			Yes	
		c) Wet switching impulse withstand voltage test			No	
		d) Wet power-frequency withstand voltage test			Yes	
		e) Mechanical failing load test carried out in bending			Yes	
		f) Mechanical failing load test carried out in torsion			Yes	
4.2		**Type tests - Special**				
		a) Radio interference test (see IEC 60437);			No	
		b) Artificial pollution test (see IEC 60507)		2A	No	
				2B	No	
				2C	No	
				2D	Yes	
				2E	Yes	
				2F	Yes	
		c) KIPTS pollution test		2A	Yes (LM)	
				2B	Yes (LM)	
				2C	Yes (HVH)	
				2D	No	
				2E	No	
				2F	No	
4.3		**Sample tests**				
		a) Verification of the dimensions			Yes	
		b) Temperature cycle test			Yes	
		c) Mechanical failing load test carried out in bending			Yes	
		d) Porosity test			Yes	
		e) Galvanizing test			Yes	
4.4		**Routine tests**				
		a) Visual examination			Yes	
		b) Mechanical test			Yes	

Annex D – C4-325 (ITEMS 3A- 3F)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

		INSUL POST C4-325 ITEMS 3A- 3F				
Item	**Clause**	**Description**	**Units**	**Schedule A**		**Schedule B**
1		**General**				
1.1		**Item description**	Select/ Tick applicable item. Only one item per sheet	3A		
				3B		
				3C		
				3D		
				3E		
				3F		
		"IEC 60273" Classification	-	C4-325		
		Specific creepage distance	mm/kV	3A	20	
				3B	25	
				3C	31	
				3D	20	
				3E	25	
				3F	31	
1.2		**Purchasing details**				
		SAP Number	-	-		
		Supplier	-	-		
		Manufacturer	-	-		
		Manufacturer product type designation/code	-	-		
1.3		**Site conditions of service**				
		Maximum ambient temperature	Degrees Celcius	45		
		Minimum ambient temperature	Degrees Celcius	-10		
		Maximum daily average	Degrees Celcius	35		
		Maximum daily variation	Degrees Celcius	35		
2		**Technical requirements**				
2.1		**Insulator details**				
		Insulator type	-	Solid core		
		Number of insulating units	-	-		
		Mass of complete insulator	kg	-		
		Insulator material	-	Porcelain		

		Colour of glaze	-	Dark Brown		
2.2		**Electrical insulation levels**				
		Rated lightning impulse withstand voltage (peak)	kV	350		
		Rated switching impulse withstand voltage, wet (peak)	kV	-		
		Rated short time power freq. withstand voltage, wet	kV r.m.s	140		
2.3		**Dimensional characteristics**				
		Minimum nominal total creepage distance (l)	mm	-		
		Arcing distance (S)	mm	-		
		Creepage factor (l/S)	-	20 mm/kV	3.75	
				25 mm/kV	3.875	
				31 mm/kV	4	
		Shed profile: Plain or Alternating	-	Alternating		
		Minimum shed spacing to projection (s/p) ratio	-	0.65		
		Minimum distance between sheds of the same diameter	mm	30		
		Maximum creepage distance vs. clearance	-	5		
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-		
		Insulator height (across mounting flanges)	mm	770 ± 1		
		Maximum nominal diameter of insulating part	mm	225		
2.4		**Mechanical characteristics**				
		Bending (cantilever) failing load	N	4000		
		Torsion failing load	Nm	1200		
2.5		**Fixing arrangements**				
		Top fitting pitch circle diameter	mm	127		
		Top fitting - number of holes	-	4		
		Top fitting - diameter of holes	-	M16		
		Bottom fitting pitch circle diameter	mm	127		
		Bottom fitting - number of holes	-	4		
		Bottom fitting - diameter of holes	-	M16		
		Flange material	-	Cast iron		
		Metal finish - minimum hot dip galvanizing thickness	µm	100		

		Cementing material	-	Portland cement		
		Mounting bolt: Length	mm	-		
		Mounting bolt: Type	Grade	8.8		
		Mounting bolt: Size	mm	-		
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes		
4.		**Test requirements**				
4.1		**Type tests - Standard**				
		a) Verification of dimensions		Yes		
		b) Dry lightning impulse withstand voltage test		Yes		
		c) Wet switching impulse withstand voltage test		No		
		d) Wet power-frequency withstand voltage test		Yes		
		e) Mechanical failing load test carried out in bending		Yes		
		f) Mechanical failing load test carried out in torsion		Yes		
4.2		**Type tests - Special**				
		a) Radio interference test (see IEC 60437);		No		
		b) Artificial pollution test (see IEC 60507)		3A	No	
				3B	No	
				3C	No	
				3D	Yes	
				3E	Yes	
				3F	Yes	
		c) KIPTS pollution test		3A	Yes (LM)	
				3B	Yes (LM)	
				3C	Yes (HVH)	
				3D	No	
				3E	No	
				3F	No	
4.3		**Sample tests**				
		a) Verification of the dimensions		Yes		
		b) Temperature cycle test		Yes		
		c) Mechanical failing load test carried out in bending		Yes		
		d) Porosity test		Yes		
		e) Galvanizing test		Yes		
4.4		**Routine tests**				
		a) Visual examination		Yes		
		b) Mechanical test		Yes		

Annex E – C4-550 (ITEMS 4A – 4F)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

		INSUL POST C4-550				
Item	**Clause**	**Description**	**Units**	**Schedule A**		**Schedule B**
1		**General**				
1.1		**Item description**	Select/ Tick applicable item. Only one item per sheet	4A		
				4B		
				4C		
				4D		
				4E		
				4F		
		"IEC 60273" Classification	-	C4-550		
		Specific creepage distance	mm/kV	4A	20	
				4B	25	
				4C	31	
				4D	20	
				4E	25	
				4F	31	
1.2		**Purchasing details**				
		SAP Number	-	-		
		Supplier	-	-		
		Manufacturer	-	-		
		Manufacturer product type designation/code	-	-		
1.3		**Site conditions of service**				
		Maximum ambient temperature	Degrees Celcius	45		
		Minimum ambient temperature		-10		
		Maximum daily average		35		
		Maximum daily variation		35		
2		**Technical requirements**				
2.1		**Insulator details**				
		Insulator type	-	Solid core		
		Number of insulating units	-	-		
		Mass of complete insulator	kg	-		
		Insulator material	-	Porcelain		

		Colour of glaze	-	Dark Brown		
2.2		**Electrical insulation levels**				
		Rated lightning impulse withstand voltage (peak)	kV	550		
		Rated switching impulse withstand voltage, wet (peak)	kV	-		
		Rated short time power freq. withstand voltage, wet	kV r.m.s	230		
2.3		**Dimensional characteristics**				
		Minimum nominal total creepage distance (l)	mm	-		
		Arcing distance (S)	mm	-		
		Creepage factor (l/S)	-	20 mm/kV	3.75	
				25 mm/kV	3.87 5	
				31 mm/kV	4	
		Shed profile: Plain or Alternating	-	Alternating		
		Minimum shed spacing to projection (s/p) ratio	-	0.65		
		Minimum distance between sheds of the same diameter	mm	30		
		Maximum creepage distance vs. clearance	-	5		
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-		
		Insulator height (across mounting flanges)	mm	1220 ± 1		
		Maximum nominal diameter of insulating part	mm	300		
2.4		**Mechanical characteristics**				
		Bending (cantilever) failing load	N	4000		
		Torsion failing load	Nm	3000		
2.5		**Fixing arrangements**				
		Top fitting pitch circle diameter	mm	127		
		Top fitting - number of holes	-	4		
		Top fitting - diameter of holes	-	M16		
		Bottom fitting pitch circle diameter	mm	127		
		Bottom fitting - number of holes	-	4		
		Bottom fitting - diameter of holes	-	M16		
		Flange material	-	Cast iron		
		Metal finish - minimum hot dip galvanizing thickness	µm	100		
		Cementing material	-	Portland cement		
		Mounting bolt: Length	mm	-		

		Mounting bolt: Type	Grade	8.8		
		Mounting bolt: Size	mm	-		
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes		
4.		**Test requirements**				
4.1		**Type tests - Standard**				
		a) Verification of dimensions		Yes		
		b) Dry lightning impulse withstand voltage test		Yes		
		c) Wet switching impulse withstand voltage test		No		
		d) Wet power-frequency withstand voltage test		Yes		
		e) Mechanical failing load test carried out in bending		Yes		
		f) Mechanical failing load test carried out in torsion		Yes		
4.2		**Type tests - Special**				
		a) Radio interference test (see IEC 60437);		No		
		b) Artificial pollution test (see IEC 60507)		4A	No	
				4B	No	
				4C	No	
				4D	Yes	
				4E	Yes	
				4F	Yes	
		c) KIPTS pollution test		4A	Yes (LM)	
				4B	Yes (LM)	
				4C	Yes (HVH)	
				4D	No	
				4E	No	
				4F	No	
4.3		**Sample tests**				
		a) Verification of the dimensions		Yes		
		b) Temperature cycle test		Yes		
		c) Mechanical failing load test carried out in bending		Yes		
		d) Porosity test		Yes		
		e) Galvanizing test		Yes		
4.4		**Routine tests**				
		a) Visual examination		Yes		
		b) Mechanical test		Yes		

Annex F – C6-550 (ITEMS 5A – 5F)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

		INSUL POST C6-550 ITEMS 5A – 5F				
Item	**Clause**	**Description**	**Units**	**Schedule A**		**Schedule B**
1		**General**				
1.1		**Item description**	Select/ Tick applicable item. Only one item per sheet	5A		
				5B		
				5C		
				5D		
				5E		
				5F		
		"IEC 60273" Classification	-	C6-550		
		Specific creepage distance	mm/kV	5A	20	
				5B	25	
				5C	31	
				5D	20	
				5E	25	
				5F	31	
1.2		**Purchasing details**				
		SAP Number	-	-		
		Supplier	-	-		
		Manufacturer	-	-		
		Manufacturer product type designation/code	-	-		
1.3		**Site conditions of service**				
		Maximum ambient temperature	Degrees Celcius	45		
		Minimum ambient temperature		-10		
		Maximum daily average		35		
		Maximum daily variation		35		
2		**Technical requirements**				
2.1		**Insulator details**				
		Insulator type	-	Solid core		
		Number of insulating units	-	-		
		Mass of complete insulator	kg	-		
		Insulator material	-	Porcelain		
		Colour of glaze	-	Dark Brown		

2.2		**Electrical insulation levels**				
		Rated lightning impulse withstand voltage (peak)	kV	550		
		Rated switching impulse withstand voltage, wet (peak)	kV	-		
		Rated short time power freq. withstand voltage, wet	kV r.m.s	230		
2.3		**Dimensional characteristics**				
		Minimum nominal total creepage distance (l)	mm	-		
		Arcing distance (S)	mm	-		
		Creepage factor (l/S)	-	20 mm/kV	3.75	
				25 mm/kV	3.875	
				31 mm/kV	4	
		Shed profile: Plain or Alternating	-	Alternating		
		Minimum shed spacing to projection (s/p) ratio	-	0.65		
		Minimum distance between sheds of the same diameter	mm	30		
		Maximum creepage distance vs. clearance	-	5		
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-		
		Insulator height (across mounting flanges)	mm	1220 ± 1		
		Maximum nominal diameter of insulating part	mm	300		
2.4		**Mechanical characteristics**				
		Bending (cantilever) failing load	N	6000		
		Torsion failing load	Nm	4000		
2.5		**Fixing arrangements**				
		Top fitting pitch circle diameter	mm	127		
		Top fitting - number of holes	-	4		
		Top fitting - diameter of holes	-	M16		
		Bottom fitting pitch circle diameter	mm	127		
		Bottom fitting - number of holes	-	4		
		Bottom fitting - diameter of holes	-	M16		
		Flange material	-	Cast iron		
		Metal finish - minimum hot dip galvanizing thickness	µm	100		
		Cementing material	-	Portland cement		
		Mounting bolt: Length	mm	-		
		Mounting bolt: Type	Grade	8.8		

		Mounting bolt: Size	mm	-		
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes		
4.		**Test requirements**				
4.1		**Type tests - Standard**				
		a) Verification of dimensions		Yes		
		b) Dry lightning impulse withstand voltage test		Yes		
		c) Wet switching impulse withstand voltage test		No		
		d) Wet power-frequency withstand voltage test		Yes		
		e) Mechanical failing load test carried out in bending		Yes		
		f) Mechanical failing load test carried out in torsion		Yes		
4.2		**Type tests - Special**				
		a) Radio interference test (see IEC 60437);		No		
		b) Artificial pollution test (see IEC 60507)		5A	No	
				5B	No	
				5C	No	
				5D	Yes	
				5E	Yes	
				5F	Yes	
		c) KIPTS pollution test		5A	Yes (LM)	
				5B	Yes (LM)	
				5C	Yes (HVH)	
				5D	No	
				5E	No	
				5F	No	
4.3		**Sample tests**				
		a) Verification of the dimensions		Yes		
		b) Temperature cycle test		Yes		
		c) Mechanical failing load test carried out in bending		Yes		
		d) Porosity test		Yes		
		e) Galvanizing test		Yes		
4.4		**Routine tests**				
		a) Visual examination		Yes		
		b) Mechanical test		Yes		

Annex G – C10-550 (ITEMS 6A -6F)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

		INSUL POST C10-550 (ITEMS 6A -6F)				
Item	**Clause**	**Description**	**Units**	**Schedule A**		**Schedule B**
1		**General**				
1.1		**Item description**	Select/ Tick applicable item. Only one item per sheet	6A		
				6B		
				6C		
				6D		
				6E		
				6F		
		"IEC 60273" Classification	-	C10-550		
		Specific creepage distance	mm/kV	6A	20	
				6B	25	
				6C	31	
				6D	20	
				6E	25	
				6F	31	
1.2		**Purchasing details**				
		SAP Number	-	-		
		Supplier	-	-		
		Manufacturer	-	-		
		Manufacturer product type designation/code	-	-		
1.3		**Site conditions of service**				
		Maximum ambient temperature	Degrees Celcius	45		
		Minimum ambient temperature	Degrees Celcius	-10		
		Maximum daily average	Degrees Celcius	35		
		Maximum daily variation	Degrees Celcius	35		
2		**Technical requirements**				
2.1		**Insulator details**				
		Insulator type	-	Solid core		
		Number of insulating units	-	-		
		Mass of complete insulator	kg	-		
		Insulator material	-	Porcelain		
		Colour of glaze	-	Dark Brown		

2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	550	
		Rated switching impulse withstand voltage, wet (peak)	kV	-	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	230	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	20 mm/kV 3.75	
				25 mm/kV 3.875	
				31 mm/kV 4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	1220 ± 1	
		Maximum nominal diameter of insulating part	mm	350	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	10000	
		Torsion failing load	Nm	4000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	127	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	M16	
		Bottom fitting pitch circle diameter	mm	225	
		Bottom fitting - number of holes	-	4	
		Bottom fitting - diameter of holes	-	M18	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	

		Mounting bolt: Type	Grade		8.8	
		Mounting bolt: Size	mm		-	
		Confirmation of the integrity of the supplied fastening arrangement	-		Yes	
4.		**Test requirements**				
4.1		**Type tests - Standard**				
		a) Verification of dimensions			Yes	
		b) Dry lightning impulse withstand voltage test			Yes	
		c) Wet switching impulse withstand voltage test			No	
		d) Wet power-frequency withstand voltage test			Yes	
		e) Mechanical failing load test carried out in bending			Yes	
		f) Mechanical failing load test carried out in torsion			Yes	
4.2		**Type tests - Special**				
		a) Radio interference test (see IEC 60437);			No	
		b) Artificial pollution test (see IEC 60507)		6A	No	
				6B	No	
				6C	No	
				6D	Yes	
				6E	Yes	
				6F	Yes	
		c) KIPTS pollution test		6A	Yes (LM)	
				6B	Yes (LM)	
				6C	Yes (HVH)	
				6D	No	
				6E	No	
				6F	No	
4.3		**Sample tests**				
		a) Verification of the dimensions			Yes	
		b) Temperature cycle test			Yes	
		c) Mechanical failing load test carried out in bending			Yes	
		d) Porosity test			Yes	
		e) Galvanizing test			Yes	
4.4		**Routine tests**				
		a) Visual examination			Yes	
		b) Mechanical test			Yes	

Annex H – C12-550 (ITEMS 7A – 7F)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Note: Details provided in Schedule B must be only for one item per sheet. Print and complete a new sheet for each separate item tendered for.

		INSUL POST C12.5-550 (ITEMS 7A – 7F)			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**	Select/ Tick applicabl e item. Only one item per sheet	7A	
				7B	
				7C	
				7D	
				7E	
				7F	
		"IEC 60273" Classification	-	C12.5-550	
		Specific creepage distance	mm/kV	7A	
				7B	
				7C	
				7D	
				7E	
				7F	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	

2.2		**Electrical insulation levels**				
		Rated lightning impulse withstand voltage (peak)	kV	550		
		Rated switching impulse withstand voltage, wet (peak)	kV	-		
		Rated short time power freq. withstand voltage, wet	kV r.m.s	230		
2.3		**Dimensional characteristics**				
		Minimum nominal total creepage distance (l)	mm	-		
		Arcing distance (S)	mm	-		
		Creepage factor (l/S)	-	20 mm/kV	3.75	
				25 mm/kV	3.875	
				31 mm/kV	4	
		Shed profile: Plain or Alternating	-	Alternating		
		Minimum shed spacing to projection (s/p) ratio	-	0.65		
		Minimum distance between sheds of the same diameter	mm	30		
		Maximum creepage distance vs. clearance	-	5		
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-		
		Insulator height (across mounting flanges)	mm	1220 ± 1		
		Maximum nominal diameter of insulating part	mm	350		
2.4		**Mechanical characteristics**				
		Bending (cantilever) failing load	N	12500		
		Torsion failing load	Nm	6000		
2.5		**Fixing arrangements**				
		Top fitting pitch circle diameter	mm	127		
		Top fitting - number of holes	-	4		
		Top fitting - diameter of holes	-	M16		
		Bottom fitting pitch circle diameter	mm	254		
		Bottom fitting - number of holes	-	4		
		Bottom fitting - diameter of holes	-	M18		
		Flange material	-	Cast iron		
		Metal finish - minimum hot dip galvanizing thickness	µm	100		
		Cementing material	-	Portland cement		
		Mounting bolt: Length	mm	-		

		Mounting bolt: Type	Grade	8.8		
		Mounting bolt: Size	mm	-		
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes		
4.		**Test requirements**				
4.1		**Type tests - Standard**				
		a) Verification of dimensions		Yes		
		b) Dry lightning impulse withstand voltage test		Yes		
		c) Wet switching impulse withstand voltage test		No		
		d) Wet power-frequency withstand voltage test		Yes		
		e) Mechanical failing load test carried out in bending		Yes		
		f) Mechanical failing load test carried out in torsion		Yes		
4.2		**Type tests - Special**				
		a) Radio interference test (see IEC 60437);		No		
		b) Artificial pollution test (see IEC 60507)		7A	No	
				7B	No	
				7C	No	
				7D	Yes	
				7E	Yes	
				7F	Yes	
		c) KIPTS pollution test		7A	Yes (LM)	
				7B	Yes (LM)	
				7C	Yes (HVH)	
				7D	No	
				7E	No	
				7F	No	
4.3		**Sample tests**				
		a) Verification of the dimensions		Yes		
		b) Temperature cycle test		Yes		
		c) Mechanical failing load test carried out in bending		Yes		
		d) Porosity test		Yes		
		e) Galvanizing test		Yes		
4.4		**Routine tests**				
		a) Visual examination		Yes		
		b) Mechanical test		Yes		

Annex I – C10-1050 (ITEMS 8A & 8B)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item 8a		**INSUL POST C10-1050 25mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C10-1050	
		Specific creepage distance	mm/kV	25	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1050	
		Rated switching impulse withstand voltage, wet (peak)	kV	750	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	460	

2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	3.875	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	2300±3,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	10000	
		Torsion failing load	Nm	4000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	275	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		Yes	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	

4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 8b		**INSUL POST C10-1050 31mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C10-1050	
		Specific creepage distance	mm/kV	31	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	

2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1050	
		Rated switching impulse withstand voltage, wet (peak)	kV	750	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	460	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	2300±3,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	10000	
		Torsion failing load	Nm	4000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	275	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	

4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		Yes	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Annex J – C4-1175 (ITEMS 9A & 9B)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item 9a		**INSUL POST C4-1175 25mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C4-1175	
		Specific creepage distance	mm/kV	25	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1175	
		Rated switching impulse withstand voltage, wet (peak)	kV	850	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	

		Creepage factor (l/S)	-	3.875	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	2650±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	4000	
		Torsion failing load	Nm	3000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	127	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	M16	
		Bottom fitting pitch circle diameter	mm	225	
		Bottom fitting - number of holes	-	4	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	

4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 9b		**INSUL POST C4-1175 31mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C4-1175	
		Specific creepage distance	mm/kV	31	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	

2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1175	
		Rated switching impulse withstand voltage, wet (peak)	kV	850	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	2650±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	4000	
		Torsion failing load	Nm	3000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	127	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	M16	
		Bottom fitting pitch circle diameter	mm	225	
		Bottom fitting - number of holes	-	4	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	

4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Annex K – C6-1175 (ITEMS 10A & 10B)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item 10a		**INSUL POST C6-1175 25mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C6-1175	
		Specific creepage distance	mm/kV	25	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1175	
		Rated switching impulse withstand voltage, wet (peak)	kV	850	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	

		Creepage factor (l/S)	-	3.875	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	2650±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	6000	
		Torsion failing load	Nm	3000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	127	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	M16	
		Bottom fitting pitch circle diameter	mm	254	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	

4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 10b		**INSUL POST C6-1175 31mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C6-1175	
		Specific creepage distance	mm/kV	31	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	

2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1175	
		Rated switching impulse withstand voltage, wet (peak)	kV	850	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	2650±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	6000	
		Torsion failing load	Nm	3000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	127	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	M16	
		Bottom fitting pitch circle diameter	mm	254	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	

4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Annex L – C10-1175 (ITEMS 11A & 11B)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item 11a		**INSUL POST C10-1175 25mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C10-1175	
		Specific creepage distance	mm/kV	25	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1175	
		Rated switching impulse withstand voltage, wet (peak)	kV	850	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	

		Creepage factor (l/S)	-	3.875	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	2650±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	10000	
		Torsion failing load	Nm	4000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	275	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Tes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	

4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 11b		**INSUL POST C10-1175 31mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C10-1175	
		Specific creepage distance	mm/kV	31	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	

2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1175	
		Rated switching impulse withstand voltage, wet (peak)	kV	850	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	2650±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	10000	
		Torsion failing load	Nm	4000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	275	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	

4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Tes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Annex M – C12.5-1175 (ITEMS 12A & 12B)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item 12a		**INSUL POST C12.5-1175 25mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C12.5-1175	
		Specific creepage distance	mm/kV	25	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1175	
		Rated switching impulse withstand voltage, wet (peak)	kV	850	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	3.875	

		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	2650±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	12500	
		Torsion failing load	Nm	6000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	300	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	

4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 12b		**INSUL POST C12.5-1175 31mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C12.5-1175	
		Specific creepage distance	mm/kV	31	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	

2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1175	
		Rated switching impulse withstand voltage, wet (peak)	kV	850	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	2650±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	12500	
		Torsion failing load	Nm	6000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	300	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	

4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Annex N – - C10-1425 (ITEMS 13A & 13B)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item 13a		**INSUL POST C10-1425 25mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C10-1425	
		Specific creepage distance	mm/kV	25	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1425	
		Rated switching impulse withstand voltage, wet (peak)	kV	950	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	

2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	3.875	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	3150±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	10000	
		Torsion failing load	Nm	4000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	300	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	

4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 13b		**INSUL POST C10-1425 31mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C10-1425	
		Specific creepage distance	mm/kV	31	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	

2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1425	
		Rated switching impulse withstand voltage, wet (peak)	kV	950	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	3150±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	10000	
		Torsion failing load	Nm	4000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	300	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	

4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Annex O – - C6-1550 (ITEMS 14A, 14B & 14C)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item 14a		INSUL POST C6-1550 25mm/kV			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C6-1550	
		Specific creepage distance	mm/kV	25	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1550	
		Rated switching impulse withstand voltage, wet (peak)	kV	1050	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	

		Creepage factor (l/S)	-	3.875	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	3350±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	6000	
		Torsion failing load	Nm	3000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	127	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	M16	
		Bottom fitting pitch circle diameter	mm	254	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		Yes	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	

4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 14b		**INSUL POST C6-1550 31mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C6-1550	
		Specific creepage distance	mm/kV	31	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	

2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1550	
		Rated switching impulse withstand voltage, wet (peak)	kV	1050	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	3350±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	6000	
		Torsion failing load	Nm	3000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	127	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	M16	
		Bottom fitting pitch circle diameter	mm	254	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	

4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		Yes	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 14c		**INSUL POST C6-1550 38mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C6-1550	
		Specific creepage distance	mm/kV	38	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	

2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1550	
		Rated switching impulse withstand voltage, wet (peak)	kV	1050	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	xxxx	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	6000	
		Torsion failing load	Nm	3000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	127	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	M16	
		Bottom fitting pitch circle diameter	mm	254	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	

		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		Yes	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Annex P – - C10-1550 (ITEMS 15A, 15B & 15C)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item 15a		**INSUL POST C10-1550 25mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C10-1550	
		Specific creepage distance	mm/kV	25	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1550	
		Rated switching impulse withstand voltage, wet (peak)	kV	1050	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	

		Creepage factor (l/S)	-	3.875	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	3350±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	10000	
		Torsion failing load	Nm	4000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	300	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	

4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 15b		**INSUL POST C10-1550 31mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C10-1550	
		Specific creepage distance	mm/kV	31	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	

2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1550	
		Rated switching impulse withstand voltage, wet (peak)	kV	1050	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	3350±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	10000	
		Torsion failing load	Nm	4000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	300	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	

4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 15c		**INSUL POST C10-1550 38mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C10-1550	
		Specific creepage distance	mm/kV	38	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	

2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1550	
		Rated switching impulse withstand voltage, wet (peak)	kV	1050	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	xxxx	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	10000	
		Torsion failing load	Nm	4000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	300	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	

		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Annex Q – - C12.5-1550 (ITEMS 16A, 16B & 16C)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item 16a		**INSUL POST C12.5-1550 25mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C12.5-1550	
		Specific creepage distance	mm/kV	25	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1550	
		Rated switching impulse withstand voltage, wet (peak)	kV	1050	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	

2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	3.875	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	3350±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	12500	
		Torsion failing load	Nm	6000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	325	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	

4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 16b		**INSUL POST C12.5-1550 31mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C12.5-1550	
		Specific creepage distance	mm/kV	31	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	

		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1550	
		Rated switching impulse withstand voltage, wet (peak)	kV	1050	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	3350±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	12500	
		Torsion failing load	Nm	6000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	325	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	

		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 16C		**INSUL POST C12.5-1550 38mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C12.5-1550	
		Specific creepage distance	mm/kV	38	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	

1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1550	
		Rated switching impulse withstand voltage, wet (peak)	kV	1050	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	xxxx	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	12500	
		Torsion failing load	Nm	6000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	

		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	325	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Annex R – - C16-1550 (ITEMS 17A, 17B & 17C)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item 17a		**INSUL POST C16-1550 25mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C16-1550	
		Specific creepage distance	mm/kV	25	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1550	
		Rated switching impulse withstand voltage, wet (peak)	kV	1050	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	

2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	3.875	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	3350±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	16000	
		Torsion failing load	Nm	6000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	356	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	

4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 17b		**INSUL POST C16-1550 31mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C16-1550	
		Specific creepage distance	mm/kV	31	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	

2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1550	
		Rated switching impulse withstand voltage, wet (peak)	kV	1050	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	3350±4,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	16000	
		Torsion failing load	Nm	6000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	356	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	

4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 17c		**INSUL POST C16-1550 38mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C16-1550	
		Specific creepage distance	mm/kV	38	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	

2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	1550	
		Rated switching impulse withstand voltage, wet (peak)	kV	1050	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	xxxx	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	16000	
		Torsion failing load	Nm	6000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	356	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	

		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Annex S – - C8-2100 (ITEMS 18A & 18B)

Schedule A: Eskom's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item 18a		**INSUL POST C8-2100 25mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C18-2100	
		Specific creepage distance	mm/kV	25	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	
2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	2100	
		Rated switching impulse withstand voltage, wet (peak)	kV	1300	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	

		Creepage factor (l/S)	-	3.875	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	4700±5,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	8000	
		Torsion failing load	Nm	4000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	325	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	
4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	

4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Item 18b		**INSUL POST C8-2100 31mm/kV**			
Item	**Clause**	**Description**	**Units**	**Schedule A**	**Schedule B**
1		**General**			
1.1		**Item description**			
		"IEC 60273" Classification	-	C8-2100	
		Specific creepage distance	mm/kV	31	
1.2		**Purchasing details**			
		SAP Number	-	-	
		Supplier	-	-	
		Manufacturer	-	-	
		Manufacturer product type designation/code	-	-	
1.3		**Site conditions of service**			
		Maximum ambient temperature	Degrees Celcius	45	
		Minimum ambient temperature		-10	
		Maximum daily average		35	
		Maximum daily variation		35	
2		**Technical requirements**			
2.1		**Insulator details**			
		Insulator type	-	Solid core	
		Number of insulating units	-	-	
		Mass of complete insulator	kg	-	
		Insulator material	-	Porcelain	
		Colour of glaze	-	Dark Brown	

2.2		**Electrical insulation levels**			
		Rated lightning impulse withstand voltage (peak)	kV	2100	
		Rated switching impulse withstand voltage, wet (peak)	kV	1300	
		Rated short time power freq. withstand voltage, wet	kV r.m.s	-	
2.3		**Dimensional characteristics**			
		Minimum nominal total creepage distance (l)	mm	-	
		Arcing distance (S)	mm	-	
		Creepage factor (l/S)	-	4	
		Shed profile: Plain or Alternating	-	Alternating	
		Minimum shed spacing to projection (s/p) ratio	-	0.65	
		Minimum distance between sheds of the same diameter	mm	30	
		Maximum creepage distance vs. clearance	-	5	
		Shed angle (Between 5 and 22,5 degrees)	Degrees	-	
		Insulator height (across mounting flanges)	mm	4700±5,5	
		Maximum nominal diameter of insulating part	mm	450	
2.4		**Mechanical characteristics**			
		Bending (cantilever) failing load	N	8000	
		Torsion failing load	Nm	4000	
2.5		**Fixing arrangements**			
		Top fitting pitch circle diameter	mm	225	
		Top fitting - number of holes	-	4	
		Top fitting - diameter of holes	-	18 (plain)	
		Bottom fitting pitch circle diameter	mm	325	
		Bottom fitting - number of holes	-	8	
		Bottom fitting - diameter of holes	-	18 (plain)	
		Flange material	-	Cast iron	
		Metal finish - minimum hot dip galvanizing thickness	µm	100	
		Cementing material	-	Portland cement	
		Mounting bolt: Length	mm	-	
		Mounting bolt: Type	Grade	8.8	
		Mounting bolt: Size	mm	-	
		Confirmation of the integrity of the supplied fastening arrangement	-	Yes	

4.		**Test requirements**			
4.1		**Type tests - Standard**			
		a) Verification of dimensions		Yes	
		b) Dry lightning impulse withstand voltage test		Yes	
		c) Wet switching impulse withstand voltage test		Yes	
		d) Wet power-frequency withstand voltage test		No	
		e) Mechanical failing load test carried out in bending		Yes	
		f) Mechanical failing load test carried out in torsion		Yes	
4.2		**Type tests - Special**			
		a) Radio interference test (see IEC 60437);		Yes	
		b) Artificial pollution test (see IEC 60507)		Yes	
		c) KIPTS pollution test		No	
4.3		**Sample tests**			
		a) Verification of the dimensions		Yes	
		b) Temperature cycle test		Yes	
		c) Mechanical failing load test carried out in bending		Yes	
		d) Porosity test		Yes	
		e) Galvanizing test		Yes	
4.4		**Routine tests**			
		a) Visual examination		Yes	
		b) Mechanical test		Yes	

Annex T – - - Type test report summary sheet (To be completed per item)

		Item Number as per Annex A convention :						
Test		**File name of electronic test report submitted**	**Applicable page number**	**Product code used in type test report**	**Full product code of item offered**	**Name of test facility and electronic file name of accreditation certificate/evidence**	**Comments**	**Outcome Passed/ Failed**
1	Verification of dimensions							
2	Dry lightning impulse withstand voltage test							
3	Wet switching impulse withstand voltage test							
4	Wet power-frequency withstand voltage test							
5	Mechanical failing load test carried out in bending							
6	Radio interference test for items 132kV and above							
7	Artificial pollution test							
8	KIPTS test for items 132kV and below (where requested)					XXXXXXXXXXXXX		

Notes:

1) If a type test is not submitted or not applicable to the design offered, clear justification must be provided in the comments column.

2) Should the product naming convention used in type test report differ from that of the product offered, clear unambiguous explanation must be given indicating how the product tested is applicable to that offered in the comments column provided.

3) If any, remaining type tests in the relevant SANS/ IEC standards for Ceramic Station Post Insulators are not listed above, it will be requested and evaluated before factory evaluation or contract award.

4) If more than one type test is contained in a single report, page numbers must also be provided.

5) All documents to be provided in hard copy in addition to any soft copies offered, as per tender requirements.

Annex U – - Summary sheet of drawings (To be completed per item)

Item Number as per Annex A convention :							
Detail/Drawing required		**Electronic File name of drawing/sheet**	**Product code used in Drawing/Sheet**	**Full product code of item offered**	**Date of Issue**	**Comments**	**Submitted (Y/N)**
1	All dimensions and associated tolerances of all fasteners and associated fittings						
2	All dimensions and associated tolerances of the insulator body and top and bottom end fittings (mounting hole details, PCD etc.)						
3	Detailed dimensioned profile of shed pair.						
4	Electrical properties: The lightning impulse withstand level (basic insulation level), switching impulse withstand level, power frequency withstand level, etc.						

5	Mechanical properties: The minimum cantilever and torsion failing loads.						
6	Minimum nominal total creepage distance and specific creepage distance						
7	Corona ring outlines for units 275 kV and above						
8	Mass of complete insulator assembly.						
9	Colour of the glaze						

Notes:

1) If a drawing or requested detail is not submitted or not applicable, clear justification must be provided in the comments column. Omission of key information may result in disqualification.

2) Drawings must contain the manufacturers name, logo and a unique drawing number as a minimum

3) Should the product naming convention used in the drawing/sheet differ from that of the product offered, clear unambiguous explanation must be given indicating how the product indicated is applicable to that offered in the comments column provided.

4) All documents to be provided in hard copy in addition to any soft copies offered, as per tender requirements.

Annex V – - Deviations and Declaration (To be completed per item)

Item Number as per Annex A convention :		
Deviation		**Comments**
1		
2		
3		
4		
5		
6		
7		

Notes:

1) For each item, all deviations to any requirement in this specification and associated technical schedule or annex must be listed above with clear explanations/ justification with regards to fitness for use for the full expected life of the product

2) All documents to be provided in hard copy in addition to any soft copies offered, as per tender requirements.

Declaration by supplier:

With the exception of the above deviations, this specification, associated technical schedules, factory evaluation and annexes together with the requirements contained within, will be fully complied with in the manufacture, testing, supply, provision of drawing and documents, packaging, labelling, transport and delivery of the product being offered, amongst others. Further it is declared that all information provided has been checked and is correct.

Signature_______________________________________ Date: _______________

Full Name and Designation of Authorised Representative:____

SECTION 5: PARTICULARS & GUARRENTEES

PART 7.1: INSULATORS 132KV

SPEC NO:

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
1	**Post insulators 132 kV**			
1,01	Manufacturer			
1,02	Type			
1,03	Details of connections -			
1,04	Material			
1,05	Voltage continuous / BIL rating	kV /		
1,06	Strength			
1,06	Cantilever	kN		
1.06.1	Torque	kN		
1.07.2	Sheds			
1,07	Creepage distance	mm		
1,07	Flashover distance	mm	> 1200	
1,08	Fixing - Top			
1,09	Fixing - Bottom			
1,10	Drawing number			
1,11	Dimensions	mm		
2	**132 kV Suspension insulators**			
2,01	Manufacturer			
2,02	Type			
2,03	Details of connections -			
2,04	Material			
2,05	Voltage continuous / BIL rating	kV/kV		
2,06	Strength in tension	kN		
2,07	Sheds			
2.07.1	Creepage distance	mm		
2.07.2	Flashover distance	mm		
2,08	Fixing - Details			
2,09	Drawing number			
2,10	Dimensions			
3	**Other 132 kV insulators - Tenderer to list**			
3,01	Manufacturer			
3,02	Type			

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
3,03	Details of connections -			
3,04	Material			
3,05	Voltage continuous / BIL rating	kV/kV		
3,06	Strength in tension	kN		
3,07	Sheds			
3.07.1	Creepage distance	mm		
3.07.1	Flashover distance	mm		
3,08	Fixing - Details			
3,09	Drawing number			
3,10	Dimensions			

SECTION 5: PARTICULARS & GUARRENTEES

PART 7.1: INSULATORS 275KV

SPEC NO:

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
1	**Post insulators 275 kV**			
1,01	Manufacturer			
1,02	Type			
1,03	Details of connections -			
1,04	Material			
1,05	Voltage continuous / BIL rating	kV /		
1,06	Strength			
1,06	Cantilever	kN		
1.06.1	Torque	kN		
1.07.2	Sheds			
1,07	Creepage distance	mm		
1,07	Flashover distance	mm	> 1200	
1,08	Fixing - Top			
1,09	Fixing - Bottom			
1,10	Drawing number			
1,11	Dimensions	mm		
2	**275 kV Suspension insulators**			
2,01	Manufacturer			
2,02	Type			
2,03	Details of connections -			
2,04	Material			
2,05	Voltage continuous / BIL rating	kV/kV		
2,06	Strength in tension	kN		
2,07	Sheds			
2.07.1	Creepage distance	mm		
2.07.2	Flashover distance	mm		
2,08	Fixing - Details			
2,09	Drawing number			
2,10	Dimensions			
3	**Other 275 kV insulators - Tenderer to list**			
3,01	Manufacturer			
3,02	Type			

ITEM	DESCRIPTION	UNIT	REQUIREMEN TS	OFFERED
3,03	Details of connections -			
3,04	Material			
3,05	Voltage continuous / BIL rating	kV/kV		
3,06	Strength in tension	kN		
3,07	Sheds			
3.07.1	Creepage distance	mm		
3.07.1	Flashover distance	mm		
3,08	Fixing - Details			
3,09	Drawing number			
3,10	Dimensions			

SECTION 5: PARTICULARS & GUARRANTEES

PART 8.2: MULTI-CORE CABLES

SPEC NO:

ITEM	DESCRIPTION	UNIT	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5	TYPE 6
	600 V PVC-SWA PVC, Multi-Core Control Cable							
1	Total length of cable	m						
2	Number of cores							
3	Cross-sectional area/core	sq mm						
4	Number of strands per core							
5	Diameter of each strand	mm						
6	Conductor material							
7	Type of insulation							
8	Radial thickness of conductor insulation							
9	Minimum average	mm						
10	Minimum	mm						
11	Maximum conductor resistance at 20°C	ohm/km						
12	Guaranteed minimum insulation resistance at 20°C in Megohm/km							
13	Diameter over laid-up cores	mm						
14	Radial thickness of sheath:							
14,1	Minimum average	mm						
14,2	Minimum	mm						
15	Nominal diameter over sheath	mm						
16	Sheath material							
17	Number of armour wires							
18	Diameter of size of armour wires							
19	Nominal diameter over armour	mm						
20	Serving material							

ITEM	DESCRIPTION	UNIT	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5	TYPE 6
21	Radial thickness of serving:							
21,2	Minimum average	mm						
21,2	Minimum	mm						
22	Nominal outside diameter	mm						
23	Mass of completed cable per 100 m							
24	Mass of copper per 100 m							
25	Gross weight of cable and drum							
26	Cable length on drum							
27	Place of manufacture							
28	Make or trade-mark							
29	Full details of core identification							

SECTION 5: PARTUCULARS & GUARRANTEES

PART 9.1: EARTHING GRID

SPEC NO:

ITEM	DESCRIPTION	UNIT	REQUIREMENT S	OFFERED
	EARTHING GRID			
1	**Earth resistance survey**			
1,1	Name of subcontractor for earth resistance survey			
1,2	Method proposed for measurement (Tenderer to			
1,3	Target resistance	ohm	1	
2	**Earth mat**			
2,1	Cross section of earth mat	sq	2 x Steel rods	
2,2	Material of earth mat		Steel rod Cu plated SABS1063&0199	
2,3	Drawing number of proposed earth mat			
3	**Earthing electrodes**			
3,1	Dimensions :			
3.1.1	diameter	mm	16mm dia	
3.1.2	area	sq. mm		
3.1.3	length	m		
3,2	Construction			
4	**Connections to equipment**			
4,1	Outdoor		exothermic welds	
4,2	Stainless steel type and cross		exothermic welds	
4,3	Stainless steel type and cross section - Complex runs, bends,		exothermic welds	
4.3.1	Indoor		exothermic welds	
4.3.2	Copper	sq	150	
5	**Method of connection and**			

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
5,1	Earth mat to earth electrode		exothermic welds	
5,2	Earth mat to copper earthing strap for indoor earthing		exothermic welds	
5,3	Earth mat to stainless steel strap for outdoor earthing		exothermic welds	
5,4	How electrolytic corrosion will be prevented		exothermic welds	
5,5	Stainless steel strap to outdoor equipment		exothermic welds	

	Standard	Technology

Title: **SPECIFICATION FOR POWER TRANSFORMERS RATED FOR 1.25MVA AND ABOVE AND WITH HIGHEST VOLTAGE OF 2.2KV OR ABOVE**

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PCM Reference: **Perform High Voltage Plant; Power Electrical & Power Reticulation Engineering**

SCOT Study Committee Number/Name: **SCOT PE SC**

Content

Figures

Tables

Executive Summary

This transformer specification document was the work produced by the Eskom SCOT Transformer Care Group in 2012 and periodically undergoing revisions. The document was compiled with intentions to align, optimise, and consolidate Eskom requirements for effective interpretation by equipment suppliers and enhance interchangeability within the organization. This was done without undermining the special requirements that are applicable in certain types and application of transformers. These are to be intentionally and adequately discussed to during design review meetings.

This document incorporates the best applicable requirements from the previous divisional documents and integrated the recent learnings from the Eskom business, the international bodies, and the experts from around the world, including suppliers from various continents. In the past Eskom purchased transformers which experienced shortened lifespans, with an average failure age of about 18 years instead of the expected 35 years and 40 years for generator-step-up and the network transformers, respectively. Three separate teams of international consultants were employed by Eskom to look at the root cause of the premature failures observed at that time. The results of the work of these consultants were incorporated into this technical specification document. These include, but are not limited to, the following:

- Composite bushings – to reduce failure and fire risks plus maintenance requirements
- Enamelled windings on certain classes of transformers – to eliminate corrosive sulphur effects and other chemical problems
- Winding arrangements – to reduce radial forces during short circuits,
- Limits on dielectric stresses and inclusion of safety margins in various aspects
- Specific oils – to reduce corrosive sulphur failures,
- Reductions in load and no load losses – to reduce life cycle costs,
- Introduction of maintenance free vacuum tap-changers technology
- Environmental considerations, including oils
- Climate change considerations

Continually as technologies evolve these are researched and considered by Eskom SCOT Transformers Care Group who are continually optimizing the designs as required. The new designs have demonstrated low failure rate and the transformer reliability has improved compared to what was experienced prior to introduction of these points.

1 Introduction

This specification document gives the requirements for all new transformers procured by/for Eskom for use in the Gx OUs, Tx Grids, and Dx OUs. This document was originally compiled and is periodically revised by the SCOT WG which is a cross divisional and multi-disciplinary team. This work was produced with the intentions mentioned below in mind, and they are:

- Acquiring transformers that are fit for purpose and can remain reliable to the expected life of beyond 40 years.
- Achieving optimized standardization thereby allowing a wide range of interchange-ability.
- The Eskom drive for low maintenance, tending towards maintenance free technologies.
- Support Eskom's drive for reducing the carbon footprint, zero harm to people and to the environment and BPP initiatives.
- Minimizing the total cost of ownership.

2 Supporting clauses

2.1 Scope

This Specification applies to all Eskom oil-filled new power transformers, having a highest voltage winding operating at or above 2.2 kV, and a rating above 1.25 MVA. This specification in not primarily intended for oil filled units like shunt and series power reactors, HVDC converter transformers, and smoothing reactors; but reference may be made to this specification when procuring those. The power transformers covered in this specification document are generally classified as follows in Eskom

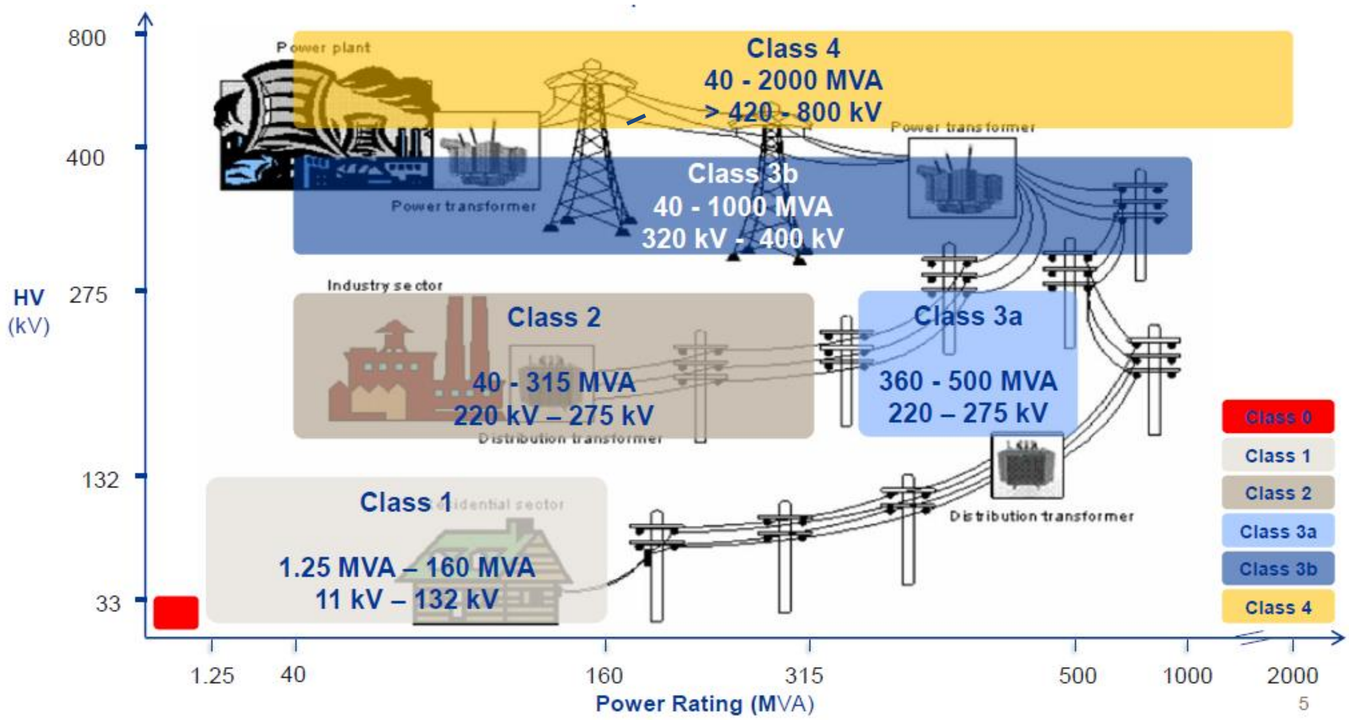


Figure 1: Classes of transformers in Eskom

2.1.1 Purpose

This document was produced in order to record the standardized requirements that shall be applied when procuring new transformers for Eskom to be used in the Eskom network. This covers transformers procured directly by Eskom, those purchased under turn-key projects or through Independent Power Producers (IPPs).

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions. It is applicable to all the *Contractors* that shall be tendering to supply transformers to Eskom.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001 Quality Management Systems.

[2] IEC 60076-1, Power transformers — Part 1 General.

[3] IEC 60076-2, Power transformers — Part 2 Temperature rise.

[4] IEC 60076-3, Power transformers — Part 3 Insulation levels and dielectric tests.

[5] IEC 60076-4, Power transformers — Guide to Lightning and Switching Impulse.

[6] IEC 60076-5, Power transformers — Part 5 Ability to withstand short circuit.

[7] IEC 60076-7, Power transformers — Part 7 Loading guide for oil-immersed power transformers.

[8] IEC 60076-8, Power transformers — Part 8: Application guide.

[9] IEC 60076-10, Power transformers — Part 10 Determination of sound levels.

[10] IEC 60076-10-1, Power transformers Part 10-1: Determination of sound levels - Application guide

[11] IEC 60076-13, Power transformers Part 13: Self-protected liquid-filled transformers

[12] IEC 60076-14, Power transformers Part 14: Design and application of liquid- immersed power transformers using high-temperature insulation materials

[13] IEC 60076-18, Power transformers Part 18: Measurement of frequency response.

[14] IEC 60085, Thermal evaluation and classification of electrical insulation.

[15] IEC 60137, Insulating bushings for alternating voltages above 1 000 V.

[16] IEC 60156, Insulating liquids – Determination of the breakdown voltage at power frequency.

[17] IEC 60185, Current transformers.

[18] IEC 60214, On-load tap-changers.

[19] IEC 60034, Rotating electrical machines.

[20] IEC 61850 (All parts) Communication network and systems in substations

[21] 32-9 Definition of Eskom documents.

[22] ESP32-644 Eskom documentation management standard

[23] 474-65 Operating Manual of the Steering Committee of Technologies (SCOT)

[24] 240-56063843 Winding and oil temperature specification

[25] 240-56063908 Oil and gas actuated (buchholz) relays fitted to transformers and reactors

[26] 240-56063886 Dehydrating breathers fitted on transformers, reactors, and on-load tap changers

[27] 240-56356191 Transformer and reactor oil level indicators

[28] 240-56063867 Rapid Pressure Rise Relay Specification

[29] 240-56063871 Pressure Relief Devices (PRD) Fitted to Transformers and Reactors Specification

[30] 240-56356202 Bag Leak Detector Specification

[31] 240 – 56535946 Transformers and Reactors cooling fans standard

[32] 240 -64917195 Technical standard for dissolved gas analysers for application in power transformers for all Eskom divisions.

[33] 240-59083215 Permanent online oil drying system used on transformers and reactors.

[34] 240-56062799 Technical Specification for Capacitor Bushings for Application in Power Transformers and Shunt Reactors in Eskom

[35] 240-56030674 Corrosion Protection of new and in-service power & station auxiliary transformers

[36] 32-406 Mineral insulating oils (uninhibited and inhibited) part 1: purchase, management, maintenance and testing

[37] 240-56062726 Standard for Intrusive work and Oil filling, under vacuum of transformers and reactors on site

[38] QM 58 Eskom Quality Procedure

[39] D-DT-3202 Eskom Drawing MV and LV cable box

[40] EST32-136: Contractor Health and Safety Requirements

[41] Eskom 10TB-018: Technical Bulletin for Loss Evaluation

[42] TPC 41-246: Management of manufacturers and suppliers equipment drawings

[43] 240 – 53902530 Substation automation – data concentrator for data retrieval and remote access

[44] 240 – 64038621 Remote device communication standard for data retrieval and remote access

[45] 240 – 46264031 Fibre optic design standards – Part 2 – Substations

[46] 240-56062720 Oil Sample point labelling standard

[47] TB 204 Cigre Publication, Guidelines for transformer design reviews

[48] South African National OHS act

[49] Eskom ORHVS

[50] TPC 41-246 Management of manufacturers and suppliers equipment drawings

2.2.2 Informative

[51] TSP 41-87

[52] DSP 34-1092

[53] GGS 1074

2.3 Definitions

2.3.1 General

Definition	Description
Appointed bodies	Refers to persons, beside Eskom employees, appointed by Eskom to provide professional services to Eskom.
Contractor	This refers to the party that received a purchase order from Eskom
Employer / Purchaser	These refer to Eskom and it is interchangeably used to refer to the customer
Partial Drain	The phrase refers to draining the transformer or reactor is such a way that the HV insulation and the active part remains fully immersed in oil and vacuuming will not be necessary after completion of work
Power Transformer	This refers to all the transformers from class 1 and to class 4 as detailed in this specification, including the generator-step-up transformers.
Service Life	This refers to the expected lifetime of the transformer operating incident free.
Network Transformer	This refers to a transformer typically used in a transmission and distribution network for coupling different voltage levels, these transformers typically are configured in redundant pairs.
GSU	Generator Step Up transformer, a transformer used at power stations to step up the output voltage of the generator to a transmission line voltage for power evacuation. These units tend to be loaded to 100%.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
A	Amperes
BPP	Business Productivity Program
CT	Current Transformer
CW	Common Winding (also called PW – Parallel Winding)
DGA	Dissolved Gas Analysis
GIC	Geomagnetically Induced Currents
GSU	Generator Step-Up transformer
HVDC	High Voltage Direct Current
HV	Highest Voltage / High Voltage
kW	Kilo Watt
LV	Lowest Voltage / Low Voltage
MV	Medium (Middle) Voltage
MW	Mega Watt
MVA	Mega Volt Ampere

Abbreviation	Description
ODAF	Oil Directed Air Forced
ODAN	Oil Directed Air Natural
ONAF	Oil Natural Air Forced
ONAN	Oil Natural Air Natural
PRD/V	Pressure Relief Device / Valve
RW	Regulating Winding (Tapping Winding)
SFRA	Sweep Frequency Response Analyses
SW	Series Winding
THD	Total Harmonic Distortion
TOV	Temporary Over Voltages
TW	Tertiary Winding (also called TV for Tertiary Voltage)
UV	Ultra Violet

2.5 Roles and responsibilities

All the Eskom employees and/or appointed bodies involved in the procurement of transformers and/or the associated accessories shall ensure that the product meets the requirements of this specification. Any deviation from these requirements shall constitute a non-conformance, unless it was agreed to in advance by a delegated Eskom transformer specialist in writing and is based on sound engineering judgement.

All the Contractors supplying transformers to Eskom must be conversant with the requirements of this specification, and shall comply with the requirements. All the deviations shall be clearly listed in the deviation schedule as part of the tender deliverables.

No deviations will be accepted unless approved by Eskom in writing. The Contractor shall ensure that he gets clarity where required and that he has all the supporting information or documents necessary for the contractor to comply with this document.

The Eskom Transformer Corporate Specialist shall be responsible for ensuring the validity of this document.

2.6 Process for monitoring

This document and its relevance will be annually evaluated by the relevant SCOT Care Group.

2.7 Related/supporting documents

The schedule A of the relevant AB schedules shall form part of this specification and they shall take precedence over this specification in case the two documents are conflicting.

3 Specification Minimum Requirements

This specification defines the minimum requirements for the site survey and assessment, design, design-review, manufacturing, factory testing, transporting, delivery to site, off-loading, assembly, installation, in-transit and on-site testing, and commissioning, and performance of the said transformers. The transformer shall at a minimum be designed for the environment where it will be utilized. The transformer manufacturer shall apply the best internationally benchmarked engineering and manufacturing practices to produce a transformer, including accessories, which in conjunction with minimal maintenance, will result in a safe and reliable service throughout the expected lifespan under the rigors of service in the Eskom power system. The transformer, when in service, shall not exhibit unsafe or any uncertain condition, e.g. stray excessive gassing, partial discharge, etc. Engineering practices or techniques that have no measurable quality control shall not be accepted for correction of deviations. Brand new transformers must be presented as brand new units in all aspects, including but not limited to, materials, appearance, DP value, criterion, and other measures.

The transformer and the associated accessories shall be risk free to Eskom.

3.1 Design Reviews

A design review shall be done on the first transformer of each type. A design review in a planned exercise is envisaged to ensure that there is a common understanding of the applicable standards and specification requirements, and to provide an opportunity to scrutinize the design to ensure the requirements meet the Employer’s requirements.

The objective is to review specific aspects of the electrical, mechanical, magnetic and thermal design to:

- Ensure there is a clear and mutual understanding of the technical requirements.
- Verify the system and project requirements and to indicate areas where special attention may be required.
- Verify that the design complies with the technical requirements.
- Identify any prototype features and evaluate their reliability and risks.

A design review meeting is required before the procurement of any materials or manufacturing proceeds. The purpose of the design review is to allow Eskom to understand the basic design, construction and installation of the transformer and to make sure that interchangeability requirements are met. Eskom shall not be obliged to accept components and/or materials procured prior to the design review and without a written agreement from Engineering. The design review shall follow an internationally benchmarked process.

The manufacturer shall design the transformer such that it performs satisfactorily under all service conditions specified in this document, and without it exhibiting signs of having defect, e.g., abnormal gassing.

The manufacturer has to demonstrate that all the decisive design parameters are well within the manufacturer’s design limits based on proven research, or relevant limits specified in standards or internationally benchmarked criteria.

Eskom reserves the right to reject the design when the manufacturer fails to demonstrate the capability for design and manufacturing of the transformer under review. This can happen when the presented design does not meet internationally and Eskom’s accepted criteria and the manufacturer cannot prove his design by previously tested transformers of the same concept and voltage class.

The manufacturer shall inform Eskom twelve (12) weeks prior to the design review. All the discussions and final decisions taken during the design review must be recorded, signed by all the parties, and submitted to Eskom.

Eskom’s participation in the design review will in no way relieves the manufacturer of any of their duties in terms of any contract.

Preliminary design review details must be supplied to Eskom at the latest of two weeks before the design review meeting date.

3.2 Site Conditions

The *Contractor* shall take note that the equipment shall operate under the following site conditions

- Outdoor installation
- Altitude above sea level – 1800m
- Ambient temperatures
  - Maximum + 40°C
  - Monthly average +28°C
  - Yearly average + 25°C
  - Minimum - 10°C
- Average humidity of 90%.
- Solar radiation 2500kWh/m^2
- Atmospheric UV radiation = High
- Seismic conditions at a minimum of 0.3g, this requirement must be proved by calculation.
- Symmetrical three phase network supply voltages, negative and zero phase sequence voltages up to 2%.
- Pollution level: Very Heavy

In special cases the site conditions, when different from these, it shall be indicated in the AB schedules.

NOTE: The yearly average for South Africa is 23°C according to the SA Weather Services website, which is 3K higher than that in IEC 60076-7. A further 2K was added for climate change reasons and hence the yearly average is considered 25°C. This information is important when considering the temperature rise limits.

3.3 Network Conditions

3.3.1 Frequency

The system nominal frequency is 50Hz.The transformer shall be designed for a rated frequency of 50Hz +/- 2.5Hz. The under frequency condition may last for 30 minutes and the over frequency for 10 minutes.

3.3.2 Voltage Unbalances

The transformer must be capable of normal operation without any deleterious effects when exposed to unbalanced voltages of 2% for the life of the unit.

3.3.3 Harmonic Pollution

The transformer must be capable of normal operation when subjected to harmonic pollution levels up to THD 3% throughout the life of the transformer.

3.3.4 Geomagnetic Induced Currents

This section is applicable to 400kV and above transformers where the Neutral of the transformer is solidly earthed and/or if GIC compatibility is specified in Schedule AB.

For the reason of GIC compatibility of 3 phase transformers, 3 limb cores are the requirement and where this is not possible, the return limbs must be optimized to achieve a good design for GIC withstand. The *Contractor* shall in details, during a design review demonstrate how he has taken care of the GIC effect on the design of the affected steel components.

The transformer shall be able to withstand a GIC of 10A in the neutral terminal for 30 minutes under the following operating conditions:

- Continuous Maximum System Voltage,
- Nominal System Frequency,
- Continuous Maximum Load,
- With a tap position such that the maximum number of turns are between the HV terminals and Neutral.

Under these conditions, the transformer must not be damaged. Thermal excursion during GIC phenomena must not shorten the transformers lifespan. For during the presence of the GIC storms special consideration must be given to effects such as vibration increases, increased magnetic forces, hot spot temperature rises, and localized heating due to stray flux changes. The effect of GIC currents on the transformer design must be quantified and the mitigation techniques used by the *Contractor* must be highlighted and submitted to the *Employer* as stipulated in Schedule AB. The *Contractor* includes a description of the intended design to be applied in the tender documentation. During the high-level initial design review phase, the *Contractor* presents the results of his studies of the GIC impact on his design and illustrates that the transformer withstands the criteria specified in this document and Schedules AB to the *Employer* for his approval. In addition, he shall include the proposal for the testing the transformer during the FAT to demonstrate its response to GIC and that the thermal excursions are not exceeded as per the design.

In the interest of being able to measure and monitor, the *Contractor* shall provide externally on the neutral terminal connection a proper CT that will enable the *Employer* to both measure and monitor the GIC level during service life. The proposal for this measurement shall be part of the tender returns and shall form part of the design review.

3.4 Ratings

3.4.1 Rated Power

The values of rated power specified in Schedule A of the enquiry document are the continuous ratings, in MVA, at which each of the windings of the transformer can operate on all tap positions at a voltage equal to the appropriate nominal system voltage, U_n, without exceeding the temperature rise limits specified in this specification.

Where mixed-cooled (transformers with radiators forming the base cooling, but also having fans and pumps that can increase cooling capability if switched on) transformers are specified, (the naturally-cooled rating (ONAN) of each of the main windings shall be at least 0.60 pu of the rated power of these windings. Class 1 transformers will have a 0.7pu ONAN rating due to their high load factor.

If a tertiary winding is specified, this shall be capable of operating under the naturally-cooled condition at any loading up to the rated power specified in Schedule A provided that the loading in the input winding does not exceed its naturally-cooled rating.

3.4.2 Rated Current

The rated current corresponds to the rated power at rated voltage on the principal tap position. Power transformers shall have overloading capabilities in accordance with IEC 60076-7.

3.4.3 Rated Voltage

The rated voltage of each winding of the transformer on the principal tapping as specified in Schedule AB unless otherwise stated corresponds to the system nominal voltage, U_n.

3.4.4 Maximum Continuous Rated Voltage

Regardless of the actual location of the tap changer in the HV winding, the rated voltage of the HV winding on any tapping is to be equal to the rated voltage on the LV winding multiplied by the voltage ratio on that tapping. For auto transformers, the LV winding refers to the secondary winding.

3.4.5 Maximum Temporary Overvoltages

Under switching conditions, the power frequency voltage may exceed the maximum system voltage (U_m). The transformers are designed to withstand the following over-voltages without harm:

1.05 U_n continuously for 400kV and above, and below 400kV – 1.1 U_n continuously (this is U_m) .

1.05 U_m	for	10 minutes
1.25 U_m	for	1 minute
1.5 U_m	for	5 second: and
1.75 U_m	for	1 second

Also see the additional requirement to comply with IEC 60076-3.

3.4.6 Overfluxing

Within the prescribed maximum equipment voltage (U_m) the transformer is able to operate continuously without damage at an overflux value as stated in IEC 60076. The U_m value shall be specified in Schedule AB.

3.4.7 Impedance

The Impedance value shall be as per Schedule A of the ordering specification based on Table 1: **Standard MVA ratings and impedances for transformers of class** of this document. The impedance for the nominal tap position and tolerance on the specified value shall be within the range of ±7.5%. The rest of the range shall be as per IEC specification.

For transformers with tertiary windings, to achieve the specified impedance values from the main windings to the tertiary winding, as specified in the schedule A in order to drop the fault level, the application of a current limiting reactor will be acceptable. The verification of the capability of such a reactor is mandatory and short circuit test results from similar units must be submitted. The reactor must be situated in such a position that failure of the reactor will not impact, nor damage the rest of the unit. The current limiting reactors must be without a magnetic core and it must not saturate during the fault conditions.

Table 1: Standard MVA ratings and impedances for transformers of Class 1

Nominal Voltage			Impedance Type	Standard MVA Rating								HV/MV Impedance (%) referred to primary power rating		HV/Ter Impedance (%) referred to tertiary power rating		Vector Group
Primary	Secondary	Tertiary		160	80	40	20	10	5	2.5	1.25	Nom @ tap 5	Min @ tap 17	Nom @ tap 5	Min @ tap 17	
132	88	22	STD	160/2	80/2	40/2	20/2					9	8			YnA0d1
132	66	22	STD	160/2	80/2	40/2	20/2					10	9			YnA0d1
132	44	22	STD		80/2	40/2	20/2					11	10			YnA0d1
88	44	22	STD		80/2	40/2	20/2					9	8			YnA0d1
132	11		HIGH			X						22	20			YNd1
132	6,6		HIGH				X					22	20			YNd1
88	11		HIGH			X						22	20			YNd1
88	6,6		HIGH				X					22	20			YNd1
66	6,6		HIGH				X					22	20			YNd1
44	6,6		HIGH				X					22	20			YNd1
132	33		STD		X	X	X					11	10			YNd1
132	33		STD					X				10	9			YNd1
132	22		STD			X	X					11	10			YNd1
132	22		STD					X				10	9			YNd1
132	11		STD			X	X					11	10			YNd1
132	11		STD					X				10	9			YNd1
132	6,6		STD					X				10	9			YNd1
132	6,6		STD				X					11	10			YNd1
88	44		STD			X	X					11	10			YNd1
88	33		STD		X	X	X					11	10			YNd1
88	33		STD					X				10	9			YNd1
88	22		STD			X	X					11	10			YNd1
88	22		STD					X	X			10	9			YNd1

Nominal Voltage			**Impedance Type**	**Standard MVA Rating**								**HV/MV Impedance (%) referred to primary power rating**		**HV/Ter Impedance (%) Referred to tertiary power rating**		**Vector Group**
Primary	**Secondary**	**Tertiary**		**160**	**80**	**40**	**20**	**10**	**5**	**2.5**	**1.25**	**Nom @ tap 5**	**Min @ tap 17**	**Nom @ tap 5**	**Min @ tap 17**	
88	11		STD			X	X					11	10			YNd1
88	11		STD					X	X			10	9			YNd1
88	6,6		STD				X					11	10			YNd1
88	6,6		STD					X	X			10	9			YNd1
66	22		STD			X	X					11	10			YNd1
66	22		STD					X	X			10	9			YNd1
66	11		STD				X					11	10			YNd1
66	11		STD					X	X	X		10	9			YNd1
66	6,6		STD				X					11	10			YNd1
66	6,6		STD					X	X			10	9			YNd1
44	22		STD				X					11	10			YNd1
44	22		STD					X	X			10	9			YNd1
44	11		STD				X					11	10			YNd1
44	11		STD					X	X	X		10	9			YNd1
44	6,6		STD					X	X	X		10	9			YNd1
33	22		STD					X	X	X	X	6	5			YNyn0
33	11		STD				X	X	X	X	X	6	5			YNyn0
33	6.6		STD					X	X	X	X	6	5			YNyn0
22	11		STD				X	X	X	X	X	6	5			YNyn0
22	6.6		STD					X	X	X	X	6	5			YNyn0

Table 2: Standard MVA and impedances for Class 2 and above transformers used in the transmission voltage level applications

	Nominal Voltage (kV)			**Ratings Main/Tertiary (MVA/MVA)**							
Standard Number	**HV**	**MV**	**Tertiary /LV**	**1**	**2**	**3**	**Impedance (%)**			**Tolerance, on nominal tap**	**Vector Group in a bank**
							Extr +	**nom**	**Extr -**		
A9	765	400	33	2000/3[2]	1000/3[2&3]	-	13.9	14	14.4	± 7.5 %	YNa0d1
A8	400	275	22	1000/3[2]	-	-	12.25		10.25	± 7.5 %	YNa0d1
A7	400	275	22	800/2	400/2	-	12.25		10.25	± 7.5 %	YNa0d1
A6	400	220	22	630/2	315/2	160/2	12		12.2	± 7.5 %	YNa0d1
A5	400	132	22	500/2	250/2	125/2	13.5		15.5	± 7.5 %	YNa0d1
D6	400	88	22	315/2	160/2	80/2	13.5		17	± 7.5 %	YNyn0d1
A4	275	132	22	500/2	250/2	125/2	11.6	11.4	12.6	± 7.5 %	YNa0d1
A3	275	88	22	315/2	160/2	80/2	12.5	13	15.4	± 7.5 %	YNa0d1
A2	220	132	22	500/2	250/2	125/2	10.3	10.5	11.7	± 7.5 %	YNa0d1
A1	220	66	22	160/2	80/2	40/2	10.6	11.2	13.3	± 7.5 %	YNa0d1
D5	400		50	60	40	-	13.7	13.47	13.3	± 7.5 %	YNd1
D4	400		30	250	-	-	15			± 7.5 %	YNyn
D3	400		15	45	-	-	12.3		11.9	± 7.5 %	YNd1
D2	275		50	60	40	-	13.7	13.47	13.3	± 7.5 %	YNd1
D1	275		22 or 11	65 [4]	40	-	12.3	12.5	12.2	± 7.5 %	YNd1

[2] The units are banks of single phase transformers

[3] Based on the sizes already requested by the customer

[4] SVC transformer 275/11kV

For Generator Step-Up transformers, unit transformers, and service transformers the sizes vary from power station to power station and will be indicated in the relevant schedules AB

3.4.8 Ability to Withstanding Short Circuit

The ability of a transformer to withstand short circuit forces shall form part of the discussion of the design review meeting.

3.4.8.1 General Requirements

For network transformers, and notwithstanding the over current limits tabulated in IEC 60076-5, the transformer with the standard minimum percentage impedances given in tables 1 and 2 of this specification, shall be capable of withstanding the thermal, mechanical and other effects using the following criteria for calculating the short circuit withstand condition:

a) Pre-fault voltage of $1.1U_n$;

b) Source impedance shall be assumed to be infinite bus;

c) Fault duration of 2s

d) The inner winding shall be designed to withstand the free buckling criteria. However, the specific stress ($\sigma_{average}$) of the inner winding shall not exceed 50% of the copper conductor yield strength. For conductors with a radial thickness of 5mm and below, the stress shall not exceed 30% of the copper conductor yield strength. Whenever a reasonable application of Epoxy Bonded CTC is possible, this would be the preferred solution. The conductor yield strength that shall provide safety margins of more than 50% (i.e. > 1.5pu) of the corresponding stresses. See also 3.6.7.

e) All material used for the radial build up of the insulation system between windings shall be pre-dried and pre-impregnated with oil prior to use.

f) The blocks located above the clamping rings, which are used to apply the axial compression shall be pinned to the clamping ring/system. All other axial pressure transition elements shall be fixed (which can be by gluing or pinning) to positions

The manufacturer shall submit with its tender a complete listing of similar transformers that have been short circuit tested and manufactured by the facility where the tendered transformers will be manufactured, the list to include the outcome of the short circuit test, the facility where tested and the date of the test. The *Contractor* shall also include a typical test certificate for a unit similar to the unit to be purchased. Upon request a complete description of the transformer characteristics shall be provided. Calculations for short circuit withstand capability shall be submitted with the tender. All the internal current limiting reactors shall be able to withstand the magnitude of the short circuit currents without damage; this must be verified by short circuit testing and calculation.

3.4.8.2 Heavy Duty (Arc Furnace) Type Transformers

If so specified in schedule 'A', the transformer windings and leads shall be mechanically braced accordingly to the manufacturer's specifications in order to cater for all additional loadings. The specific requirements and provisions shall be evaluated during the transformer design review.

3.4.9 Clearances in Air

When assembled with the connections as in service, electrical clearances in air shall be adequate to withstand the assigned impulse withstand test voltages and TOVs at the prescribed altitude. This is to be demonstrated by impulse voltage type tests specified in Schedule AB, during the performance of which all relevant fittings are in position as for service conditions. Care is to be taken to ensure that fittings are located such that there is no interference with the external connection to the bushing terminals, and the clearances to such connections are not less than the appropriate minimum phase-to-earth clearance given in IEC 60076-3.

For class 1 transformers, care shall be taken to ensure that fittings are located so as not to interfere with the external connection to the bushing terminals, and the clearances to such connections shall not be less than the appropriate minimum phase-to-earth clearance given in column 2 of Table 3. The lines of approach of these connections may lie anywhere within the limits indicated in Figure 2, and the required phase-to-earth clearance shall apply at all points along these lines, as shown at the points marked 'L'. In addition, the minimum vertical working clearances from floor level to live metal shall be as listed in column 3 of Table 3

For other transformers not listed above, this shall be specified in schedules AB and be clarified during the mechanical design review meeting.

The voltage rating for the insulation external to the transformer should be assumed to be the same as the insulation ratings internal to the transformer.

Table 3: Electrical clearances in air

System highest voltage Um (kV)	Minimum phase-to-earth clearance 'L' (mm)	Minimum vertical working clearance from ground level to live metal (see note 1) (mm)	'X'-Dimension (2,5 x L) (*Min 3 000 mm) (mm)	'Y'-Dimension (L + 3000) (mm)
3,6	80	2 580	3 000	3 080
7,2	150	2 650	3 000	3 150
12	200	2 700	3 000	3 200
17,5	230	2 730	3 000	3 230
24	320	2 820	3000	3 320
36	430	2 930	3 000	3 430
48	540	3 040	3 000	3 540
72	770	3 270	3000	3 770
100	840	3 340	3 000	3 840
145	1 200	3 700	3 000	4 200
NOTES:				
1) The minimum distance from the transformer base or ground level to the flange base of a bushing (or surge arrester) shall be 2 500 mm.				

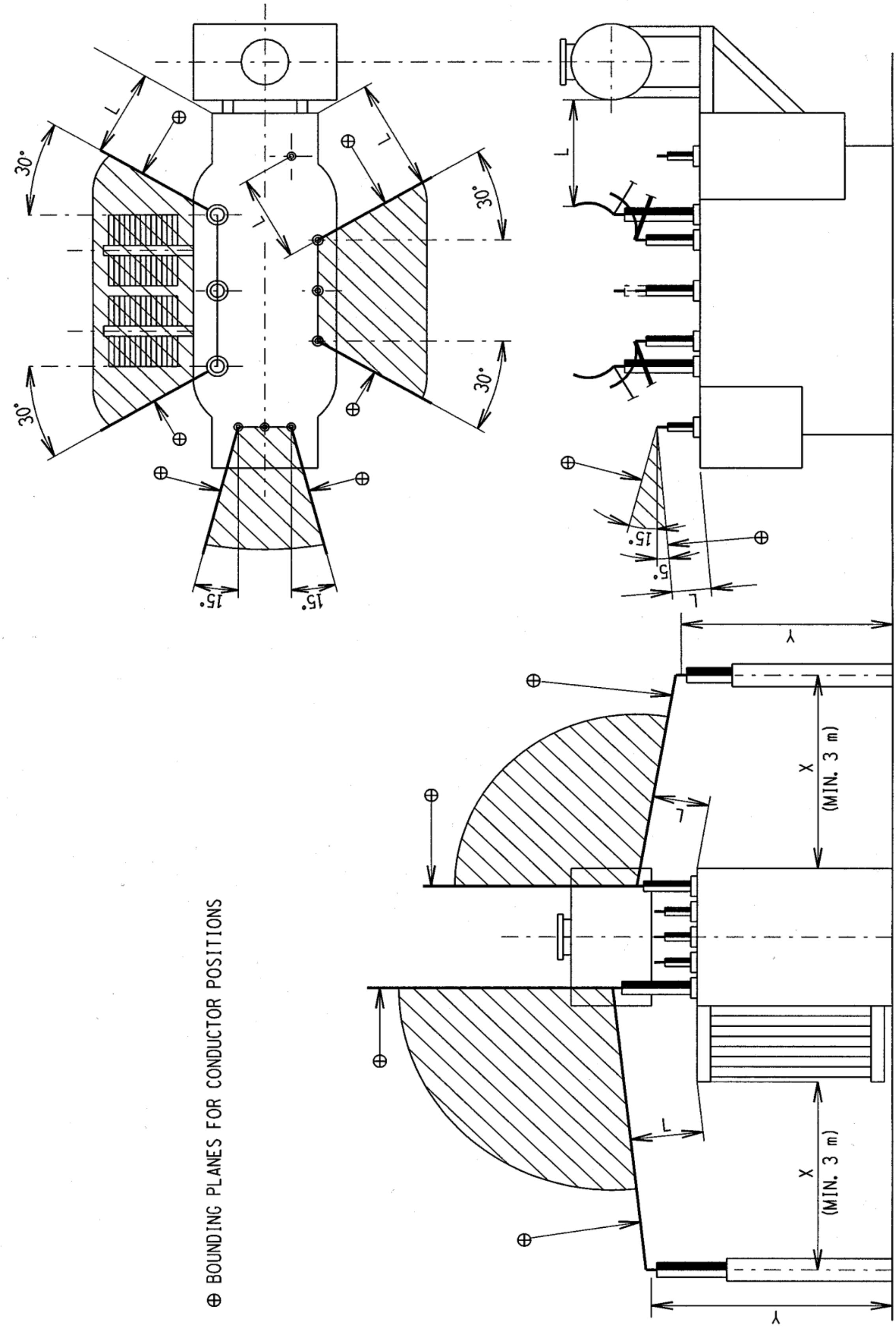


Figure 2: External connections, clearances from lines of approach

3.5 Core

3.5.1 Design

For the 3 phase power transformers the 3-limb core designs are the requirement for GIC control. In the cases where this is not possible, it shall first be agreed to by the *Employer,* and the *Contractor* shall demonstrate that the return limbs have been optimized for GIC purposes.

For rated voltage and rated frequency, the maximum core flux density in the limbs and in the yokes shall not exceed 1.75 at nominal tap. For transformers used in the compensator circuits e.g. STATCOMs and SVCs, care should be taken that the flux density does not exceed the above value at nominal voltage and taking into consideration the fully capacitive mode of operation.

The maximum temperature rise of the core surface in contact with oil and cellulose insulation above the average ambient temperature of 25°C should not exceed 80K for all possible rated in service conditions. The core surface temperature must be limited to the temperature capability of the material in contact with the core using average ambient specified. The material used in core cooling ducts, and between the core and frames, and between the core and the tie plates shall have a continuous temperature rating of 150°C minimum.

3.5.2 Materials

The core shall be manufactured of high permeability; non-ageing cold rolled grain oriented steel sheet laminations having smooth, insulated surfaces. The maximum allowable size of burrs on the slit or cut edge of the electromagnetic steel shall not be capable of causing damage to the insulation between sheets. For all transformers core shall be of mitred construction. The core sheets shall be properly stacked in the step-lap configuration and all the insulation designed in a way that no detrimental changes in physical or electrical properties will occur during the lifetime. All materials shall be brand new and presented in quality and condition that reflect such.

3.5.3 Clamping

For the core clamping, no bolts through the limbs and yokes shall be used. The limbs should be fastened with non-metallic bands/belts. Non continuous steel straps or rods used around the yokes must be insulated from the yokes to prevent short circuits to the core and circulating currents. The pressure of the yokes shall be adequate to prevent movement of the lamination during shipping accelerations. All the return limbs shall be vanished to improve the mechanical stability during shipment/ transportation.

3.5.4 Stack-stack Resistance

The resistance between the core stacks shall be such that no dangerous or detrimental voltages arise. The control of the stack to stack resistance shall be done using engineering techniques where quality control is measurable and adjusting is possible. Scratching of the core laminations to reduce the inter-stack resistance is not allowed.

3.5.5 Earthing

The main magnetic core shall be directly grounded via a bushing on top of the cover with a removable external ground connection. The core shall be bonded to the core clamping structure at one point only, which is easily accessible, and protected to allow testing after installation of the transformer.

No core earthing connection shall have a cross-sectional area smaller than 80 mm^2, with the exception of the connections inserted between laminations which may be reduced to a cross-sectional area of 20 mm^2, where they are clamped between the laminations.

The core earth grounding point shall be clearly marked with a permanent label. The factory core insulation resistance value(s) shall be permanently marked at the core earth grounding point together with **"CORE EARTH MUST ALWAYS BE CONNECTED WHEN EQUIPMENT IS ENERGISED"** and indicating the terminal identification.

3.5.6 Temperature Rise

Hotspot rise above ambient of metal parts in contact with oil shall not exceed 80K under the most extreme operating circumstance. Also, the most onerous temperature of any part of the core and its supporting structure in contact with insulation or other thermally non-conducting material should not exceed the safe operating temperature of that material. Adequate safety margins should be included when determining these criteria.

3.5.7 Electrical Continuity

Where the core laminations are divided into sections by insulating barriers or cooling ducts parallel to the plane of the laminations, tinned copper bridging strips shall be inserted to maintain electrical continuity between sections.

3.6 Coils/Windings

3.6.1 Design

Core form windings shall be of circular concentric type. All the conductor joints within the winding must be minimized and are only permissible at locations on the outer surface of windings. Multiple strand joints shall only be applied in areas of low stray flux density. Shell form windings are not preferred and can only be considered in special circumstances and when approved by Eskom in writing.

3.6.2 Materials

All windings shall be constructed with copper conductors only. Continuously Transposed Conductors (CTC) shall be free from inter-strand shorts after the winding has been completed. For all the transformers of class 2 and above the windings shall be vanished/enamelled conductor to prevent corrosive sulphur effects between the insulation and the conductor. Where the varnish is removed to make joints in the conductor, special arrangements must be made to ensure no corrosive sulphur damage can take place. The shear or tear strength of the bond and base of enamel/ epoxy shall not be less than 40% of the room temperature strength when heated to 125°C after curing. This requirement excludes the tertiary windings of the auto transformers made from non-CTC conductors, and there non-enamelled conductor can be used.

3.6.3 Hot Spot Calculations

The calculated hot spot shall be based on the maximum calculated localized losses in the windings, the insulation on the points with maximum losses, and the oil rise in the windings. If the designer is not able to determine the oil rise in the windings, an added 5K will be made at the design review to allow for the difference between the oil rise in the windings and bulk top oil in the tank.

The maximum hot spot in the leads shall not be more than 1K above the maximum calculated hot spot in the windings.

Winding hot spot shall be measured directly during a heat run test at the factory before release.

3.6.4 Insulation

When determining the equivalent power frequency for impulse voltages i.e. Design Insulation Level (DIL) for analysis of insulation stresses, the ratio of full wave impulse voltage to the power frequency is desirably 2.5, however, the Employer considers values and ranges indicated in Table 4 below as reasonable. The minimum acceptable margin in oil spaces shall be 20% based on the Weidemann® oil strength data for gas saturated oil. For the purpose of controlling the oscillations in the windings, especially the regulating windings, the use of adequate metal oxide surge arrestors is acceptable. Such a design must ensure that the surge arrestors are clamped using a spring loaded mechanism to ensure that they remain intact for the expected life. For the Extra High Voltage (EHV) and Ultra High Voltage Units (UHV) units, it must be taken into consideration that switching surges can reach to about 3.0 pu.

Table 4: Conversion factors for insulation stresses analysis

Type of waveform	Conversion factor
Lightning impulse	2.5 – 2.9
Switching Impulse	1.8 – 2.1
Power frequency	1.633Um
AC Long duration	1.22Utest

All conductor insulation shall be thermally upgraded paper, except when it is otherwise stated.

The expected life of the paper insulation is 35 to 40 years and the processes implemented in the factory during the manufacturing of the transformer shall not reduce the paper life to less than 950 DP value. The *Contractor* shall demonstrate this for each transformer using a direct DP measurement method. The test must be done using an adequate paper sample. The *Employer* may from time to time request a physical paper sample for verification purposes by an independent or internal laboratory. This must be catered for during the production activities. DP values below the indicated value will entitle the *Employer* to a compensation event.

3.6.5 Joints and Internal Connections

Copper conductor shall be used throughout, for the windings and for the leads.

There shall be no soldered joints or terminals in the transformer. All internal lead connections shall be brazed, welded, or compression type. If compression type is used, then the method employed must be approved by the *Purchaser*.

No joints are permitted internal to the windings unless it involves a single strand of a multiple strand (5 or more strands) conductor. Joints shall be permitted at crossovers and leads external to the windings. The manufacturer shall have an established quality assurance program to detect, prevent and repair nicks, dents, burrs and other imperfections in the conductor material. The manufacturer shall have an established quality assurance program to ensure that all joints comply with the requirements.

All internal connections shall be designed so that bushings can be removed or installed without exposing the paper/ winding block. Inspection covers must be available to enable verification of tightness of connections. Where there are joints in adjacent leads they may not overlap but must be staggered. All leads must be securely supported and braced.

Table 5 — Minimum insulation, fault and creepage levels for Class 1 power transformers – These should match IEC requirements

System highest voltage U_m (kV_{rms})	System nominal voltage U_n (kV_{rms})	System fault level (kA)	Lightning/switching impulse voltage withstand level at sea level (BIL) / (SIL) (kV peak)		60 s power frequency voltage withstand level at sea level (60s 50Hz)		Bushings – Line		Bushings – Neutral		Bushings	Tap changer		
			Line Terminal	Neutral Terminal	Separate source	Induced	BIL (kV peak)	60s 50Hz (kV_{rms})	BIL (kV peak)	60s 50Hz (kV_{rms})	Creepage (31mm/kV)	System nominal voltage (U_n) (kV_{rms})	BIL (kV peak)	60s 50Hz (kV_{rms})
3.6	3.3	20	40	40	10	6,6	200	70	200	70	110	3.3	45	16
7.2	6.6	25	75	75	20	13,2	200	70	200	70	220	6.6	75	22
12.0	11	25	95	95	28	22	200	70	200	70	375	11	95	28
17.5	16	20	125	110	38	32	200	70	200	70	540	16	110	38
24	22	20	150	150	50	44	200	70	200	70	740	22	150	50
36	33	20	200	200	70	66	**See 240-56062799 for full requirements**					33	200	70
48	44	20	250	200x	70x	95						33	200	70
72	66	20	350	250x	95x	140						44	250	95
100	88	25	450	250x	95x	150						44	250	95
145	132	40	550	250x	95x	230						44	250	95
145	132	40	550	110+	38+	230	NOTE 1: Phase-to-phase values specified in this table for all transformer windings shall be designed to withstand the appropriate test voltages, and shall be tested as specified in IEC 60076. NOTE 2: 145kV values specified in the last table are for Auto Transformers only.					16	110	38
245	220	65	1050 /840			460						To be discussed during design review meeting and to meet IEC requirements		
300	275	65	1050 /840			460								
420	400	65	1425 /1050			630								
800	765	50	1950 /1425			900								

Non uniform insulation + Fully graded insulation

x Partially graded insulation

Surge protection of non earthed HV neutral of YNd1-connected transformers

The neutral ends of the HV windings of all YNd1-connected transformers with partially graded HV winding insulation (132 kV, 88 kV, 66 kV and 44 kV HV windings) shall have surge arrester protection in cases where their neutral terminals are not earthed (see note below).

Arrester rating

This following information shall appear on the rating and diagram plate and shall bear the following cautionary instruction:

"HV winding insulation partially graded. HV neutral shall be solidly earthed or protected by a .... kV r.m.s. continuously rated (MCOV) metal oxide surge arrester with a .... kV peak residual voltage (10 kA)".

The continuous voltage rating and residual voltage (10 kA) of the required surge arrester shall be inserted as follows:

a) For a 66 kV, 88 kV and 132 kV partially graded insulation transformer the values shall be a minimum of 48 kV r.m.s. and shall not exceed 165 kV peak, respectively.

b) For a 44 kV partially graded transformer the values shall be a minimum of 36 kV r.m.s. and shall not exceed 125 kV peak, respectively.

NOTE: This reduction in insulation has been adopted in order to effect a worthwhile saving in the cost of these transformers, whose neutrals would generally be earthed but may occasionally be unearthed.

The insulation levels chosen are adequate to meet the voltages impressed on the neutrals of these transformers during the works tests, but may be inadequate to ensure the safety of these windings in the case of transformers whose neutrals are unearthed in service, e.g. In the case of simultaneous voltage surges entering the star windings from two or more HV line terminals. For this reason provision is made for surge arrester protection.

3.7 Transformer Construction and Assembling

3.7.1 Winding Arrangement

The transformer winding arrangement shall be indicated in the schedules AB issued with the enquiry and it shall take precedence to the arrangements indicated below. The preferred winding arrangements are as in Table below

Table 6: Winding Arrangement configurations

Transformer Class	Winding Arrangement
Two-winding transformers	Core/LV/HV/RW
Three-winding transformers	Core/TW/CW/RW/SW

3.7.2 Sizing and Compressing

Each winding shall be compacted with a minimum pressure of 7.5N/ mm² on the spacers, for helical and disc windings. It is expected that the windings will be dried under constant pressure. All windings shall be sized using a maximum tolerance of -0 + 2mm. The sizing pressure after final vapour phase drying shall not be less than 5N/ mm² on the transformer board spacers.

The manufacturer will be responsible for proposing methods for checking the pressure on the windings after the assembly is completed to ensure that it is not less than 5N/mm^2 on all spacers.

The *Contractor* shall fully demonstrate the adequate clamping of the windings as required at all stages of manufacturing. The clamping pressure shall be sufficient even for the maximum forces assumed occurring during the coldest conditions of the unit.

3.7.3 Terminal Arrangement

The interchangeability of transformers requires that main terminals are arranged in a standard layout.

All terminal groups shall be arranged so that when viewed in the direction of power flow, the neutral terminal appears on the left, followed by the line terminals in alphabetical order, as shown in the illustration below. The power shall always be assumed to flow from the winding having the highest voltage rating towards all other windings.

LV winding terminals shall appear on the right-hand end of the transformer when viewed from the HV side. In the case of delta-connected stabilising windings, the "T" - terminal shall occupy the indicated position. For Generator step up transformers, this shall be indicated in the schedules AB and be discussed during the design review meeting.

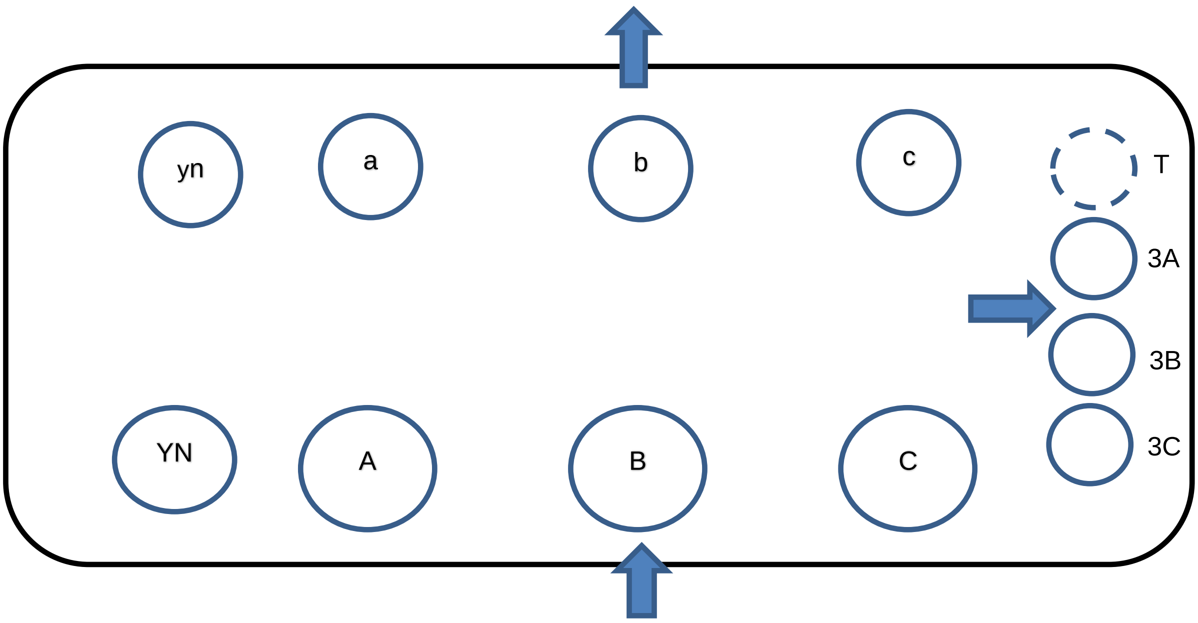


Figure 3: Illustration of terminal positioning

3.7.4 Termination on bushings

Winding termination interfaces with bushings shall be designed to allow for repeatable and safe connection under site conditions without jeopardizing the in-service integrity of the transformer.

The winding-end termination, insulation system and transport fixings shall be so designed that the integrity of the insulation system is not easily compromised during repeated work in this area.

Allowances shall be made for accommodating up to 100 mm tolerance on bushing axial dimensions and the fact that bushings may have to be rotated to get oil level inspection gauges to face in a direction that allow easy inspection from ground level. In particular, rotation or straining of insulated connections shall be avoided during the fastening of conductor pads from the winding onto the termination surfaces of the bushing.

Suitable inspection and access facilities into the tank shall be provided to minimize the possibility of creating faults during the installation of bushings.

3.7.5 Clamping

The *Contractor* shall fully demonstrate that adequate clamping of the windings as required at all stages of manufacturing is controlled.

3.7.6 Drying

The *Contractor* shall fully demonstrate that adequate drying and moisture ingress into the winding as required in all stages of manufacturing is controlled.

3.8 Bushings

The bushings used shall be of technology that provides safe operation of the transformer, maintenance free or at most minimum maintenance, environmentally friendly, and as far practically possible does not add fire risk. Only the dry technology of bushings is acceptable except in exceptional cases which shall be agreed with Eskom during a tender stage and shall be indicated in Schedules AB. One such case is when such a technology does not exist at all or is not mature enough in the category of the required bushings. The outer body shall be made with composite insulator in grey colour.

The bushings shall comply with the requirements of the bushings specification 240-56062799 and as stipulated in schedules AB of a given purchase order. For units going to long-term storage (spares) the bushings shall be sealed on the oil side as a preparation for such a storage.

3.9 Tap Changers

3.9.1 Type of tap changers

Tap changers can be specified as both On-Load Tap Changers (OLTC) and Off-Circuit Tapping Switches (OCTS). The required tap changer shall be indicated in the relevant schedules AB.

3.9.2 On Load Tap Changers

On load tap changing equipment shall be designed and constructed in accordance with the latest revision of IEC 600214. The OLTC should be of the resistance bridging type. The tap changer supplied must present no risk to the transformer during any operating condition, albeit on load or on no-load, both oil type and vacuum type will be considered. The offered solution is desired to provide 300 000 intrusive maintenance free operations All tap changers must have undergone adequate testing to demonstrate their capability to perform under expected operational and loading conditions as per IEC. Eskom, in its discretion and based on the experience, may require additional testing to the ones specified in IEC 600214.

3.9.3 Off Circuit Tapping Switches

When specified, the transformer shall be provided with a ganged off-circuit tapping switch, operated by an external handle situated in an unobstructed position, not more than 1,5 m above ground level.

The contacts shall be positively self-locating in each tapping position without constraint from the operating mechanism, which shall provide for padlocking in each position.

The tapping positions shall be indelibly marked to correspond with the data given on the rating-and-diagram plate and these markings shall be legible by a person standing at ground level.

Off circuit tap switches shall be fitted with direct or gear driven operating mechanisms.

3.9.4 Tapping Range

The tapping range is specified taking into consideration the requirements of standardizing and interchange-ability. The required tapping range shall be specified in Schedules AB of the ordering specification. For transmission and distribution class transformers, the regulation is normally selected as:

All on-load regulated transformers have on-load taps from +5% to -15% of the HV terminal voltage in 16 equal steps of 1,25% each. This excludes the transformers with the HV of 400kV and above, for these transformers no plus (+) range is required and only -15% is required.

When an off-circuit tap switch is specified, the range shall be +5% to –5% of the HV terminal voltage in 4 steps of 2,5% each.

For each transformer enquiry, the requirements shall be indicated in schedules AB

3.9.5 Electrical Location (Positioning) of the Tap Changer

For double-wound transformers (Y-connected and Primary assumed to be the HV winding) the tap changer shall be positioned on the neutral side of the primary winding.

Tap-changers shall be installed in the H.V. series winding (MV potential) at the line end of common winding (auto transformers only).

3.9.6 Ratings

3.9.6.1 Current Rating

The rated through current of the tap changer, as defined in of IEC 60214, shall not be less than that resulting from the highest value of continuous maximum load in the tapping winding of the transformer (It shall be able to operate at the emergency and overload ratings of the transformer without harm.

It is permissible that tap changing be inhibited during transformer overload conditions above 1,5 p.u.

3.9.6.2 Short Circuit Currents

In addition to the requirements of 8.3 of IEC 60214 for on-load tap changers, tap changing equipment shall be capable of carrying the same currents, due to external short-circuit, as the transformer windings with which they are associated.

3.9.6.3 Insulation Level Requirements

Notwithstanding the requirements of 8.6 and table V of IEC 60214, on-load tap changing equipment, including all insulating and barrier boards, shall withstand the impulse and dielectric test voltages applicable to the part of the transformer windings with which they are associated, as specified in schedule A & B of this Specification.

If any specific critical phase to phase insulation situations exist in the transformer it should be noted that the Employer’s surge arresters will only limit incoming surges on a phase to ground basis and that phase to phase insulation will therefore be protected by two arresters in series. This particularly applies to three-phase line end tap changers and their leads, as well as the leads of single-phase tap changers. The Contractor must design for this situation.

3.9.7 Design Requirements

The voltage class of tap changers located at the line end terminals shall be a minimum of one voltage class higher than the class of the terminal.

The rated current shall comply with the requirements of IEC 60076-7 loading guide. The tap changer should not limit the overload design of the transformer.

The OLTC voltage ratings shall be specified in the schedule B of the ordering specification. The voltage withstand capability of the OLTC has to be selected by the transformer manufacturer.

3.9.8 Other Tap Changer Requirements

3.9.8.1 Replacement of current switching contacts

The current breaking contacts of diverter switches shall be easily replaceable.

3.9.8.2 Diverter and selector switch compartments

Drop-down tanks that necessitate the provision of pits in the foundations are unacceptable.

Each diverter and selector switch compartment shall be provided with an oil drain valve or plug.

Care shall be taken to close the drain valve or plug of the diverter compartment before operating the tap-changers on load in the factory or after installation. Failure to do so will require full reprocessing of the oil in the transformer at the Contractor’s cost.

Current breaking switches (e.g. diverter and selector switches as distinct from tap selectors and change-over selectors) shall not operate in the insulating oil of the main transformer.

The insulating oil for these switches shall be completely segregated in a oil and gas-tight compartment separate from that in the main transformer tank and the oil conservator for maintaining the oil level in the compartments containing such switches, shall be separated from the main transformer oil conservator. Where a common conservator tank construction is employed to serve both the main tank and the tap-changer switching compartment, the two bodies of oil shall be segregated by an oil and gas tight steel partition. Each body shall have its own separate dehydrating breather and oil level indicator, that shall be clearly labelled to relate it to the corresponding oil body. A protection for the loss of oil in the tap changer compartment of the conservator shall be provided.

3.9.8.3 Protective devices for diverter and selector switch compartments

Protective functions provided for the diverter switch and selector switch compartments shall effect the tripping of the circuit-breakers controlling the transformer in the case of:

low oil level (may be omitted if a surge relay, that fulfills this function, is provided).

a surge of oil produced by a fault inside the compartment, or a rise in pressure or temperature resulting from such a fault, whichever one of these three is most appropriate to the design of the apparatus.

Where a pressure sensitive device is provided, the associated contacts shall close under a steady increase of pressure. The operating pressure level shall not be less than 100 kPa or as recommended by the manufacturer, taking the static head of oil into consideration.

3.9.8.4 The Breather

The oil in the diverter switch and selector compartments shall only communicate with the atmosphere through a dehydrating breather containing a silica gel charge of at least 1 kg. The breather shall comply with the requirements of the breather specification 240-56063886. Self dehydrating breathers are acceptable.

3.9.8.5 Buchholz relay/Surge Protection for selector compartment

Where tap selectors and change-over selectors are contained in compartments separate from current breaking switches, those compartments shall be protected by the Buchholz relay serving the main transformer tank, unless separate oil surge and low-oil level relays are provided. Provisions shall be made for filtering and draining the oil in those compartments.

3.9.8.6 Alarm and tripping contacts for protective devices

These contacts shall comply with the requirements of 3.9.10.2.

The requirements are that for all trip and alarm information to be duplicated (2 x potential free contacts per function). E.g. Buchholz Trip, Buchholz Alarm, Winding Temp Trip, Winding Temp Alarm, Pressure Relief Trip, Rapid Pressure Relief Trip, etc.

3.9.8.7 Strength of tap-changer compartments and insulating barriers

Tap-changer compartments and insulating barriers shall have adequate strength to resist, without suffering permanent distortion or damage of any sort, from the forces resulting from the application of a full internal vacuum at sea level.

In the case of insulating barriers, the vacuum is unequalized (i.e. applied from one side only, against atmospheric and oil pressure on the other side), and applied internally from either side, with the following provisions:

a) in the case of tap-changers energized at voltages below 88 kV, the vacuum requirement applicable to the tap-changer compartment will be limited to that which produces a pressure differential between the tap-changer compartment and the atmosphere of not more than 65 kPa; and

b) where such insulating barriers serve tap-changers mounted wholly within the transformer tank, (e.g. diverter switch cylinder) the application of the vacuum or pressure may be equalized on both sides of a diverter switch compartment by interconnecting the two conservators.

3.9.8.8 Sealing of tap-changer parts for transport

Where it is necessary to remove parts or the whole of the on-load tap changer for transport purposes, it shall be possible, unless otherwise approved, to complete erection on site with the transformer windings and terminal insulation covered with oil.

3.9.9 Driving mechanism, control and indicating equipment

3.9.9.1 Enclosures of apparatus

The driving mechanism shall be enclosed in a ventilated, dust-proof, weather-proof and vermin-proof cubicle provided with an adequate 50Hz supply, separately fused, anti-condensation heater and switch (with a solid withdrawable link in its neutral lead), and, at its lowest point, with a 25 mm diameter gauze covered drain hole. The internal surface corrosion proofing and finishing shall comply with 240-56030674 Corrosion Protection of new and in-service power & station auxiliary transformers.

Where a gland plate for cables is provided, ample space shall be allowed from the terminal strip for arranging the entry of the cable cores (see also 3.10)

Note: Unless specified to the contrary, the automatic and remote control panels and equipment for the on-load tap-changer (those to be installed in the Eskom control room only) will be supplied and installed by the *Purchaser*.

3.9.9.2 Design of driving mechanism: synchronism and limit stops

The driving mechanism shall be so designed that once a tap-changing operation has been initiated, the diverter switch or selector switch contacts will not remain in an intermediate position should the power supply for the driving unit fail.

The design shall include means to ensure that tap-changers fitted to three single-phase units, or units operating in parallel, remain in step. Mechanical stops shall be provided to prevent the mechanism from overrunning its end position.

3.9.9.3 Manual operation

For maintenance and emergency operation of the tap-changing equipment, a readily detachable handle shall be provided for manual operation. Adequate provision shall be made to prevent the diverter switch or selector switch contacts being left in an intermediate position when operated manually.

To prevent power operation with the handle in position, a normally closed contact in the control or motor circuits shall be provided that opens when the handle is inserted.

The tap-changer controller shall be accessible from ground level (± 1,2 m from base plate), i.e. all operating inspection points shall not be positioned higher than 1.8 meters from base as to ensure that the operator does not have to leave ground level.

All risks or special requirements related to this operation shall be clearly indicated in the manual and on the physical box such that they catch the attention of the reader or operator.

3.9.9.4 Electrical operation

The following are the minimum requirements which shall be mounted in the driving mechanism enclosure or other suitable kiosk, mounted near the transformer (see also Figure 4).

Control relays shall only respond to control initiation pulses of 150 ms duration or longer.

The rating of control relay contacts shall be in accordance with 3.9.10.2.

All contactor operating coils and trip coils shall be rated at dual voltage of 220V d.c. and 110 V d.c, unless otherwise specified.

a) Tap-changer drive motor

See motor “a” on **Figure 4.**

A tap-changer drive motor rated at:. 400 V a.c, three-phase, 50 Hz shall be fitted.

b) Tap-in-progress indication

A terminal shall be provided for the neutral of the 400V a.c supply and one terminal of the motor shall be connected to an external terminal for a "tap-in-progress" lamp. (Refer to **Figure** 4)

Or alternatively, a "tap-in-progress" indication contact similar to contact 'A' of 0, shall be provided.

c) Circuit-breaker for motor protection

See "b" on Figure 4.

1) For a three-phase drive motor, a circuit-breaker fitted with three-phase thermal overload protection and single-phasing protection and a separate d.c. shunt trip coil shall be provided. The trip coil shall be provided with a contact to break its own current if the coil rating exceeds 50 W. The trip coil rating in watts shall be stated on the OLTC drive schematic diagram.

2) Where "raise" and "lower" contactors are fitted, both the circuit-breaker and the d.c. shunt trip coil shall be provided.

d) Protection of tap-changer during system faults

A self-resetting contactor shall be provided in the motor circuit for overcurrent blocking of the tap-changer drive under system fault conditions. The contactor shall be fitted with a d.c. operating coil, and normally closed contacts capable of interrupting motor starting currents. Contactors with normally open contacts that require the coil to be continuously energized are not acceptable.

e) Local control

"Raise" and "Lower" push-buttons or a control switch for the local control, mechanically or electrically interlocked, shall be provided (see "d" on Figure 4).

As shown in Figure 4, these raise/lower control devices shall be connected to separate terminals for use in the *Purchaser*’s control scheme. They shall not be connected for direct control of the OLTC drive.

f) "Raise and Lower" motor-operating contactors

Direct-current operated "Raise" and "Lower" contactors for controlling motor direction shall be provided (see "e" on Figure 4.

g) Completion of tap-change operations

Auxiliary contacts shall be provided for sealing "Raise" and "Lower" contactors and mechanism contact "A" for controlling the sealing of the "Raise" and "Lower" contactors (see "f" and "g" in Figure 4) (see d)).

h) Step-by-step and parallel operation

See "h" and "i" on (Figure 4). The manufacturer shall provide and install all the appropriate equipment and circuitry inside the driving mechanism i.e. contacts, relay(s) etc. in order to perform within the mechanism box the full step-by-step function (see fig. 8 step-by-step typical circuit). For operation of step-by-step relay(s) and single or two contacts shall be provided. When single contact is used this must close in either “Raise” or “Lower” direction, when two contacts are used, one contact shall close only when the drive moves in the "Raise" direction and the other shall close only when the drive moves in the "Lower" direction.

These contacts may take the form of mechanism contacts or, alternatively, auxiliary contacts on the "Raise" and "Lower" contactors may be used.

In the latter case an additional mechanism contact, similar to 'A' in g) above shall be provided for the step-by-step circuit if the 'A'-contact is the normally open type, i.e. if the mechanism contact through which the "Raise" and "Lower" contactors are sealed is the type that is open in the rest position and closed during operation.

The essential features of the contacts provided for the step-by-step circuit are that they shall not operate the step-by-step relays before the "Raise" and "Lower" contactors have had time to seal themselves in, and that they shall remain closed throughout a tap-change operation, and, preferably, also throughout a transition step. If they do not remain closed throughout a transition step, then a spare mechanism contact shall be provided and wired to separate terminals.

i) Tap position indication, supervision and monitoring

Two spare sets of coded, voltage free contacts shall be provided (see Figure 5).

Tap position switch for use in parallel checking circuit. This switch may take the form of either a change-over switch that changes its position at the end of each tap-change operation or a multi-position rotary switch with as many contacts as there are taps on the transformer. These switches shall be of the break-before-make type. (see l on Figure 5).

j) Limit switches

See “n” on Figure 4

Limit switch contacts, to prevent the tap-changer from overrunning the end positions, shall be provided.

These contacts shall be provided where indicated in the initiating circuits and shall preferably be provided in the motor circuits as well if, in the case of single-phase motors, motor contactors are provided.

Note: The preceding clauses list the *Purchaser*’s minimum requirements, but if the *Contractor* wishes to add further relays (e.g. for step-by-step control), this is acceptable though not desirable.

k) Approval of components

All contactors, switches, circuit-breakers, relays and contacts incorporated in the electrical control of tap-changers, shall be subject to the *Purchaser*’s approval.

3.9.9.5 Mechanical tap position indicators

An externally visible mechanical tap position indicator shall be provided on the driving mechanism.

3.9.9.6 Diverter and selector switch compartments

Maximum and minimum tap position indicators arranged for manual resetting shall be fitted to the driving mechanism to register the operating range encountered in service.

3.9.9.7 Operation counters

Externally visible mechanical counters (e.g. cyclometers) shall be provided to register the number of tap-change operations. These recorders shall have at least six (6) digits, and shall have no provision for resetting. These counters shall be of suitable quality for at least 10^6 operations. This shall be supported by a type test certificate.

3.9.10 Drawings and technical data

a) Details on transformer outline drawings

The main features of tap-changers, including the fittings and protective devices specified, shall be indicated on the transformer outline drawings.

b) Schematic diagrams

Transformer on-load tap changer drive schematic diagrams showing the rating in watts of the d.c. shunt trip coils fitted to the driving motor circuit breakers, shall be supplied. The *Contractor* shall indicate on this diagram which of the requirements, detailed in 3.9.9.4 above, each device will fulfil.

c) Timing charts

A diagram or chart showing the relative timing of all contacts during both a regular tapping step and a transition step shall be provided.

3.9.10.1 Tap position numbering

For both off-circuit and on-load tapping arrangements the tap position shall be numbered so that an increase in tap position number represents an increase in the controlled, or outgoing voltage. Controlled secondary voltage is defined as the voltage that is changed as a result of the change in tappings. In the case of interconnection or coupling transformers involving power flow in both directions the controlled voltage will be specified in schedule A of an enquiry document

Note: Transition steps that give the same outgoing voltage should all take the same tap position number, distinguished in each instance by a lower case letter; e.g. 9(a), 9(b) and 9(c) where there are three transition steps.

3.9.10.2 Alarm, control and tripping contacts

Alarm and tripping contacts shall be provided with electrically independent and unearthed circuits and shall be insensitive to vibration and earth tremors. This insensitivity shall not depend on the method of mounting, but shall be an inherent feature of the contact assembly.

Auxiliary relays shall not be used.

a) Alarm and control contacts

Contacts providing alarm output shall be rated as follows:

Make and carry for 200 ms:	5 A @ d.c. 250 V
Carry continuously	2 A @ d.c. 250 V
Break (inductive L/R = 40 ms):	30 W or 0.2A @ d.c. 250 V

b) Tripping contacts

Contacts providing trip outputs shall be rated as follows:

1)	Make and carry for 200 ms	30 A @ d.c. 250 V
2)	Carry for 1s:	10 A @ d.c. 250 V
3)	Carry continuously:	5 A @ d.c. 250 V
4)	Break (Inductive L/R = 40 ms):	30 W or 0.2A @ d.c. 250 V

c) Tests

Devices fitted with alarm and tripping contacts shall be tested as specified in 3.17 and as per IEC 60076 applicable parts.

Standard on-load tap-changer control schemes: minimum requirements for driving mechanisms:

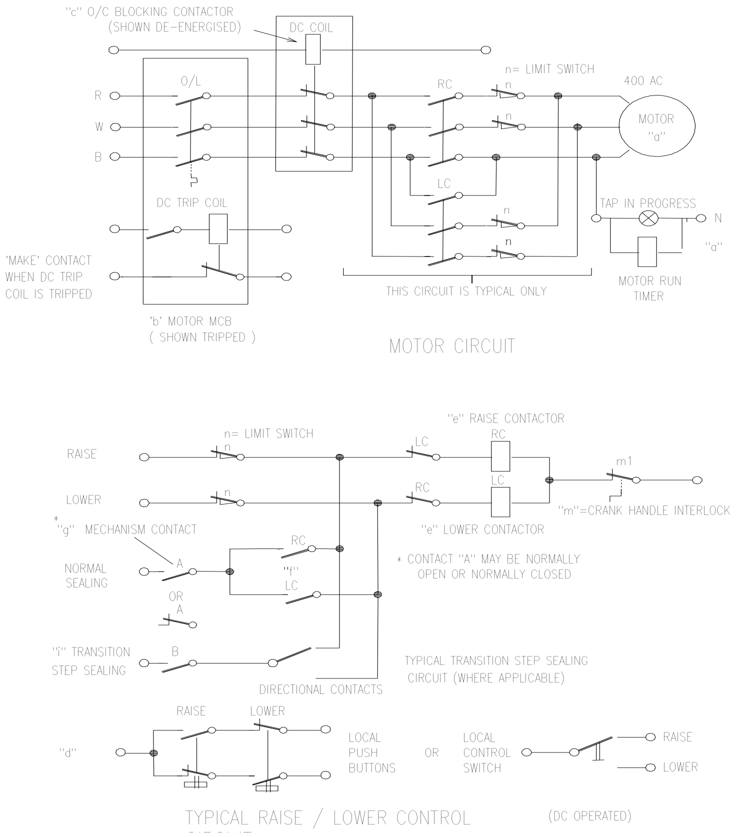


Figure 4: Control circuits for all three-phase OLTC motor drives

Notes to Figure 4

1) If the motor is continuously rated for the stalled condition, the thermal overload protection may be omitted.

2) Where 'raise' and 'lower' contactors are not provided and the motor current does not exceed 5A when starting or running, the separate d.c. shunt trip coil may be omitted.

3) In the case of single-phase motors continuously rated for the stalled condition and with a motor current not exceeding 5 A when starting or running, the circuit-breaker may be omitted entirely, provided no 'raise' or 'lower' contactors are fitted.

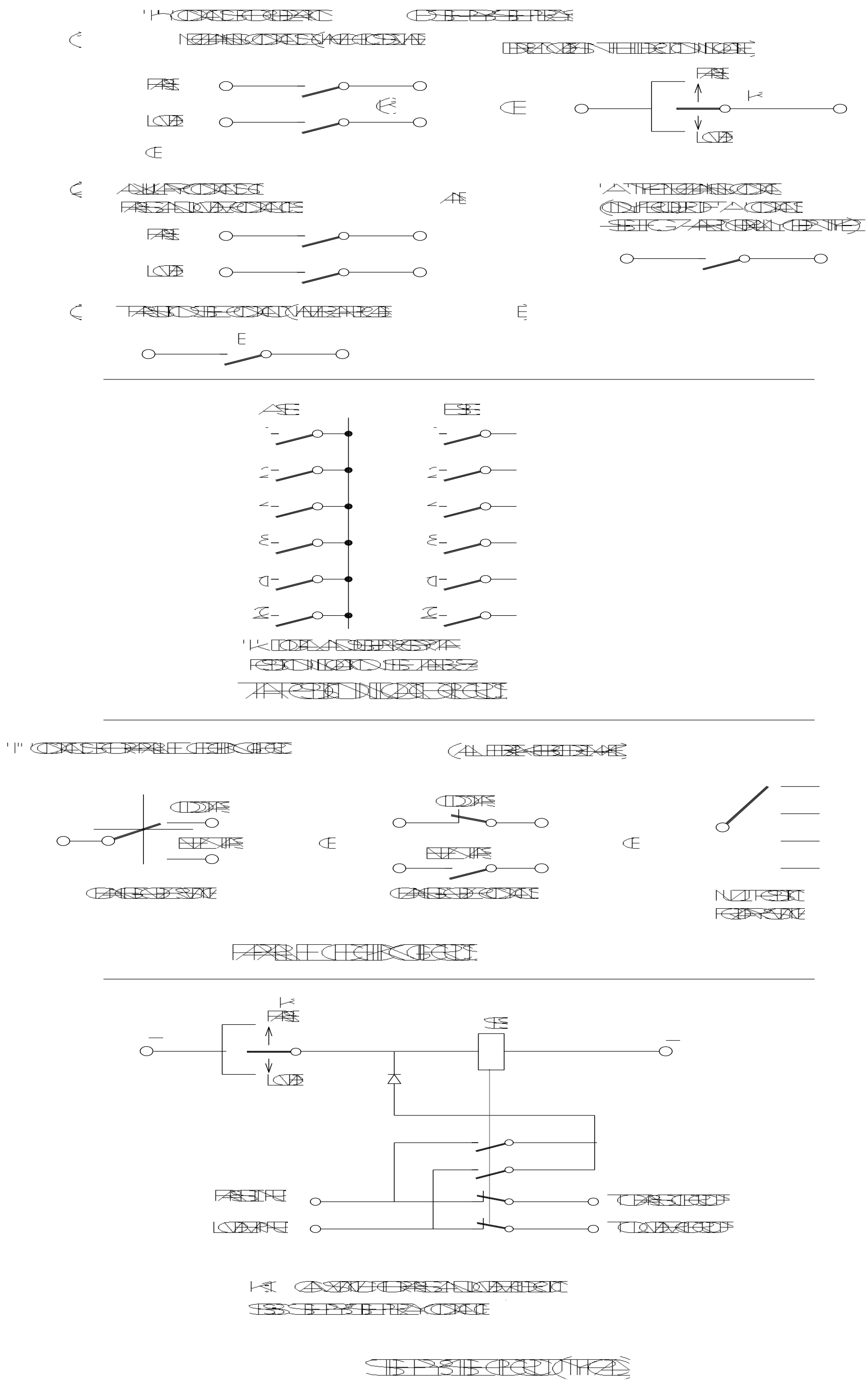


Figure 5: Common circuits for OLTC control

Table 7: Tap position encoder contact state at each tap position

Position	**20**	**10**	**8**	**4**	**2**	**1**
1	0	0	0	0	0	1
2	0	0	0	0	1	0
3	0	0	0	0	1	1
4	0	0	0	1	0	0
5	0	0	0	1	0	1
6	0	0	0	1	1	0
7	0	0	0	1	1	1
8	0	0	1	0	0	0
9	0	0	1	0	0	1
10	0	1	0	0	0	0
11	0	1	0	0	0	1
12	0	1	0	0	1	0
13	0	1	0	0	1	1
14	0	1	0	1	0	0
15	0	1	0	1	0	1
16	0	1	0	1	1	0
17	1	1	0	1	1	1
0 = contact open		1 = contact closed				

3.10 Tank and Parts

3.10.1 Tank Design

The shape of the transformer tank and fittings, including the underbase shall be such that no water can be retained at any point on their external surfaces. Furthermore the lid on the inside shall be shaped to ensure that all free gas generated inside the transformer escapes to the conservator by way of the gas and oil actuated relay.

The tank and cover shall be designed so that local heating due to stray flux in any structural part shall not exceed the top oil temperature limit specified for the transformer, by more than 10 °C.

Heating, due to stray flux, shall also not cause local temperature elevations of more than 15 °C relative to the oil temperature at that level.

Thermometer pockets shall be located so as to avoid errors in temperature indication due to the heating effects resulting from stray flux. Thermometer pockets shall be located in a position where the least traffic is during activities such as OLTC maintenance and bushing replacements.

The general design of the tank and the turrets must be always be such that the maintenance activities and replacement of components (e.g. all bushings, PRVs and etc) can be carried out by only partially draining the unit. This must be demonstrated during a design review.

3.10.2 Tank Base

The underbase shall be suitable for the movement of the transformer in any direction, by sliding on greased rails. For the class 1 transformers, the tank base shall be provided with four hauling eyes not less than 50 mm in diameter, as near as possible to the extremities of the length and width of the tank.

Unless otherwise approved, transformer underbase shall be of a thickness not less than that specified in this document. Fabricated bases shall not retain water. Skid bases are not accepted, except in special cases where they may be needed, it shall be so indicated by the *Employer.* The position of the axial and transverse centre lines as shown on the dimension and foundation drawings shall be accurately stamped onto the tank at the base level, on both sides and at both ends, and indicated by means of a red enamelled mark at each point.

Table 8: Minimum thickness of transformer tank base plates — mild steel

Length of tank (m)	**Minimum plate thickness** (mm)
Fabricated bases,	
not exceeding 2,5	10
exceeding 2,5	12
Flat bases,	
not exceeding 2,5	12
over 2,5m but less than 5	20
over 5m but less than 7,5	26
exceeding 7,5	32

3.10.3 Tank Main Top Cover

The top cover of the tank shall be the welded type unless stated otherwise in the schedule AB or during the mechanical design review. The positioning of the auxiliary components and pipes on the top cover must take into considerations the need to walk on the top of the tank during the maintenance activities. Preferably the conservator tank should not be on the top cover as it makes movement extremely difficult to almost impossible during inspection and maintenance activities. The top cover shall be painted with a non-slippery paint to enhance safety of personnel.

3.10.4 Tank Strength and Oil Tightness

3.10.4.1 Rigidity

Transformer tanks and their associated components shall have adequate mechanical strength and rigidity to permit the complete transformer, filled with oil, to be lifted, jacked and hauled in any direction, and to be transported without structural damage or impairment of the oil tightness of the transformer, and without the necessity for the special positioning of sliding rails in relation to the tank. Tank stiffeners shall not cover welded seams, to enable the repair of possible oil leaks. The tank and transformer as a whole shall be suitable for transport by low-bed or beam wagon.

3.10.4.2 Internal Pressure and Vacuum

Transformer tanks, complete with all fittings and attachments normally in contact with the transformer oil, and filled with oil of the specified viscosity, shall withstand the pressure and the leakage tests. When empty of oil they shall withstand the full vacuum test. In the case of type tests for strength and oil tightness the fittings (e.g. pressure relief devices and bushing stems) may be tested separately. The ability of the tank to withstand overpressure shall be co-ordinated with the pressure relief valves.

The tank shall be designed to withstand full vacuum for vacuum filling. If barrier boards are installed between the main tank and any other tank (selector tank) the barrier board shall be designed to withstand full pressure of the main tank filled with oil on the one side of the barrier board with full vacuum on the on the other side of the board

3.10.4.3 Joints

A transformer tank and accessories shall be designed and constructed in such a manner that minimum points of possible leaks exists. Only valves and inspection covers of specific purpose shall be provided.

a) All gasketed joints shall be designed, manufactured and assembled to ensure long term leak-free and maintenance free operations.

b) Joints that need not be removed for normal maintenance or transport shall be welded.

c) Details of all gasketed joints shall be submitted for approval during the mechanical design review meeting.

3.10.4.4 Gasket Types

a) Subject to clause b), all gasketed joints shall be of the O-ring and groove type. The O-ring shall be manufactured from nitrile rubber or better.

b) Bolt-on type tap-changers and selector tanks that have to be removed for transport or maintenance are specifically excluded for the use of O-ring type gasket joints. In these applications rectangular cord and groove joints where the nitrile rubber cord is not joined but passed twice around the perimeter with the loose ends at the bottom, are acceptable. Alternatively a flat nitrile rubber gasket with stoppers to prevent over compression will be acceptable.

c) Approved non O-ring gaskets that need re-tightening in order to avoid oil leaks as a result of shrinkage, shall be retightened in the second 6 months of service by the *Contractor* at no extra cost to the *Purchaser*. All costs to maintain the system leak free shall be for the *Contractor*'s account during the guarantee period.

3.10.4.5 Attachments to the transformer tank

Attachments to the transformer tank shall only be fixed by bolting them to the prepared flat surface of a flange facing, either integral with or welded to the tank and sealed by a gasket or O-ring to the mating flange of the attachment. Joints dependent on the sealing of screw threads, and direct welding of fittings to the tank will not be accepted.

3.10.4.6 Pipe joints

Oil pipes above 15 mm bore shall have flanged, gasketed and bolted joints. Flexible compression joints will not be accepted unless specifically approved. Joints dependent on the sealing of screw threads will not be accepted.

3.10.4.7 Drilling of pipe flanges

Except where otherwise stated, the drilling and bolting of pipe flanges and the mating flanges of fittings shall comply with BS 4504 or DIN 2631.

3.10.5 Access openings and covers

An appropriate number of suitably proportioned handholes and manholes shall be provided for easy access to the upper portions of the core and windings assembly, the lower ends of bushings, internal current transformers and the oil side of their terminal boxes (see 3.6.3). Manholes for the purpose of internal inspection are preferred to be as close as to ground level as necessary to eliminate the need of climbing.

The following minimum inspection covers shall be provided on the main tank:

- At each bushing terminal where the bushing is connected to the winding
- On the tank wall, a minimum of one accessible from ground level to allow access for active part inspection at least 600 mm in diameter. The inspection cover shall be located to allow for maximum access to the active part and the tap changer. Where this is not possible more than one inspection cover shall be provided.
- On the top cover, a minimum of one to allow access for active part inspection at least 600 mm in diameter.

3.10.6 Handles

Manhole covers shall be provided with stout handles to facilitate their removal.

3.10.7 Lifting lugs

Covers with a mass greater than 25 kg shall be provided with symmetrically arranged lifting lugs.

3.10.8 Valves and oil sampling devices

3.10.8.1 Isolating valves

Suitably dimensioned isolating valves shall be provided:

a) at each point of connection to detachable cooling apparatus; and

b) at each point of connection to tap-changer compartments, cable disconnecting chambers and cable sealing boxes supplied from the transformer tank.

c) Isolating valves shall provide effective sealing at 100 kPa pressure and full vacuum at sea level.

d) Radiator isolating valves shall be freely accessible for opening and closing with the transformer fully assembled.

e) No special tools or tools shall be required to open or close radiator valves.

f) Radiator valves shall be fitted to allow replacement of individual radiators.

3.10.8.2 Filtering and drain valves

Two 50 mm double-flange valves shall be provided for filtering purposes. At least one valve shall be located at the top of the tank adjacent to the oil conservator, and another at the bottom of the tank on the opposite end to give a cross current of oil during filtration. The lower valve shall be a combined drain and filtering valve and, as such, shall be positioned so that it drains, as far as possible, all the oil from the transformer tank. For class 2 and above transformers, the top filtration valve shall be routed inside the transformer tank and be brought out on ground level, and shall be clearly marked**.** The intake of the pipe for the top filtration valve shall be positioned at the allowable partial drain level.

All valves shall be painted with the same colour as the transformer tank.

No valves shall be fitted by means of stud welding or welding to the main tank.

The tap-changer diverter chambers shall be fitted with 20 mm (¾ inch) drain valves for maintenance purposes. If inaccessible from ground level, they shall be piped down to 1,5 m above ground level.

All drain valves shall be protected against mechanical damage. The means of mechanical protection shall be indicated on the general arrangement drawing.

3.10.8.3 Oil sampling devices

If specified in AB schedule, an oil sampling device consisting of a flange and drain plug as per the Oil sampling specification 240-56062720 or other approved device shall be provided in the following locations where applicable:

a) at the bottom of the transformer tank, bolted and fitted with O-rings to the free flange of the 50 mm drain valve specified in 3.10.8.2;

b) at the bottom of each separate tap-changer selector compartment;

c) on the free flange of the tap-changer diverter chamber; and

d) at the end of the main Buchholz relay sample pipe. A ¼" needle valve shall be provided on the Buchholz pipe for oil sampling.

These points shall all be numbered on the sampling point with the number corresponding to the same point on the valve function plate (see 3.10.8.8).

The tap changer diverter chambers shall be fitted with 25 mm individual drain valves for maintenance purposes. If inaccessible from ground level, they shall be piped down to 1.5 m above ground level.

Each diverter shall be fitted with individual sampling points.

The sample pipes shall be copper tubing with an ID of at least 7 mm (3/8" or 10 mm copper tubing). All fittings used shall be 3/8" brass or stainless steel. Only SAE 45-degree flares must be used on the copper tubing - compression fittings are not acceptable. The tubing shall be protected against physical damage by appropriate routing, fastening and / or protective conduit. Provision shall be made to secure oil sample copper tubing with rails welded to the tank and structures. At no point shall the copper tubing make contact with any steel surfaces.

A sample valve shall be provided and located approximately 1.5 m above ground level and be easily accessible from the transformer plinth. The sample valve shall be a needle type valve of 3/8" or 10 mm size – ball valves may not be used. Only brass or stainless steel needle valves shall be used. A stopper plug shall be provided to seal the open end of the sample valve.

All oil sampling devices to be accessible from ground level.

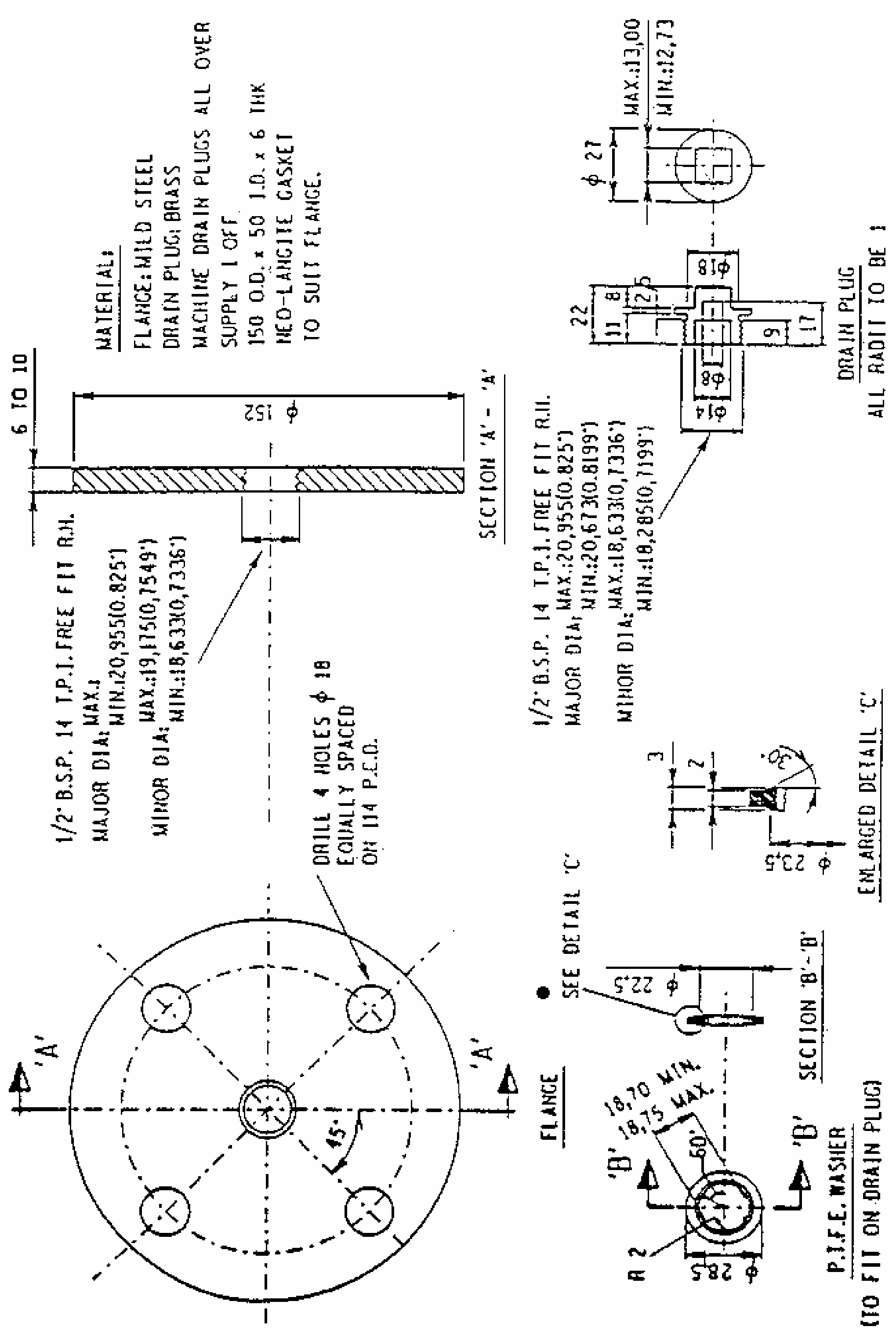


Figure 6: Oil sampling flange interfaces

3.10.8.4 Strength and oil tightness

Valves and oil sampling devices shall be of adequate strength to withstand the hydraulic and mechanical loads imposed upon them during testing, processing and transporting of the transformer and in service. Pewter and similar low strength materials will not be accepted.

Valve discs, wedges, wedge facing rings, seats and seat rings, stems and spindles shall be of approved non-corrodible material. Valves and oil sampling devices shall withstand the 3.18 test requirements,

3.10.8.5 Valve stem seals

Valve stem seals shall be capable of adjustment in service without draining the transformer oil. In this connection, and generally, aluminium (or aluminium alloy) threads shall not mate with threads of brass valve stems.

3.10.8.6 Padlocking

Suitable means shall be provided for padlocking valves in both the open and closed positions. This is applicable only to class 1 transformers.

3.10.8.7 Blanking plates

All valve entries communicating with the atmosphere shall be sealed using bolted and gasketed (“O” rings accepted) blanking plates, or captive screwed caps, or plugs as the case may be. The O rings of viton material or type are preferred to the traditional nitrile ones.

3.10.8.8 Valve function plate

A schematic diagram plate indicating all valves, vent plugs and sampling points shall be provided in the same manner as the rating and diagram plate. This plate shall also indicate the position of all valves in operation, and out of operation.

3.10.8.9 Valve position indication

The position of each valve, i.e. either fully open or fully closed, shall be clearly and unambiguously visible on inspection. Where this is not so, e.g. in the case of lever operated valves, the “open” and “closed” positions of the lever in relation to a clearly recognizable part of the transformer shall be depicted on the valve function plate specified in 3.10.8.8.

3.10.8.10 Labelling of oil sampling devices

All the oil sampling points shall be numbered the same as on the valve function plate with exception of the two routine sampling points that shall also be labelled. The labels shall comply with the requirements of the labelling specification 240-56062720

3.10.9 Jacking Pads

Four suitably and symmetrically placed jacking pads shall be provided in positions that shall be accessible when the transformer is loaded on to the transport vehicle, except where jacking pads are used as transport pads on vehicles with built-in jacking.

The position of the jacking pads shall be such that they do not restrict the direction in which the transformer could be moved (forward, backward and sideways) once off-loaded on site.

Each jacking pad shall be designed to support, with an adequate factor of safety at least half of the total mass of the transformer filled with oil, allowing maximum possible misalignment of the jacking force in relation to the centre of the working surface.

Unless otherwise approved, the heights of the jacking pads above the bottom of the transformer base, and the unimpeded working surface of the jacking pads shall be as in **Table 9** (read in conjunction with **Figure 7**).

Table 9: Jacking pad dimensions

Transformer mass complete with oil (metric tons)	**Min/max height of jacking pad above base "A"** (mm)	**Overhang to centre of jacking pad "B"** (mm)	**Unimpeded working surface of pad "C"** (mm)	**Width of symmetrical unimpeded access to jacking pad "D"** (mm)
60 and below	460/530	115	170 x 170	230
Above 60	650/700	150	210 x 210	300
Access in direction 'E' shall be unrestricted.				

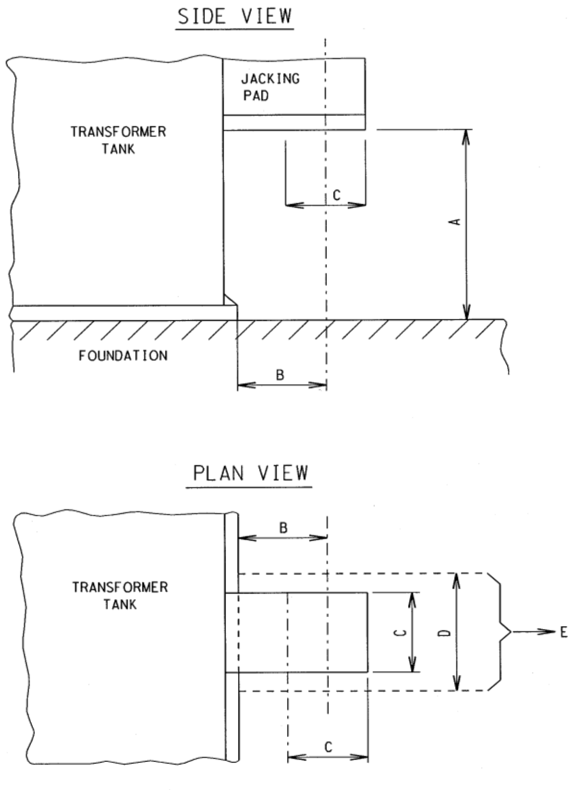


Figure 7: Arrangement of jacking pads

3.10.10 Lifting Lugs

Four symmetrically placed lifting lugs shall be provided so that it will be possible to lift the complete transformer when filled with oil without structural damage to any part of the transformer. The factor of safety at any one point shall not be less than 2.

The lifting lugs shall be so arranged and located as to be accessible for use when the transformer is loaded on the transport vehicle, and so as not to cause fouling of any of the transformer fittings and accessories.

3.10.11 Centre of Gravity

Centre of gravity shall be clearly visible and indicated on all sides of the transformer tank.

3.10.12 Manholes and Handholes

At least one manhole shall be provided on the sidewall, to allow access for internal inspections not higher than 500 mm from the base of the tank. Manholes shall be round with a diameter of not be less than 600 mm.

Hand holes shall be provided to facilitate the removal and installation of bushings. Lesser dimensions are acceptable for class 1 transformers due to their physical size.

3.10.13 Provisions for earthing

Provision shall be made for earthing the transformer and associated apparatus as follows:

3.10.13.1 Transformer tank earthing

At a height not less than 300 mm from the base of the transformer tank and near each end of each of the two major sides of the tank (i.e. in four positions).

These provisions shall take the form of earthing pads integral with the tank walls; where the pads are attached by welding, such welding shall be continuous around the perimeter of the pads. Earthing pads shall be stainless steel and allow installation of 50 x 3 mm flat copper straps.

3.10.13.2 Transformer neutral(s) earthing (direct)

A stainless steel pad having the same clamping arrangement as the transformer earthing pads and integral to the transformer tank shall be provided for each transformer neutral terminal for earthing.

1) This pad shall be mounted as near as possible to its corresponding neutral terminal in order to ensure a short and steady connection to earth. The pads shall be mounted on the side of the tank from the top to ground at 800 mm intervals.

2) The manufacturer shall supply a suitably rated corrosion protected connection between the neutral bushing and the earth, insulated from the tank and metal.

3.10.13.3 Transformer surge arrester earthing (line and neutral surge arresters)

The surge arrester mounting brackets shall be used as the earth path for surge arrester discharging to earth via the transformer tank (i.e. copper earth tails shall not be used for surge arresters).

Where brackets for phase and neutral surge arresters are to be fixed to the tank using tank mounted bolts, stainless steel pads (similar to the transformer tank earthing pads that form an integral part of the tank) shall be used. When these pads are attached by welding such welding shall be continuous around the perimeter of the pads.

Where brackets are not directly mounted onto the tank (on radiators) a separate suitably rated corrosion protected connection shall be provided to the earthing pad on the tank.

Note: Bolted down surface contact areas of transformer surge arrester support brackets and earthing pads shall be free of any paint or metal spray coatings.

- All tank attached apparatus, including cable marshalling boxes, tap-changer operating gear and mechanism boxes, pipes, fan and pump motors shall be bonded to their supporting structures.
- Earthing pads, as specified in 3.10.13, shall also be provided on each end of the supporting structures for all separately mounted cooler banks and oil conservators and on all free-standing cubicles.
- No copper shall be used as connections for the purpose of earthing.

Note: Integral pads to suit the fault levels specified.

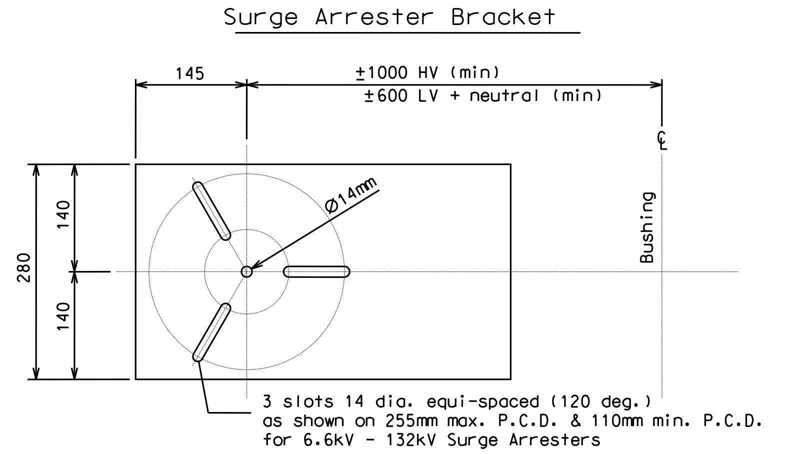
3.10.14 Brackets for Surge Arrestors

For terminals of 132kV and below, the surge arrestor brackets used to mount the Primary, Secondary and Tertiary surge arrestors to the transformer shall comply with the following requirements:

a) The surge arrester mounting brackets shall be provided to suit the dimension shown in **Figure 8: Surge arrester bracket dimensions** The outline and dimension drawings provided in terms of a contract, shall show the surge arresters mounted on the transformer with all necessary clearances and sizes dimensioned.

b) Universal surge arrester mounting details, fully dimensioned, shall be shown in an inset on these general arrangement drawings.

c) Refer to 3.10.13 for the earth continuity requirements of the surge arrester brackets.



Notes :

1. All steel work shall comply with SABS 1200H.
   All steel work shall be hot dip galvanised to SABS ISO 1461.
   no cutting, welding or drilling shall be done after the galvanising process is completed.
   Tolerance - on dimensions +/- 2
   - on hole centres +/- 1
2. Steel plate 10mm thick.

Voltage	No.off	Phase spacing	HV / MV
132 kV	3	*	HV
88 kV	3	*	HV
66 kV	3	*	HV
44 kV	3	*	HV
33 kV	3	700mm C/C	MV
22 kV	3	700mm C/C	MV
11 kV	3	700mm C/C	MV
6.6 kV	3	700mm C/C	MV

*= Centre phase inline outer phases, bushing centres + 450mm min.

Figure 8: Surge arrester bracket dimensions

The surge arrestor bracket arrangement must be finalised during the mechanical design review meeting.

3.10.15 Permanent Ladder

A permanent steel ladder shall be welded to the main tank in a position to provide unrestricted access to the top of the transformer with the unit fully assembled. The ladder shall not interfere with or restrict maintenance activities and routine inspections. It shall not cover or restrict access to inspection / manhole covers and interfere with fitting of monitoring and on-line drying equipment.

A safety harness securing point shall be positioned at the landing space immediately above the steel ladder on the top cover.

3.10.16 Partial Draining

To facilitate oil leak repairs on inspection covers and header pipes, transformers shall be designed to allow partial draining to a level of at least 150 mm below the top lid cover without exposing any cellulose insulation. Refilling of the transformer shall not trap air under inspection covers or top lid. Where necessary, bleeding points shall be provided to vent trapped air.

The tank side wall shall be permanently marked by welded sign or labelling to indicate the minimum oil level allowed for partial draining without exposing any cellulose insulation. The labelling shall be submitted to the purchaser for approval. This mark shall be located on the side wall i.e. same face where the bottom drain valve is located.

3.11 Auxiliary Supplies, Terminal Boxes, Wiring and Cabling

3.11.1 Supply Voltage

The auxiliary power supply will be rated at 400/230 Vac, three phase, 4-wire, 50 Hz. The unearthed DC supply will be 110 V or 220 V nominally as specified in Schedule A. If any device is using supply other than 110V or 220V DC, a converter that will provide such voltage shall be supplied by the *Contractor*, e.g., Seal-in relay for rapid pressure devices.

3.11.2 Marshalling and Terminal Boxes

The Marshalling box shall be mounted on the transformer main tank. It shall be mounted in a position that it can remain fitted to the transformer tank during transport and installation. The Marshalling box shall be mounted on vibration reducing mountings to prevent damage or malfunction of internal accessories. The base of the Marshalling box shall not be lower than 300 mm form the base of the transformer but limited to 400 mm. All parts inside the marshalling box must be accessible from ground level.

Marshalling boxes and terminal boxes shall be vermin-, dust- and weather-proof and shall be provided with easily removable covers fixed by not more than two screws.

Covers for terminal boxes may be of the slip-on type, and those for Marshalling boxes shall be hinged in a vertical plane. Marshalling kiosk access doors shall open to a minimum angle of 120 degrees and shall be provided with a door open retainer. The door retainers must be strong enough to hold the cover in the presence of wind stresses.

Covers in a vertical plane shall, in addition to a gasketed seal, be provided with a double-curved flange along the top edge and sides. The door opening in the box shall have a double-curved flange around its entire perimeter, the outer face of which shall form the gasketed joint. The top of the box shall be made to overhang the cover, except in the case of slip-on covers. These shall be double-curved and fitted with drip ledges for internal corrosion proofing.

Marshalling boxes and terminal boxes, arranged in a vertical plane, shall be provided with a 25 mm vent and drain hole covered by a fine mesh of non-corrodible wire, fitted at the lowest point. This fitting shall be flush inside to permit total drainage.

The glass windows must be made of adequate material such that they do not fade at the specified ambient conditions.

3.11.2.1 Transformer Standard Interface box

A marshalling interface box (MIB) with a standard terminal layout that includes all transformer terminals and tap change drive terminals shall be provided. The MIB shall consist of a single box that houses at least 170 terminals and shall be mounted on the side of the transformer. The supplier shall supply and terminate a cable between the tap-change drive and the MIB to transfer the tap change functions, as specified in the MIB layout, to the MIB. All normal transformer functions as specified in the MIB layout below shall also be cabled to the MIB either directly or through a transformer terminal box. A 25A 380V triple pole circuit breaker shall be supplied and wired from the Cooler Supply as specified in the MIB layout, for the tap-change drive and the supplier shall supply and terminate a cable between the tap-change drive and the MIB to provide a three phase AC supply to the tap-change drive. Earth Leakage Protected 16 Amp double pole 230V AC supply Circuit Breakers for the Permanent Online Dryers and Online Gas Analyser units shall also be supplied inside the MIB.

Spare terminals may be used by the manufacturer to terminate any extra functions that will not normally be used in an Eskom application. *The Contractor* may however not deviate from the prescribed terminal allocation. Terminals indicating functions that are not provided by the manufacturer shall be left open. The manufacturer shall fit partitions between terminals X1.26, X1.27, X1.28, X1.29, X1.30, X1.31, X1.32; X1.34, X1.35, X1.36, X1.37, X1.38; X5.1, X5.2, X5.3, X5.4, X5.5, X5.6, X5.7, X5.8, X5.9, X5.10, X5.11 and X5.12.

Eskom will supply and terminate two 37-core 2,5mm2 and two 10-pair twisted pair telephone cables between the MIB and the transformer protection and tap change control cabinet, in the substation control room and one 4-core 35mm2 cable between the MIB and the transformer distribution board. The supplier of the Permanent Online Dryer will supply and install one 4-core 2,5mm2 cable between the MIB and the Permanent Online Dryer. The supplier of the Online Gas Analyser will supply and install one 3-core 2,5mm2, one 4-core 2,5mm2 and one 2-core 1,5mm2 cable between the MIB and the Online Gas Analyser unit.

Table 10: Standard layout for Marshalling Interface Box fitted to transformers

Device	**Abbreviation**	**Terminal number**	**Wire Marking**	**Application**
Gas and oil relay 1	G.O.R. 1	X1.1 - X1.2 X1.3 - X1.4	X1.1 - X1.2 X1.3 - X1.4	Trip 1 Alarm 1
Pressure relief valve 1	P.R.V 1	X1.5 - X1.6 X1.6 - X1.7	X1.5 - X1.6 X1.6 - X1.7	Normal open contact Normal closed contact
On Load Tap Change Protection	O.L.T.C. Prot	X1.8 - X1.9 X1.9 - X1.10	X1.8 - X1.9 X1.9 - X1.10	Normal open contact Normal closed contact
Oil temperature indicator	O.T.I	X1.11 - X1.12 X1.13 - X1.14	X1.11 - X1.12 X1.13 - X1.14	Trip alarm
HV Winding temperature indicator	H.V.W.T.I	X1.15 - X1.16 X1.17 - X1.18	X1.15 - X1.16 X1.17 - X1.18	Trip alarm
MV Winding temperature indicator	M.V.W.T.I	X1.19 - X1.20 X1.21 - X1.22	X1.19 - X1.20 X1.21 - X1.22	Trip alarm
Tertiary Winding temperature indicator	L.W.T.I	X1.23 - X1.24 X1.25 - X1.26	X1.23 - X1.24 X1.25 - X1.26	Trip alarm
Oil level indicator	**O.L.I**	X1.27 - X1.28	X1.27 - X1.28	Oil level alarm High/Low
Tap-change oil level indicator	**O.L.T.C.O. L.I**	X1.29 - X1.30	X1.29 - X1.30	Oil level alarm High/Low
		X1.31 – X1.32		Spare
Cooler abnormal	CFA	X1.33 - X1.34	X1.33 - X1.34	Common alarm for cooler
Fans/Pumps/ Thermometer AC Supply	ACF(Temp)	X1.35 - X1.38	R, S, T ,N	3 ϕ Control supply (WFF35 stud terminals)
Fans/Pumps/ Thermometer DC Supply	DCF(Temp)	X1.39 - X1.41	X1.39+ X1.40- X1.41	110/220Vdc Cooler stop and thermometer supply
MIB Heater / Earth Leakage Supply	MCB(AC-H)(EL)	X1.42 – X1.43	X1.42 – X1.43	AC supply for MIB heater / Plug Socket
Drykeep Earth Leakage Supply	MCB(AC)-(DKP)	X1.44 – X1.45	X1.44 – X1.45	AC supply for Drykeep
DGA Earth Leakage Supply	MCB(AC)-DGA	X1.46 – X1.47 X1.58	X1.46 – X1.47 90	AC supply for DGA Earth terminal
Thermometer failure	Therm-FA	X1.48 – X1.49	X1.48 – X1.49	Thermometer failure alarm
Analogue output – Oil temperature	mA(OT)	X1 50 – X1.51	X1 50+ – X1.51-	Analogue output 4- 20mA (IDC Terminals)
Analogue output – HV Winding temperature	mA(HVWT)	X1.52 – X1.53	X1.52+ – X1.53-	Analogue output 4- 20mA (IDC Terminals)

Analogue output – MV Winding temperature	mA(MVWT)	X1.54 – X1.55	X1.54+ – X1.55-	Analogue output 4- 20mA (IDC Terminals)
Analogue output – Tertiary Winding temperature	mA(LVWT)	X1.56 – X1.57	X1.56+ – X1.57-	Analogue output 4- 20mA (IDC Terminals)

Device	**Terminal number**	**Wire Marking**	**Application**
HV "A" phase CT	X2.1 – X2.2	1AS1 - 1AS2	Protection
HV "B" phase CT	X2.3 – X2.4	1BS1 - 1BS2	Protection
HV "C" phase CT	X2.5 – X2.6	1CS1 - 1CS2	Protection
MV "a" phase CT	X2.7 – X2.8	1aS1 - 1aS2	Protection
MV "b" phase CT	X2.9 – X2.10	1bS1 - 1bS2	Protection
MV "c" phase CT	X2.11 – X2.12	1cS1 - 1cS2	Protection
HV neutral CTs	X2.13 – X2.14 X2.15 – X2.16	1YNS1 - 1YNS2 2YNS1 - 2YNS2	Protection Protection
MV neutral CTs	X2.17 – X2.18 X2.19 – X2.20	1ynS1 - 1ynS2 2ynS1 - 2ynS2	Protection Protection
Tertiary "a" Phase CT	X2.21 – X2.22	1-3AS1 - 1-3AS2	Protection
Tertiary "b" Phase CT	X2.23 – X2.24	1-3BS1 - 1-3BS2	Protection
Tertiary "c" Phase CT	X2.25 – X2.26	1-3CS1 - 1-3CS2	Protection
HV "A" phase CT	X2.27 – X2.28	2AS1 - 2AS2	Protection
HV "B" phase CT	X2.29 – X2.30	2BS1 - 2BS2	Protection
HV "C" phase CT	~~X2~~.31 – X2.32	2CS1 - 2CS2	Protection
MV "a" phase CT	X2.33 – X2.34	2aS1 - 2aS2	Protection
MV "b" phase CT	X2.35 – X2.36	2bS1 - 2bS2	Protection
MV "c" phase CT	X2.37 – X2.38	2cS1 - 2cS2	Protection
Tap Changer Motor	X3.1 – X3.4	R,W,B,N	3 ϕ Motor supply/ HEATER AND LIGHT
Tap Change AC Supply	X3.5 – X3.6	L, N	Tap Change Control and AC Supply
Voltage Monitoring Relay DC Supply	X4.1 – X4.2	+, -	Voltage Monitoring Relay DC Supply
Tap Position Device	X4.3 – X4.4	X4.3 – X4.4	Parallel check for even taps
Tap Position Device	X4.5 – X4.6	X4.5 – X4.6	Parallel check for odd taps
LOCAL RAISE OR LOWER SWITCH	X4.7 – X4.9	X4.7 – X4.9	Local control Switch (7 Com, 8 Raise, 9 Lower)
RAISE (SI)	X4.10 – X4.11	X4.10 – X4.11	Seal In for raise operations (When required)
LOWER(SI)	X4.12 – X4.13	X4.12 – X4.13	Seal in for lower operations (When required)
RAISE OPERATION	X4.14	X4.14	Initiate raise operation
LOWER OPERATION	X4.15	X4.15	Initiate lower operation

Overcurrent Block Supply	X4.16 – X4.17	X4.16 – X4.17	Energize O/C block contactor (Negative may be commoned)
MOTOR SUPPLY MCB	X4.18 – X4.2	X4.18 – X4.2	Trip motor supply MCB (Negative may be commoned)
MOTOr TRIP/HEATER AC FAIL/TAP CHANGE MONITORING SUPPLY	X4.20 – X4.21	X4.20 – X4.21	Motor supply MCB has tripped/HEATER SUPPLY FAIL/TAP CHANGE MONITORING SUPPLY FAIL
Tap Change In Progress	X4.22 – X4.23 - X4.24	X4.22 – X4.23 – X4.24	Indication for tap-change in progress (raise, lower)
Motor Running Timer	X4.25	X4.25	Motor running timer
Encoder Supply	X4.26 - X4.27	X4.26 - X4.27	Encoder Supply
BCD OUTPUTS - LOCAL	X5.1 – X5.6	X500, X501, X502 X504, X508, X510	Binary coded decimal output to tap position LOCAL indicator
BCD OUTPUTS - REMOTE	X5.7 – X5.12	X600, X601, X602 X604, X608, X610	Binary coded decimal output remote indication

Additional Functions

Device	**Abbreviation**	**Terminal number**	**Wire Marking**	**Application**
Gas and oil relay 2	G.O.R. 2	X11.1 – X11.2 X11.3 – X11.4	X11.1 – X11.2 X11.3 – X11.4	Trip 2 Alarm 2
Rapid pressure rise relay 1	R.P.R. 1	X11.5 – X11.6	X11.5 – X11.6	Trip 1
Rapid pressure rise relay 2	R.P.R. 2	X11.7 – X11.8	X11.7 – X11.8	Trip 2
Conservator bag leak detector	C.B.L.D	X11.9 – X11.10	X11.9 – X11.10	Alarm
Sudden flow valve	S.F.V.	X11.11– X11.12	X11.11-X11.12	Alarm 1
Pressure relief valve 2	P.R.V 2	X11.13- X11.14	X11.13-X11.14	Normal open contact
Pressure relief valve 2	P.R.V 2	X11.15– X11.16	X11.15– X11.16	Normal closed contact
Digital Gas Analyser	DGAUA	X11.17– X11.18	X11.17– X11.18	Unhealthy Alarm
Digital Gas Analyser	DGAGC	X11.17-X11.19	X11.17-X11.19	Gas Caution Alarm
Digital Gas Analyser	DGAGA	X11.17-X11.20	X11.17-X11.20	Gas Alarm
Digital Gas Analyser	DGAACF	X11.21-X11.22	X11.21-X11.22	AC Fail Alarm (N/C contact)
Auxiliary Transformer Gas and oil Relay	AT G.O.R.	X11.23- X11.24 X11.25-X11.26	X11.23- X11.24 X11.25-X11.26	Trip Alarm
Auxiliary Transformer Oil Temp Indicator	AT O.T.I.	X11.27- X11.28 X11.29-X11.30	X11.27- X11.28 X11.29-X11.30	Trip Alarm

3.11.3 Earthing terminal

An earthing terminal of M12 to M16 shall be provided in each terminal and marshalling box with a stud on both the inside and outside.

3.11.4 Spare terminals

Each marshalling box shall be provided with not less than 10% spare terminals with a minimum number of twelve, unless otherwise agreed.

3.11.5 Incoming auxiliary circuits

To prevent entry of water, the auxiliary wiring from the gas- and oil-actuated relay, current transformers and other auxiliary apparatus, shall be arranged for side or bottom entry into the marshalling or terminal box. If bottom entry is adopted, the gland plate used shall be independent of that provided for the *Purchaser*'s outgoing cables. If cables enter the terminal boxes or marshalling kiosk from the side, drip-loops shall be provided to prevent water from entering the cable gland.

3.11.6 Provision for outgoing cables

The marshalling box shall be provided with a separate, removable, undrilled plate to take the *Purchaser*'s cable glands, mounted at least 100 mm below the bottom of the terminal blocks, or other equipment, in such a manner as to facilitate the entry or the *Purchaser*'s cables. The gland plate shall be of 6 mm thick brass sheet. Steel plates are not accepted

The gauze covered drain and vent hole may be fitted to this gland plate. The gauze covered drain hole must be in the lowest part of the kiosk and must not be on the gland plate.

3.11.7 Cabling and Wiring

Only UV stable, heat and oil resistant PVC SWA (steel wire armouring) cable shall be used on transformers. Only corrosion resistant cabel glands for armoured cables shall be used. Plastic compression type cable glands shall not be used on armoured cables. Heat, oil and UV restant cable shrouds shall be fitted to all cable glands.

All cable terminations shall be provided with cable numbers fitted to the cables on both ends. Only permanently engraved, non-corrodible, UV, oil and heat resistant material shall be used for cable numbering. These labels shall be permanently fixed to the cable ends just before the glands on the outside of the terminal box.

The cable armouring shall be earthed at least one side. Earthing shall be by means of the steel cable gland.

3.11.8 Insulation

Wiring insulation shall be oil- and moisture proof, and, where affected by temperatures above that of the ambient air, shall have thermal characteristics at least equal to class 'A' of IEC 85.

3.11.9 Insulation test voltage

All auxiliary circuits shall withstand a test voltage of 2 kV DC for 60 seconds to earth and to all other circuits.

3.11.10 Type of conductor

All secondary wiring used on the transformer for current transformer secondary and other auxiliary equipment shall have a minimum cross-section of 2, 5 mm^2 , and shall be limited to 30 strands per cable, flexible, 660/1000 V grade wire in accordance with SABS 1507 or to the *Purchaser*'s approval.

As far as possible, only cables with the correct number of strands shall be used. Where this is not possible the free stands shall not be cut, but effectively earthed on one side of the cable.

3.11.11 Supporting and securing of cables

All cables shall present a neat appearance and shall be supported on cable rails elevated 20 – 30 mm from the tank surface. The rails shall be welded to the transformer tank surface. Similar rails shall be provided to route and secure cables to auxiliary components, i.e. oil level indicators, Buchholz relays, cooling fans, etc.

Cables shall be secured to cable rails by means of stainless steel strapping with a minimum width of 6 mm and not exceeding 10 mm.

Routing of cables shall be done to eliminate the cable from touching sharp edges on the transformer tank structure.

No cables in steel conduit will be accepted.

3.11.12 Identification of wiring

All equipment boundary/interface terminals and the equipment wires connected to those terminals shall have a unique wire/terminal number in accordance with the manufacturer's drawings approved by the *Purchaser*'s. The wires shall be marked with black letters impressed on a white background or black letters on a yellow background providing that the colour selected is consistent throughout the panel and/or suite of panels and is to the *Purchaser*'s approval.

For heavy conductors and very light wiring (telephone type) where the preferred type of marking ferrules is not available, other methods may be approved.

Ferrules shall be arranged to read upright on cable terminal strips and to read from terminal to insulation in the case of relay apparatus and instrument connections.

3.11.13 Cabling by the Purchaser

Multi-core cabling to the remote control point will be provided by the *Purchaser*. Where a separately mounted outdoor control cubicle is provided near the transformer and where the *Contractor* is responsible for erection, he shall provide and connect all cabling between this control cubicle, the transformer marshalling box and the auxiliary apparatus on the transformer together with all necessary cable fittings, attachments and identification of cables and cable cores.

3.11.14 Identification of fuses and circuit breaker

All fuses and circuit breakers shall be labelled indicating the rating and circuit.

3.11.15 Identification of equipment

All equipment identification labels in marshalling kiosks and control cubicles shall be fixed on permanent surfaces next to the equipment (above, underneath or next to) and not on removable covers or on the equipment itself.

3.12 Rating and Diagram Plates

3.12.1 General

Rating and diagram plates shall comply with the requirements of IEC 60076 except where otherwise stated in this specification.

3.12.2 Materials and methods of marking

Rating and diagram plates shall be of stainless steel not less than 1,2 mm in thickness.

The required information shall be engraved on the plate and the engraving filled with glossy black, baked enamel.

Other arrangements shall be specifically approved.

3.12.3 Mounting

The rating and diagram plates shall be mounted on the door of the marshalling interface box for all tank mounted boxes. If otherwise, the plates must be mounted on the tank. The plates must be finished in accordance with 240-56030674 situated in an accessible position not more than 1,5 m above ground level, and secured by stainless steel screws.

3.12.4 Information to be displayed

The minimum information to be displayed on the rating and diagram plate shall be in accordance with the requirements of IEC 60076 with addition of the following as detailed in **Figure 9**.

a) the tapping current values shall be shown for HV, MV and tertiary terminals for all tapping positions;

b) the capability of the transformer (including bushings and tap-changers) to carry overloads in accordance with the emergency duties detailed in IEC 60076-7 shall be shown;

c) the system fault levels in kA for which the transformer is designed

d) the zero sequence impedances in the case of three-winding auto transformers;

e) the current transformer data shall be shown;

f) a statement that the manufacturer deems it necessary for the transformer to be oil-filled under vacuum;

g) a statement that the transformer will withstand full vacuum at sea level;

h) the *Purchaser*'s reference number shall appear on the rating and diagram plate;

i) values for all relevant parameters used by the digital temperature gauge for the winding hot-spot and transformer lifetime calculations as per IEC 60354 or IEC 60076-7

j) The temperature probe hole diameter/s and depths.

k) a blank space for the *Purchaser*'s asset number shall be provided;

l) the type, make and designation numbers of all bushings, to enable full identification (relating to stock spares) while the transformer is energised;

m) the valve and oil sampling point functions and positions;

n) a warning statement that the conservator contains a bag or other sealing systems if it is the case; and

o) the type of corrosion protection: Corrosive or low corrosive.

p) Initial DP value

q) Tie-in resistor schematic and value (if used).

r) Vector Group

s) Surge Arrestors on regulating winding

t) Tertiary Reactor

Whilst a single plate is preferred, separate plates mounted adjacent to the main plate are acceptable for the information required by items (f), (g), (h), (m), (n), and (o).

MANUFACTURER

POWER TRANSFORMER

3 PHASE 50 HERTZ SPECIFICATION DISSCAAD3 REV 7

TRANSFORMER SERIAL No.	30432	ONAN RATING (MVA)	24	CORE & WINDING MASS (kg)	26 300	SYSTEM FAULT LEVELS (kA PER PHASE)	HV	40
ESKOM ASSET No.	-	ONAF RATING (MVA)	40	OIL MASS (kg)	15 560		LV	25
ESKOM ORDER No.	4500239975	MAXIMUM ALTITUDE (m)	1800	TOTAL MASS (kg)	57 220	DESPATCHED MONTH/YEAR	/	

PERCENT IMPEDANCE VALUES AT 75° C AND AT STATED CURRENTS SHOWN BELOW			INSULATION LEVELS (IMPULSE/POWER FREQUANCY)	
NORMAL POSITION TAP 5	%	175 AMPS	HV LINE (kV)	550/230
MAXIMUM VOLTAGE TAP 1	%	175 AMPS	HV NEUTRAL (kV)	250/95
MINIMUM VOLTAGE TAP 17	%	175 AMPS	LV LINE (kV)	95/28
			LV NEUTRAL (kV)	

TYPE OF CORROSION PROTECTION	LOW/TO SCSSCAAP9
TRANSFORMER MUST BE OIL FILLED UNDER FULL VACUUM	
SUITABLE FOR FULL VACUUM AT SEA LEVEL	
CONSERVATOR FITTED WITH PRESERVATION BAG	YES
SUITABLE FOR ARC FURNACE DUTY	NO
INITIAL DEPOLYMERISATION VALUE OF INSULATION	
TRANSFORMER NOISE LEVEL (IEC 60076-10) db	

THIS TRANSFORMER IS SUITABLE FOR OVERLOADS IN ACCORDANCE WITH IEC 60354

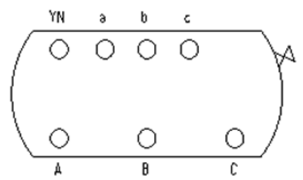
DETAILS OF CURRENT TRANSFORMERS TO SABS IEC 60044-1 AND DSP0013

APPLICATION	EF	REF	REF	REF	REF	O/C	O/C	O/C	WTI					
NUMBER	1YN	2YN	1A	1B	1C	1a	1b	1c	1W					
SERIAL No.														
RATIO OR IP	200	300	300	300	300	2400	2400	2400	1470/1,5					
TURNS RATIO	200/1	300/1	300/1	300/1	300/1	2400/1	2400/1	2400/1						
ACROSS	S1-S2	S1-S2	S1-S2	S1-S2	S1-S2	S1-S2	S1-S2	S1-S2	S1-S2					
VA OR Vk/Im	200/0,50	300/0,33	300/0,33	300/0,33	300/0,33	750/0,042	750/0,042	750/0,042	10					
CLASS & ALF	TPS	TPS	TPS	TPS	TPS	TPS	TPS	TPS	10P					
kA / sec														
AT/ MINUTES														
Rs AT 75°C	<0,8	<1,2	<1,2	<1,2	<1,2	<4,8	<4,8	<4,8						

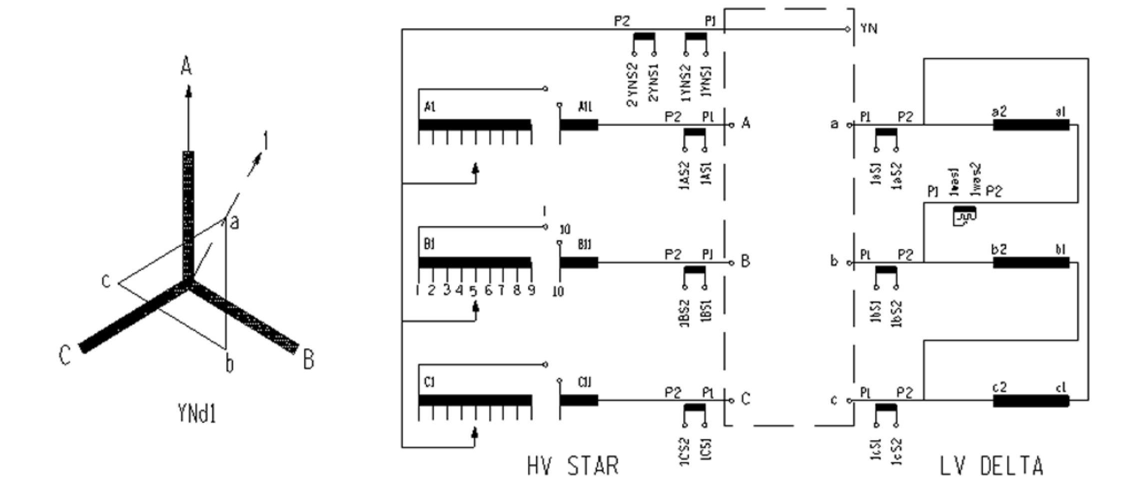
VOLTS	AMPS	ON LOAD TAPCHANGER CONNECTS	ON LOAD TAPCHANGER POSITION	ACROSS	VOLTS	AMPS	ACROSS
138 600	166,6	10-9 1-N	1			2099,16	
136 950	168,6	10-9 2-N	2			2099,07	
135 300	170,7	10-9 3-N	3			2099,61	
133 650	172,8	10-9 4-N	4			2099,52	
132 000	175,0	10-9 5-N	5	A - B - C	11 000	2100	a - b - c
130 350	177,2	10-9 6-N	6			2099,82	
128 700	179,4	10-9 7-N	7			2099,98	
127 050	181,8	10-9 8-N	8			2099,79	
125 400	184,2	10-9 9-N	9A			2099,88	
125 400	184,2	10-9 9-N	9B			2099,88	
125 400	184,2	10-9 10-N	9			2099,88	
125 400	184,2	11-1 10-N	9C			2099,88	
125 400	184,2	11-1 1-N	9D			2099,88	
125 400	184,2	11-1 1-N	9E			2099,88	
123 750	184,2	11-1 2-N	10			2099,88	
122 100	184,2	11-1 3-N	11			2099,88	
120 450	184,2	11-1 4-N	12			2099,88	
118 800	184,2	11-1 5-N	13			2099,88	
117 150	184,2	11-1 6-N	14			2099,88	
115 500	184,2	11-1 7-N	15			2099,88	
113 850	184,2	11-1 8-N	16			2099,88	
112 200	184,2	11-1 9-N	17			2099,88	

BUSHING DETAILS (TYPE & RATING)

POSITION	MAKE & TYPE	INS.LEVEL	AMPS
HV LINE	ABB, GOB 750 / 1250	750	1 250
HV NEUTRAL	ABB, GOB 380 / 800	380	800
LV LINE	ABB, CED 36 / 2500	200	2 500
LV NEUTRAL			



RELATIVE POSITIONS OF TERMINALS AND MAIN DRAIN VALVE



HV WINDING INSULATION PARTIALLY GRADED. HV NEUTRAL SHALL BE SOLIDLY EARTHED OR PROTECTED BY A 48 kV CONTINUOUSLY RATED METAL OXIDE SURGE ARRESTER WITH A 163 kV PEAK RESIDUAL VOLTAGE (10 kA)

Figure 9: Typical Rating and Diagram plate

3.13 Painting of Tanks and Parts

The painting of the transformer tank, the conservator tanks, the piping, the covers, the turrets and all other items that need to painted or galvanized shall done according to the requirement of the Eskom painting specification 240-56030674. The following items shall also be painted:

- the flange facing surfaces.
- the blanking plates that are used during transportation.

3.14 Special Auxiliaries

All auxiliary components used in the Eskom transformers shall comply with the relevant specification and must be approved by Eskom. An auxiliary component will be declared approved when it has been technically evaluated by relevant specialist and the approval is in writing. Auxiliary components shall comply with 240-62773019 as applicable.

3.14.1 Buchholz Relay

An oil and gas actuated relay suitable for operation in transformer oil as specified over the temperature range from - 10°C to + 115°C shall be interposed in the connecting pipe between the oil conservator and the transformer tank. The relay shall be fitted in such a manner that all the gasses from the tank pass through and are trapped by the relay as the gasses move towards the oil conservator. The mounting angle shall be as per the relay OEM instruction so as not to compromise the reliability of the relay.

For the purpose of redundant protection, transformers and reactors having a voltage rating of 220 kV and above or a rating of 100 MVA(r) and above shall be provided with two Buchholz relays. The relays shall be installed in series in the connecting pipe between the oil conservator and the transformer tank, mounted at least five pipe diameters apart - measured from facing flanges.

The oil and gas actuated relay shall comply with the requirements of 240-56063908. A valve must be fitted between the Buchholz relay and the conservator.

3.14.2 Pressure relief devices

Transformers rated below 100 MVA shall be equipped with one spring operated pressure relief device and those of 100MVA and above shall have two devices.

Pressure Relief Devices (PRD) shall comply with the requirements of 240-56063871 and shall be mounted so as not to entrap gases that may be generated or released inside the transformer. These devices shall be fitted directly to the side walls of the transformer tank at a level as near as possible to the top of the windings. Where one device is fitted it shall be positioned as close as possible to the centre phase. Where there are two devices they shall be arranged on opposite sides of the transformer, i.e. between 'A' and 'B' phases on one side and between 'b' and 'c' phases on the other. Alternative mounting positions, such as on the tank cover, may be considered if adequate mechanical protection can be provided to avoid inadvertent damage by erecting personnel. All mounting positions shall be such that the PRD(s) is(are) positioned above the partial drain mark. This shall be subject to approval by the *Purchaser* and be discussed during a mechanical design review meeting.

A combined weather guard and oil deflector shall be fitted to ensure free deflection of the oil towards the ground and provide adequate protection from the environmental elements. These must however not reduce the oil evacuation capability of the device.

Despite any testing requirements in this specification the overpressure device shall not be influenced to generate invalid trip signals by tank vibrations and the magnetic fields generated during normal operation and through faults.

3.14.3 Rapid Pressure Rise Relay

Each new transformer and reactor rated ≥ 80 MVA and ≥ 132 kV shall be provided with at least one rapid pressure rise relay. In the case of large units ≥ 500 MVA and ≥ 400 kV, two units, one on each of the longitudinal end shall be fitted. The function of the rapid pressure rise relay is to detect dynamic over-pressure conditions caused by abnormal activity inside the main tank and to provide a trip signal to remove the equipment from service. A suitable double flanged gate valve shall be fitted between the relay and the transformer tank to allow for maintenance without the need to drain the transformer oil. The position of the relay shall be such that maintenance and/or replacement of the components (valve and relay) can be done with partial drain. The position shall be discussed during a mechanical design review and submitted for approval. The relay shall be provided with seal in and reset feature and test facilities.

This component shall comply with the requirements of 240-56063867.

3.14.4 Thermometers for Oil and for Winding Temperatures

Oil temperature indicators (OTI's) and winding temperature indicators (WTI's) are fitted to transformers to measure the oil and winding temperatures. The indicators do not only display the temperature but are also used to start / stop forced cooling, provide high temperature alarm and trip signalling. The winding temperature gauges shall be provided for all the windings i.e HV, MV, and LV, where applicable.

These shall comply with the requirements of 240-56063843.

Class 1 Transformers shall be fitted with a Digital Temperature instrument in accordance with 240-75763120 for ambient, and oil and winding temperature measurements, fan control and alarm/tripping. The digital instrument shall be augmented by a conventional device as per 240-56063843 for oil temperature measurement and alarm and tripping.

The choice of the instrument technology shall be concluded during a design review meeting.

3.14.5 Fibre optic temperature probes

For all transformers when specified in the Schedules AB, for identification of hot spot temperatures, fibre optic temperature probes must be positioned based on mutual agreement between the *Contractor* and Eskom during the design review sessions. The sensors will be installed permanently for future use, with the connection points easily accessible 1.5m from ground level. A redundant sensor will be installed near the primary sensor.

For all the units fitted with fibre optic sensors, the units should have a through wall plate fitted at the top of the transformer tank (above the partial drain level) and extensions pre-fitted (factory supplied) terminating in to the marshalling kiosk. The position of the through wall plate and the internal extensions pathway within the tank must not follow a path whereby personnel entering the interior of the transformer would easily be able to damage them; furthermore the cover used for the plate must be a dedicated one and not an inspection cover.

3.14.6 Oil Level Indicators

Each conservator tank (main tank and OLTC) shall be provided with a dial-type oil level indicator that will show the correct oil level inside the tank. Direct reading fluid type oil level indicators shall not be used.

The indicators shall be suitable for the design of the conservator, i.e. free-breathing or bag type conservators.

Expected design life of the oil level indicator shall match the design life of a transformer, at least 40 years.

The oil level indicator shall comply with all the requirements of 240-56356191

3.14.7 Fans, Pumps and Radiators

Transformers and reactors are fitted with radiators to reduce operating temperatures. Where forced air cooling is required, fans are installed beneath the radiators and air is forced in a vertical direction to increase cooling of the oil. The fan motors shall be of the standard induction motor. The GSUs will be fitted with coolers. Pumps may be fitted in the event of forced oil cooling.

All radiators shall be mounted onto the main tank of the transformer. Each radiator shall be provided with top and bottom shut-off valves and shall be detachable from the main tank. The radiators shall be hot dipped galvanised only. The galvanising shall comply with SANS 1461. Radiators shall not be positioned over manholes, hand holes or inspection covers.

Radiators shall be equipped with stainless steel type DIN 42 558 bleeding and drain plugs. Seals shall be UV, heat and oil resistant. The bleed points shall have a double seal system.

Radiators shall have the necessary lifting eye connections. For shipping and storage, all flanged openings shall be permanently sealed by means of a blank, bolted and gasketed cover.

The fans and the radiators shall comply to the requirements of 240-56535946 and the requirements indicated in Schedules AB.

The transformer shall be supplied with cooler control equipment including:

a) an isolating switch rated to carry and break full-load current for each group of fan and pump motors;

b) a "manual"/"auto" change-over switch;

c) a contactor for each group of fan and pump motors. A set of normally open contacts shall be provided to initiate an alarm circuit if the contactor is tripped by its overload element. All such contacts of the various groups shall be paralleled and wired to a pair of terminals in the control cabinet.

d) contactors shall maintain supply to motors at supply voltage down to 0,85 pu of the rated supply voltage at their terminals. Tripping shall only occur on a controlled basis and there shall be automatic restarting in the staggered mode if the voltage recovers while the transformer is in service; and

e) provision for disconnection of all cooling pumps and fans on the closure of a contact provided by the purchaser. The “fan/pump stop” facility shall be provided via a latching relay, with the operate coil set by the application of 110V or 220Vdc (user selectable) via the purchaser’s Master trip relay. A reset push button shall be prvided in the Marshalling Interface Box for resetting the latching relay. The operating coil of the latching relay shall be continuously rated as it will be activated by a latched input function.

3.14.8 Air Bag

As indicated in Schedules AB certain units shall be fitted with an air bag in the conservator. The details of the airbag, including the dimensions shall be included in the manual and the drawings documentation. This should be such that it makes it easier for Eskom to order a replacement bag, should it become necessary, in the future.

3.14.9 Air Bag Leak Detector

Each transformer and reactor fitted with an air bag shall be provided with a bag leak detector. The function of the bag leak detector is to detect a leaking air bag. The abnormality will be detected by this detector and an alarm will be signalled to the control panel of the respective transformer or reactor. A contact will provide an alarm signal that the bag leak detector has operated to alert maintenance staff.

The air bag leak detector shall comply with the requirements of 240-56356202, and its intake shall be positioned about 100 mm from the top of the conservator tank, without compromising its reliability. The proposal for the installation shall be submitted at tender stage and shall form part of the mechanical design review. A bleed pipe and valve must be brought to ground level and fitted with a locking device to prevent unauthorised opening of the valve. A tag complying with the requirements of 240-56062720 shall be provided written **: “BAG LEAK DETECTOR AIR RELEASE”.**

A second valve to get the trapped air from the conservator must be provided. The associated text should read “**CONSERVATOR TANK AIR RELEASE”.** Both valves should have mechanical tamper proof covers.

3.14.10 Dehydrating Breathers

The dehydrating breathers used in the transformers shall comply with the requirements of 240-56062529. Self dehydrating breathers are acceptable and can be discussed during a mechanical design review.

3.15 Insulating Oil

The *Contractor* shall approve the oil to be used, and such oil must comply with the requirements of the latest revision of the Eskom Oil specification 240 - 75661431 and must be from the list of the approved oils. The list is available from Commercial. In support of the Eskom drive for environmentally friendly products, the so called green oils shall be considered for acceptance and they must comply to IEC 62770.

The *Contractor* shall also ensure that the oil used during manufacturing and testing at the factory is mixable with the intended oil for use in service. The mixing of the two oils should not expose Eskom to any risk and this must be approved during design review.

3.16 Cooling

3.16.1 General

Temperature limits as specified in IEC 60076. Unless otherwise specified differently in Schedule A of the purchasing specification, the weighted annual average ambient temperature of 30°C has to be taken into account.

With reference to 30 °C ambient temperature the temperature rise specified in IEC has to be reduced by 10°C.

3.16.2 Cooling Systems

Depending on the MVA rating and as specified in Schedule A of the specification, the following cooling systems can be applied: ONAN, ONAN/ONAF, ONAN/ONAF/ODAF, ONAN/ODAN, and ONAN/ODAF.

In cooling systems where forced oil cooling (OF) is in combination with natural oil cooling (ON), the core cooling has to be incorporated in the forced oil flow system.

When directed oil (OD) cooling is incorporated in the cooling system, low oil speed pumps (i.e. propeller pumps with low hydraulic resistance) have to be applied to ensure the directed oil flow.

Oil flow indicators shall be located so they are visible and can be easily read from the ground level.

Where only ONAF cooling is used, it must be capable of 100% of the capacity requirements.

Where ONAN as a cooling combination is used, natural cooling must be capable of at least 70% of the cooling capacity requirements.

For Generator-step-up transformers the cooling combination is either OFAF or ODAF as specified in Schedule AB. For special applications OFWN or OFWF type cooling may be specified. In order to eliminate the possibility of ingress of water into the oil, the maximum total pressure head of water at any point within the primary oil/water heat exchanger is kept below the static head of the oil at that point. In the case of OFWN (or ODWN) cooling, this can be achieved by providing pressure break tanks open to the atmosphere and fitted with balance type float valves for water level control. In the case of OFWF (or ODWF) cooling, the two stage cooling is provided in the form of double tube primary oil/water heat exchangers whose cooling water is circulated through low/high pressure heat exchangers (intercoolers).

Note: The water side of the water to water and / or water to oil cooling are provided with sacrificial anodes in the water boxes

3.17 Current Transformers

All current transformers shall comply in all respects with the requirements specified in Schedule AB and/or the following

3.17.1 Number and Location

The specification defines requirements for built-in CT's to be used by the purchaser.The Contractor shall specify, design and install any additional CT's required to meet other requirements(e.g.WT).The positioning of the CTs in the transformer turret must not compromise the safe operation of the transformer. The Contractor shall demonstrate by field calculations that the CTs and the associated wiring are positioned / traversing in a very low field or no field area.

The number, ratings and location of current transformers associated with each power transformer, shall be as specified in Table 11: Built-in CTs for 12B for Auto transformers and 20 MVA configuration, Table 12: Built-in current transformers for star-delta units above up to 20MVA (12D), Table 13 Built in Current Transformers for star-star transformers (12F), and Table 14: Built-in current transformers for star - Delta units above 20MVA(Class TPS "PX"core details).

All Current Transformers specified by the purchaser shall be (Class “PX”, as per latest IEC 61869-2 specification. Tests certificates shall be provided.

3.17.2 Transformer Short-circuits and Overload

Current transformers shall be capable of withstanding mechanically and thermally the same loading and overload, as specified in this document for the power transformer.

3.17.3 Insulation levels and short circuiting for testing.

Current transformers shall withstand all dielectric tests applied to the power transformer windings, and shall be in position and in circuit during the power transformer voltage withstand and impulse tests. Open circuits shall be avoided during testing of the transformer. All current transformers shall be short circuited in the factory and so delivered to site.

3.17.4 Terminal Connections

Current transformer secondary terminals, where applicable, shall comply with the requirements described below, and they shall be indelibly marked for identification. All current transformer terminals inside the power transformer shall be of the stud type and all connections shall be securely locked by means of lock nuts or locking plates. Steel lock washers are not acceptable.

3.17.5 Termination of Leads - Internal

Particular attention shall be paid to the termination of leads inside the transformer tank with a view to ensuring secure connection of current carrying lugs, and the elimination of all possible tension in the leads plus any possible risk due to the presence of the electric field as stated in 13.14.1 of this document.

3.17.6 Required Data

The following information relating to protective current transformers shall be submitted for approval:

- magnetization curve;
- secondary winding resistance (temperature compensated to 75°C); and
- secondary winding leakage reactance.
- insulation resistance

3.17.7 CT Designation

Where more than one protective current transformer is provided in any one phase, the current transformer designated "main protective current transformer" shall be located furthest from the transformer windings. In addition, protective current transformers together with current transformers in general, shall be given designations as indicated in figures 9 and 10 below

3.17.8 CT for Winding Temperature Indication for Delta Windings

Where the current transformer for a winding temperature indicator is associated with a delta-connected winding, it shall be located inside the delta so that it can detect all over current conditions of the delta winding, including those circulating current conditions resulting from external earth faults on the associated power systems.

3.17.9 Type and Accessibility

Current transformers shall preferably be of the bushing type. Separately mounted CT's shall be located above the transformer core and winding assembly and be provided with adjacent hand holes in the tank side or cover of a size adequate for their removal and replacement, which must be capable of taking place without the lowering of the oil and exposure of the paper insulation. The terminal box shall be positioned in the area outside the zone of high electric field of the associated bushing. This shall be demonstrated during a design review meeting and be verified during production.

3.17.10 Data for Rating and Diagram Plates

Where current transformers are built into the transformer, the combined rating and diagram plate shall provide full details of each current transformer's location, polarity, secondary terminal markings and also all the information required by IEC 61869-2 as applicable, with the provision that no information be duplicated.

The following symbols may be used on rating and diagram plates:

- IL = Secondary insulation Level (2 kV DC)
- Hz = Rated frequency
- Ith = Rated short-time current and rated time kA-s;
- Rs = Secondary winding resistance at 75 ºC;
- N = Turns ratio
- Vk = Kneepoint voltage
- Im = Magnetising current
- Ip = Primary current
- Is = Secondary current
- VA = Output in (VA).

3.17.11 Terminal Markings

The system of marking for identifying the terminals for current transformers supplied with power transformers, shown in figures 9 and 10, indicates: the polarity of the primary and the secondary terminals, or, where no primary terminals exist as such, the orientation of the current transformer; and the current transformer designation, viz. the connection in which it appears (e.g. a phase or neutral connection); the sequence relative to other current transformers appearing in the same connection. The current transformer winding (primary and/or secondary) and its polarity shall be denoted by the letter P and/or S and the Annexure 1 & 2 as specified in IEC 61869-2. The convention to be used always places P1 (and/or S1) nearer the external terminal of the transformer and P2 (and/or S2) nearer the winding.

The winding alpha-numerics and the polarity alpha-numerics shall be prefixed by letters denoting the phase or neutral connection in which the current transformers appear and these alpha-numerics shall be prefixed by numerals giving the sequence of the current transformers relative to other current transformers in the particular phase or neutral connection, as indicated below. These numbers shall be counted in the case of star-connected windings, from the power transformer external terminal towards the neutral point connection, and in the case of delta-connected windings in a direction from the external terminal through the particular phase winding towards the junction with another phase.

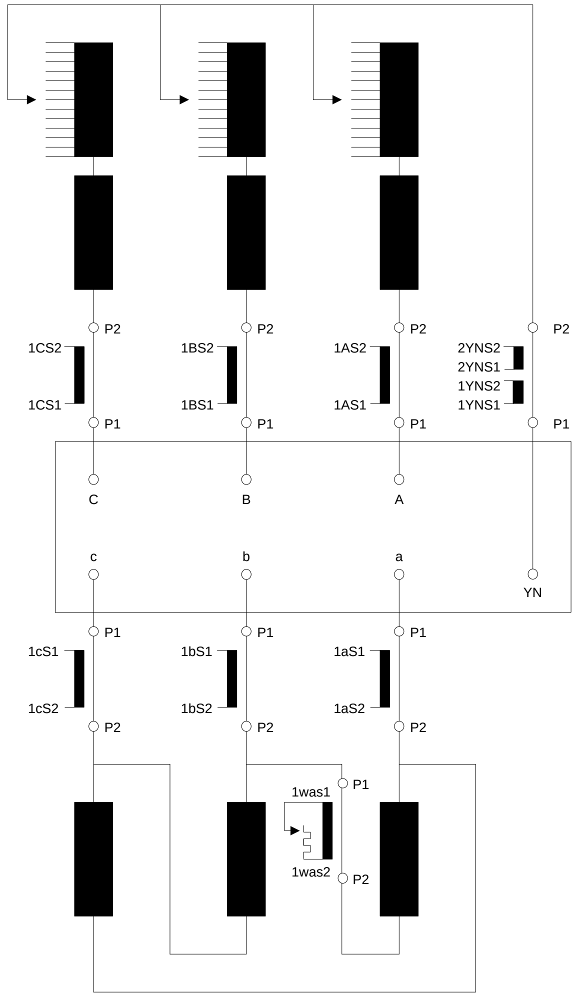


Figure 10 : Terminal Markings for 'Class 1' 2-winding transformers

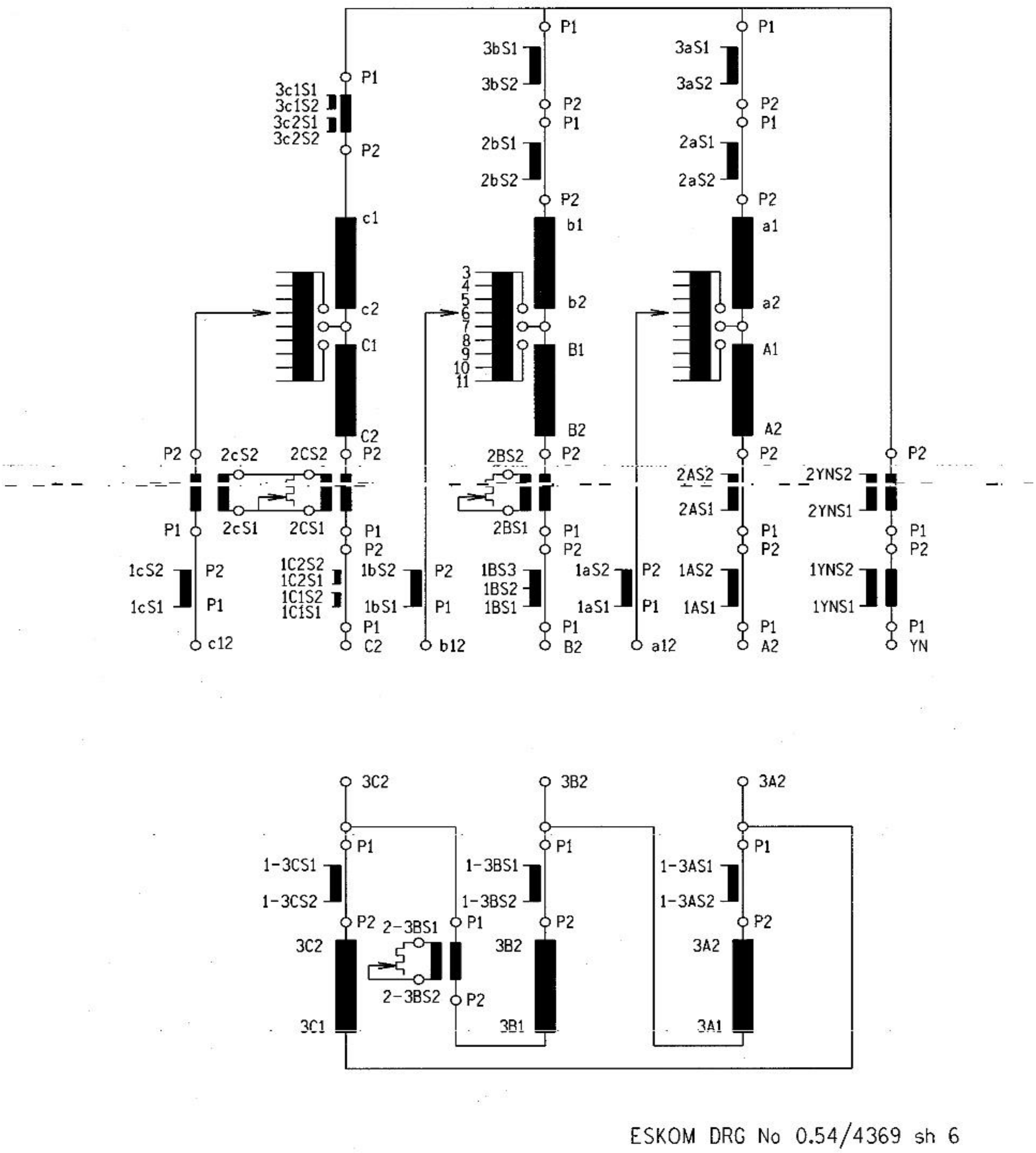


Figure 11: CT Terminal Markings for 3 winding auto transformers

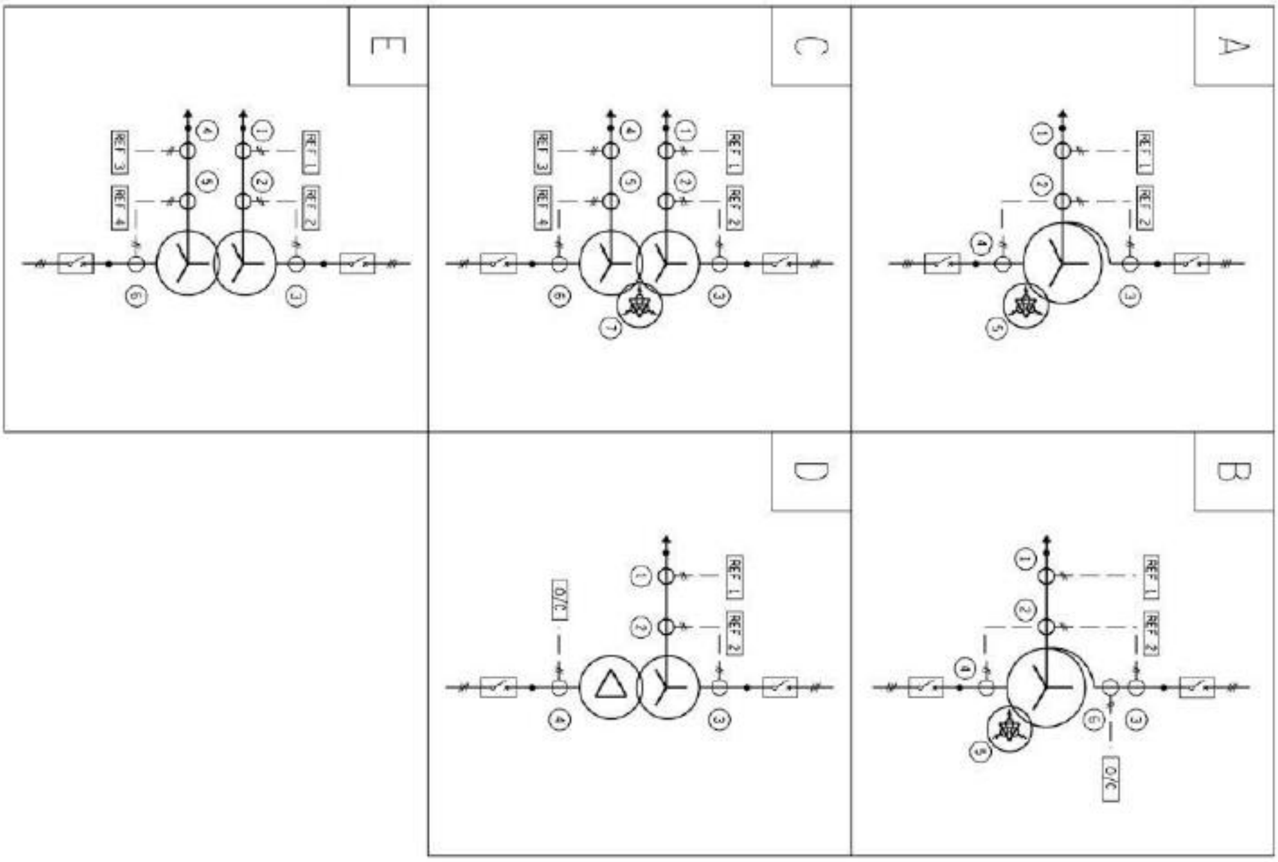


Figure 12: Built-in Current Transformers

Table 11: For Autotransformers of 12B and 20MVA

TRANSFORMER		IN-BUILT CURRENT TRANSFORMERS RATIOS		
kV	MVA	Cores 1, 2, 3 and 6 (class PX)	Core 4(class PX)	Core 5 (class PX)
132/44	20/5	400/1	200/1	100/1
88/44	20/5	400/1	200/1	200/1

Table 12: In-built current transformers for 12D (Star/delta transformers up to 20 MVA)

Transformer		**In-built current transformer ratios**		
kV	**MVA**	**Core 1** **(Class "PX")**	**Core 2, 3** **(Class "PX")**	**Core 4** **(Class "PX")**
132/33	20 10	200/1 200/1	400/1 400/1	400/1 200/1
132/22	20 10	200/1 200/1	400/1 400/1	600/1 400/1
132/11	20 10	200/1 200/1	400/1 400/1	1200/1 600/1
132/6.6	20 10	200/1 200/1	400/1 400/1	2400/1 1200/1

Transformer		**In-built current transformer ratios**		
88/44	20	200/1	400/1	400/1
88/33	20 10	200/1 200/1	400/1 400/1	400/1 200/1
88/22	20 10 5	200/1 200/1 200/1	400/1 400/1 200/1	600/1 400/1 200/1
88/11	20 10 5	200/1 200/1 200/1	400/1 400/1 200/1	1200/1 600/1 400/1
88/6,6	20 10 5	200/1 200/1 200/1	400/1 400/1 400/1	2400/1 1200/1 600/1
66/22	20 10 5	200/1 200/1 200/1	400/1 400/1 200/1	600/1 400/1 200/1
66/11	20 10 5 2,5	200/1 200/1 200/1 100/1	400/1 400/1 200/1 200/1	1200/1 600/1 400/1 200/1
66/6.6	20 10 5	200/1 200/1 200/1	400/1 400/1 200/1	2400/1 1200/1 600/1
44/22	20 10 5	200/1 200/1 200/1	400/1 400/1 400/1	600/1 400/1 200/1
44/11	20 10 5 2,5	200/1 200/1 200/1 200/1	400/1 400/1 400/1 400/1	1200/1 600/1 400/1 200/1
44/6,6	20 10 5 2,5	200/1 200/1 200/1 200/1	400/1 400/1 400/1 200/1	2400/1 1200/1 600/1 400/1
NOTE: For these ratings the 200/1 ratio has been selected as the lowest ratio to avoid wound primary current transformers on the basis that modern low burden protection can be set with adequate sensitivity using these current transformers.				

Table 13: Built-in CTs for 12A configuration

TRANSFORMER		**IN-BUILT CURRENT TRANSFORMER CORES**	
kV	**MVA**	**Cores 1, 2, 3 (class "PX")**	**Core 4 (Class "PX")**
400/275	800/40 400/40	2400/1 1000/1	1600/1 1600/1
400/220	630/40 315/40	2400/1 1000/1	1600/1 1600/1
400/132	500/40 250/40 125/20	2400/1 1600/1 1000/1	1600/1 1600/1 800/1

275/132	500/40 250/40 125/20	2400/1 1600/1 1000/1	1600/1 1600/1 800/1
275/88	315/40 160/20 80/10	2400/1 1600/1 1000/1	1600/1 800/1 400/1
220/132	500/40 250/40 125/20	2400/1 1600/1 1000/1	1600/1 1600/1 800/1
220/66	160/20 80/10 40/10	2400/1 1600/1 400/1	800/1 400/1 400/1
132/88	315/40 160/20 80/10	2400/1 1600/1 1000/1	1600/1 800/1 400/1
132/66	80/10 40/10	1600/1 1000/1	400/1 400/1
132/44	80/10 40/10	1600/1 1000/1	400/1 400/1
88/44	80/10 40/10	1600/1 1000/1	400/1 400/1

Table 14: Built-in current transformers for star-delta units above 20MVA (12D)

Transformers		**In-built current transformer ratios**		
kV	**MVA**	**Core 1**	**Cores 2,3**	**Core 4**
132/33	80 40	400/1 200/1	600/1 400/1	1 600/1 800/1
132/22	40	200/1	400/1	1 200/1
132/11	40	200/1	400/1	2 400/1
88/44	40	200/1	400/1	600/1
88/33	80 40	400/1 200/1	600/1 400/1	1 600/1 800/1
88/22	40	200/1	400/1	1200/1
88/11	40	200/1	400/1	2 400/1
66/22	40	200/1	400/1	1 200/1

Table 15: Built in Current Transformers for star-star transformers (12F)

Transformer		**In-built current transformer turns ratio**				
kV	**MVA**	**Core 1 (Class “PX”)**	**Cores 2 & 3 (Class “PX”)**	**Core 4 (Class “PX”)**	**Cores 5 (Class “PX”)**	**Core 6 (Class “PX”)**
132/11	40	200/1	200/1	2400/1	2400/1	2400/1
	20	200/1	200/1	1200/1	1200/1	1200/1
66/11	40	400/1	400/1	2400/1	2400/1	2400/1
	20	200/1	200/1	1200/1	1200/1	1200/1
33/22	5	200/1	200/1	200/1	200/1	200/1

33/11	20 10 5 2,5	400/1 200/1 200/1 200/1	800/1 400/1 200/1 200/1	1200/1 600/1 400/1 200/1	1600/1 800/1 400/1 200/1	1200/1 600/1 400/1 400/1
33/6,6	10 5 2,5	400/1 200/1 200/1	800/1 400/1 200/1	1200/1 600/1 400/1	1600/1 800/1 400/1	1200/1 600/1 400/1
22/11	20 10 5 2,5 1.25	400/1 200/1 200/1 200/1 200/1	800/1 400/1 200/1 200/1 200/1	1200/1 600/1 400/1 200/1 200/1	1600/1 800/1 400/1 200/1 200/1	1200/1 600/1 400/1 400/1 400/1
22/6,6	10 5 2,5	200/1 200/1 200/1	400/1 200/1 200/1	1000/1 600/1 400/1	1000/1 600/1 400/1	800/1 400/1 200/1
33/3,3	5 2,5	200/1 200/1	200/1 200/1	1000/1 600/1	1000/1 600/1	300/1 400/1
22/3,3	5 2,5	200/1 200/1	200/1 200/1	1000/1 600/1	600/1 600/1	400/1 400/1

Table 16: Built-in current transformers (Class “PX” core details

	CLASS "PX" CORE SPECIFICATION		
TURNS RATIO Np/Ns	**Im (mA) (MAX)**	**Vk(Volts) (MIN)**	**Rs(Ohms) (MAX)**
1/ 100	500	150	0,4
1/ 200	500	200	0,8
1/ 300	330	300	1,2
1/ 400	250	400	1,6
1/ 500	200	500	2
1/ 600	170	600	2,4
1/ 800	125	600	3,2
1/1000	100	650	4
1/1200	83	650	4,8
1/1400	71	650	5,6
1/1600	63	700	5,6
1/2000	50	700	8
1/2400	42	750	9,6
1/3000	35	780	12
1/4000	25	860	16
Im = CT excitation current Vk = knee-point voltage			
The knee-point of the excitation curve is the point where an increase of 10 % of the secondary emf results in a 50 % increase of excitation current.			
Class PX -to meet requirements of the latest revisions of NRS 029-CT’s rated for AC voltages from 3,6-420Kv as well as IEC 60044 Part 1 and Part 6.			

3.18 Transformer Testing

3.18.1 Active Part and General testing

All transformers shall be tested to the latest IEC requirements. Special requirement is however applicable for the switching impulse test. Rated switching impulse withstand voltages are assigned to the winding with highest U_m. Test stresses in other windings are proportional to the turns ratio and are adjusted by selecting appropriate tappings to come as close as possible to the assigned value in Table of the addendum. The switching impulse stresses in other winding shall be limited to approximately 80% of the assigned lightning impulse withstand voltages at those terminals. Lightning impulse shall include chopped wave testing, unless it is otherwise stated.

The Employer shall indicate in the schedules AB the required tests and the classification thereof. Eskom representative shall participate in the testing of each transformer as shall be indicated in the applicable document viz, Inspection and test plan, Product/Process Quality Plan or any equivalent. It is required that for the non-South African factories, the notification of such tests be given in writing at the latest of 10 weeks before date of testing. This date will be a preliminary date that can change by a few days as the time gets closer.

After a successful testing, it is required that the Contractor carries out an internal inspection on each unit and where it is possible, and shall confirm through a report to the Employer that he is satisfied that all is still in order. This inspection shall be carried out when a transformer is in a cold condition. The transformer can only be shipped or transported once an official release from Eskom has been obtained by the Contractor in writing.

3.18.2 Transformer Tank Testing

3.18.2.1 Tank and fittings

Each transformer tank complete with all the fittings and attachments normally in contact with the transformer oil, and filled with oil with a viscosity not greater than that specified in 32-406, shall withstand, for 24 h, at room temperature, without leakage, a hydraulic pressure that is not less than 35 kPa above the maximum working pressure at every point in the transformer.

3.18.2.2 Pressure relief valve

One pressure relief valve of each make and type, set to open at the specified pressure, shall withstand, for 24 h, at room temperature, an internal pressure of oil of 20 kPa above the maximum working pressure at the position of the valve, without leakage.

3.18.2.3 Internal hydraulic pressure withstand

One tank, radiators and oil conservator of each type and size shall be subjected, for 1 min, to an internal hydraulic pressure equal to 70 kPa or the maximum operating pressure plus 35 kPa whichever is the greater, without suffering permanent deflection, measured after a first application greater than the amounts specified in the schedules of this specification.

After a second application no further permanent deflection shall be measurable.

3.18.2.4 Vacuum withstand

One tank, radiators and oil conservator of each type and size, both empty of oil, shall be subjected, for 1 min, to an absolute internal pressure of 1,5 kPa, against atmospheric pressure at sea level on the outside, without suffering permanent deflection, measured after a first application greater than the amounts specified in Table 14 of this specification. After a second application no further permanent deflection shall be measurable.

NOTE: The above two tests may, by agreement, be combined.

Table 17: Maximum permanent deflection of steel tank panels between stiffeners

Maximum permanent deflection (mm)	Major dimension of fabricated assembly (mm)
16	> 3 000
14	> 2 700 ≤ 3 000
12	> 2 300 ≤ 2 700
10	> 2 000 ≤ 2 300
8	> 1 650 ≤ 2 000
6	> 1 300 ≤ 1 650
4	> 950 ≤1 300
3	> 750 ≤ 950
2	> 600 ≤ 750
1	> 450 ≤ 600
0	≤ 450

3.18.2.5 Dye-penetration testing

To avoid leaks, dye-penetration testing shall be done prior to corrosion proofing of the tank and other manufactured fittings after any welding.

3.19 Transformer Transportation

3.19.1 General Conditions

It shall be the *Contractor*'s responsibility to make all arrangements for transport with the appropriate authorities. Eskom will only accept delivery from the *Contractor* on site. It shall be the *Contractor*'s responsibility to co-ordinate the arrangements for all stages of the transport of the transformer from the manufacturer's works to site, including trans-shipping where necessary. Where off-loading is required, all apparatus, materials and packages shall be addressed to the *Contractor*, who shall take delivery of the same at site.

The dimensions of the transformer shall be such that when packed for transport, it will comply with the requirements of the loading and clearance restrictions for the approved route. The max transport dimensions are limited to the following, otherwise indicated in the relevant purchase order.

Height 5 000 mm

Width 4 300 mm

Length 10 500 mm

All metal blanking plates and covers which are specifically required to transport the particular transformer, shall be considered part of the transformer and be handed over to Eskom after completion of erection. A listing of all these items and relevant drawings shall be included in the manuals, to enable Eskom to have the plates manufactured if required. The dimensions and quantity of each item required for transport shall be on the drawings. Where the supply of oil is included in the contract and where transport weight limitations permit, the transformers shall be transported with sufficient oil to cover the core and windings during all transport and storage conditions. The tank shall be sealed for transport to prevent all breathing.

Alternatively, where the above method is not applicable, the transformer shall be maintained continuously under positive pressure of dry air of at least 20 kPa during transport and storage until final installation. The pressure and the temperature at the time of filling shall be documented as part of the quality system. A pressure gauge, suitably protected shall be fitted to each transformer to facilitate checking of gas pressure during transit and on site. The pressure gauge shall be situated at ground level not higher than 1.5 m. The gauge, pipework and other accessories shall be protected against transportation and handling damage. The pressure gauge shall be clearly visible for routine checks without having to remove protective covers. A non-return valve shall be provided at the point of entry into the transformer to prevent loss of dry air due to pressurising equipment failure. The dry air cylinder shall be located at ground level fixed to the side of the main tank.

The total duration that the unit is filled with dry air shall be limited to six months where after the transformer must be appropriately processed and filled with oil as for service. Every precaution shall be taken to ensure that the transformer arrives at site in a satisfactory condition so that after proper oil processing and filling it may be put into service without the necessity for extensive drying out.

Full details of the proposed method of transport shall be submitted for approval.

The costs of any necessary extensions and/or improvements to existing facilities for transporting to site and escort and permit fees shall be included in the *Contractor*'s prices.

3.19.2 Impact Recorders

The supplier shall attach to each transformer an impact recorder, which shall be capable of recording shocks in three axes. One impact recorder shall be mounted inside the tank on the active part and the other one on the tank wall. This shall remain the property of the *Contractor* and will be returned by the purchaser with transportation charges collect. The chart, or three copies of it, shall be delivered to Eskom.

The *Contractor* shall inspect the impact recorder charts before unloading, and provide a report to the *Employer.*

3.19.3 Testing During Transport

Procedure 240-56030661 Requirements for transportation and movement of large electrical equipment shall be used.

The Contractor shall perform SFRA test and Core Insulation Resistance Test (500 V DC for one minute) during the following transport stages:

a) At the factory before loading into the transport

b) Alongside ship prior to loading

c) Before offloading from ship

d) After offloading from ship when on ground (in case of not loading direct to the road transport)

e) After loading on road transport, before start moving (Insulation resistance only for d) and e))

f) On arrival at destination port before loading for road transport

g) On arrival at site after final positioning

All test results shall match the original factory test results for acceptance. The results of the above tests shall be documented, signed off as part of the quality process and included in the transformer manuals, both hard copies and soft copies where applicable.

3.19.4 Sea Transport

The *Contractor* shall make the necessary arrangements for suitable slings or lifting tackle to be available for off-loading at the quay-side and may make use of the equipment provided under the contract, on the condition that it is handed over to Eskom in good order.

3.19.5 Road Transport

The transport arrangements shall include any necessary extensions and/or improvements to road routes, bridges, and civil works, and also the assurance that any abnormal loads comprising the transformers, their transporters, ancillary apparatus and plant and equipment required for erection shall pass without obstruction throughout the selected route.

3.19.6 Transport support brackets

Attention is drawn to the necessity of receiving approval from the transport contractor of the design and spacing of transport support brackets to avoid overstressing of the relevant trailer carrying beams.

3.20 Erection

3.20.1 General

Erection shall include off-loading, installation, full assembly, oil treatment and testing of the transformer.

All equipment provided for erection shall be removed from site when erection is completed and the site cleaned of any debris and oil spillage.

3.20.2 Foundation Tolerances and Transformer Layout Details

Foundation tolerances and layout details shall be submitted for prior approval by Eskom. When the foundation has been constructed, before installation begins, the *Contractor* or his appointed representative shall inspect and confirm the suitability of it to handle the intended transformer.

3.20.3 Site Installation

Site installation shall be performed by the OEM.

All installation projects shall comply with the OSH Act No. 83 of 1993 and ORHVS.

Before commencement of site / store installation a Scope of Work shall be compiled and agreed upon between the OEM and the *Purchaser*. Compiling of the SOW shall be the responsibility of the *Contractor*. The requirements of the Eskom document 240-56062726 *Standard for Intrusive work and Oil filling, under vacuum of transformers and reactors on site* shall be the minimum requirements for handling the transformer during works on site. OEM requirements that are betterment of these requirements will be welcomed. An internal inspection, where possible, will be done by an Eskom employee at the completion of all the intrusive work to ensure that there is no risk when the unit returns into service. This activity does not relieve the supplier/ *Contractor* from his obligation to provide a risk free unit to Eskom.

3.20.4 Functional Tests

Functional tests shall be done on site after complete erection to verify that all the systems are working in harmony. These tests shall include but are not limited to

- Fan and oil pump direction and setting of overload protection relays.
- Correct operation and indication of tap changers.
- All valves in service position.
- Functional test for all alarm and tripping contacts.
- Pump start not tripping buchholz
- Cooling system philosophy

3.20.5 Electrical Tests According to IEC

The onsite testing shall include, but not limited to, the:

- Voltage ratios on all winding sets, tap positions and on all phases
- Impedance test at all tap positions
- Vector group
- Three-phase 380 V magnetising currents
- Winding insulation test – minimum 5kV
- Core insulation test (500 V DC for 1 minute)
- CT polarities, function and insulation
- Fan- and oil pump motor insulation test
- Control/power cabling insulation (minimum 1 kV)
- Tap changer continuity test
- Winding & bushings insulation integrity test (Doble M4000 instrument)
- SFRA after final assembly and oil filling (Doble M5000 instrument)
- Zero sequence impedance

All the required tests shall be indicated in the relevant ITP or PQP document which shall be finalized between the *Employer* and the *Contractor* before installation commences.

3.21 Condition Monitoring

Condition monitoring is a very valuable tool for transformer life management. For a smart grid network it is important that transformer visualization is achieved at its best. It is preferred that all the condition monitoring signals from the transformer and from the components are available from one central point right at the transformer. These signals will then be sent to appropriate points where the operator can see them as well as to the APM tool for automated life assessment. The communication channels must comply with the requirements of IEC61850.

3.21.1 Gas Analysers

An option for a gas analyser to be provided & installed together with the transformer should be given on the tender return for all transformers of 80MVA or higher and highest voltage above132kV, and it should meet all the requirements of 240-64917195. Two valves shall be provided, one as an intake from the transformer tank to the gas analyser and the other as the outlet back to the transformer from the gas analyser. The oil intake shall be from the top oil expanse level, with the pipe routed inside the main tank against the tank wall to the intake valve. These valves shall be 25mm double flanged gate valves and be at ground level (1.5m or below).

For transformers with power rating below 80MVA and with highest voltage of 132kV and below, only the valves will be required but not the gas analyser itself.

3.21.2 On line drying system

An option for an on line drying system to be provided & installed with the transformer must be given on the tender return, it should meet all the requirements of 240-59083215. Provision for online dryer system shall be made with two gate valves installed for supply and return oil with appropriate locations for effective drying. The valves shall be 25mm double flanged gate valves full flow design. A method of anti-vibration shall be provided for mountings of online dryers (moisture removers). This requirement is fully applicable only to transformers with power rating of 80MVA and above plus with a highest voltage of above 132kV.

For transformers with power rating below 80MVA and with highest voltage of 132kV and below, only the valves will be required but not the online dryer itself.

3.21.3 Fibre optic temperature sensors

Transformers shall be provided with fibre optic temperature sensors as indicated in the AB schedules. The vendor must provide with the transformer the fibre optic extensions and the signal conditioning device to present the temperatures as 4-20mA signals to be connected to the data concentrator mentioned above or directly to the Eskom protection panels. These should be terminated in the transformer marshalling kiosk.

3.21.4 General

The condition monitoring station should have a life span matching that of the transformer and must not introduce more frequent maintenance requirements.

All bidders shall provide a proposal for a condition monitoring system for active part, bushings, and on-load tap changers.

3.22 Documentation

Drawings, Photographs, Instruction Books, and Test Reports-As listed below shall be sent to Eskom. All drawings shall include the following information: Eskom, Serial Number, Design Fault Levels, gravitational force design limits, Power Ratings, Voltage Ratio, and Eskom Purchase Order Number.

Five (5) copies of outline, nameplate, base, bushings, schematics and complete wiring diagrams, terminal block arrangement drawings showing physical locations with dimensions are to be submitted for approval. The nameplate, schematic and wiring diagrams shall be submitted one month after the receipt of Purchase Order. The remaining drawings shall be submitted together a minimum of 8 months prior to delivery. The base drawings shall indicate the dimensions, jacking points, load bearing surfaces, and approximate total weight to facilitate the customer's foundation design. *Purchaser* shall return one copy of each drawing with comments or approval. All approved drawings are to be submitted in paper and in a CD. A late drawing penalty shall be assessed according to the schedule A of the specification.

Four (4) Photographs of the core and coil assembly shall be taken at such angles as to provide the maximum of design and construction information for records.

Quality Control Information-after an order has been, a copy of the manufacture quality control manual will be provided upon request to Eskom for their review.

One (1) complete transformer manual shall be delivered with the transformer. The manual shall be easily accessible and protected from moisture / water damage during transport and storage. This manual shall be used for erection and commissioning purposes and shall include the factory test results and diagrams.

A further (4) manuals and one (1) electronic copy on CD shall be delivered not later than 14 days after completion of all commissioning tests. This manual shall include the electrical results from the commissioning testing carried out on site as well as testing done during transport. All oil sample results from tankers and main tank shall also be included. In the CD an original file in the original format for the SFRA test shall be included for the future reference purposes.

All drawings are to comply with the Eskom drawing standard TPC 41-246 .

3.23 Adjudication of Tenders

3.23.1 Failure Rates, Reliability and Manufacturing Experience of *Contractor*s

The failure rate, reliability and manufacturing experience of the transformers, reactors and phase-shifters supplied from the transformer factory from which the Employer's transformer(s) will be sourced during the contract duration are to be provided in Schedules A&B. The statistical data of failure rates and manufacturing experience reflects the experience of the factory from which the Employer's transformers will be sourced and not the company group.

The factory failure rate, in service failure rate, manufacturing and testing experience statistical data is used during the tender evaluation.

3.23.2 Population

The population of transformers to be considered in the calculations of the in failure rates is all the transformers and reactors with a rating above 10 MVA(r) that was manufactured at the factory over the past 10 years, irrespective of who was the customer.

3.23.3 Factory Failure

A failure in the factory is defined as a situation arising where major opening/dismantling of the transformer is required to correct a failure caused during factory testing. Thus having to drop the oil, un-tank or remove the top yoke in order to repair a failure or defect caused during testing is defined as a factory failure.

3.23.4 Factory Failure Rate

The factory failure rate (one-year) is defined as the ratio of the number of factory failures to the population of transformers, reactors and phase-shifters manufactured over a one-year period. A minimum of 10 years data must be provided in the tender documentation. The factory failure rate (five-year) is the rolling average of the factory failure rates (one year) taken over a five year period. Failures during testing of special transformers or new developments may be excluded from this statistics. Eskom allows for a maximum of 3% factory failure rate per annum. Eskom reserves the right to audit these figures at any given point. If an approved supplier's performance during the contract period deteriorate and is above this 3% figure, Eskom may terminate placing further orders at any given time.

3.23.5 In-service Failure

An in-service failure is defined as a forced outage failure plus a scheduled outage failure as defined in IEEE 57.117.1986. Further to the definition in IEEE 57.117.1986 the failure is only regarded as an in-service failure if the transformer had to be removed from its bay for the defect to be repaired.

3.23.6 In-service Failure Rate

The in-service failure rate (one-year) is defined as the ratio of the number of in-service failures to the population of transformers, reactors and phase-shifters accumulated service time over a one-year period. A minimum of 10 year's data must be provided in the tender documentation. The in-service failure rate (five-year) is the rolling average of the in-service failure rate (one year) taken over a five year period.

3.23.7 On Time Delivery

The On-Time Delivery Rate is defined as the number of the units that were delivered on or earlier than the agreed contractual date. This shall be calculated on ex-works.

3.23.8 On Time Delivery Rate

The On-Time Delivery Rate is defined as the number of the units that were delivered on or earlier than the agreed contractual date over the number of units delivered over the period of 12 months. Eskom requires an on time deliver rate of ≥95%. If an approved supplier's performance during the contract period deteriorate and is below this 95% figure, Eskom may terminate placing further orders.

3.24 Quality Assurance

The official Eskom Standard for "Quality Assurance Requirements for the Procurement of Assets, Goods and Services" is TST41-168.

Eskom or the representative reserves the right to inspect the materials, equipment manufacture and witness the tests. The manufacture shall allow access to the Eskom representative without any hindrance or additional charges to the Eskom. The Manufacture shall notify Eskom at least 10 weeks prior to commencement of the tests.

The Manufacturer shall submit a schedule within four weeks of the award of the contract.

This shall show dates for:

- Engineering
- Submit transformer Outline drawing to allow foundation design
- Submit Drawings for approval
- Supply of Instruction Manuals
- Purchasing and Delivery of Components
- Manufacturing and Assembly
- Testing of Transformer
- Shipment to Site

If a unit fails under test, the supplier will officially notify the employer in writing within 24 hrs of the failure, the *Contractor* will set up a meeting with the employer to discuss and agree on a way forward. The *Contractor* will supply a written report on the failure within 30 days of the failure.

3.25 Loss Evaluation

All losses will be capitalised using the formula below when adjudicating the tenders.

3.25.1 Guaranteed losses

The manufacture shall guarantee the following losses for each transformer:

- No-Load loss in kilowatts at rated voltage and rated frequency.
- Total losses in kilowatts at rated output, rated voltage and rated frequency
- Auxiliary losses – 50% of the total of the auxiliary supply load to be added to the load losses to give total load losses.
- Load losses shall be evaluated for MVA rating as specified in schedule A of the rating for each transformer.
- Transformer losses determined under tests shall be corrected to 75°C. No-Load loss shall not be corrected.

The transformer cost shall be evaluated as follows:

Evaluated Cost = P + [A * E] + [B * L]

Where: P = Transformer tender price

A = Evaluated Cost of No-load loss per kW

B = Evaluated Coast of Load loss per kW

E = No-load loss in kW

L = Load loss in kW

Table 18: Coefficients of losses

Calendar Year	No load losses A (R/kW)	Load losses B (R/kW)
2023	R87 900	R19 200
2024	R93 200	R20 300
2025	R98 800	R21 600
2026	R104 800	R22 800
2027	R111 400	R24 200
2028	R118 100	R25 700

3.25.2 Non Conformance on losses

If the measured no-load losses and/or load losses exceed the IEC tolerances Eskom reserves the right to reject the transformer.

If the no-load losses and/or load losses measured exceed the guaranteed value then the incremental cost of loss evaluation shall apply as a penalty multiplied by the factor 4.

If the measured temperature rises exceed the guaranteed values, the highest deviation in degrees (top oil rise, average winding rise, hot spot rise) will be penalised. For each 1°C exceeding the guaranteed value, 1.5% of the transformer purchase price will be penalised. If the deviation is more than 5°C the transformer will be rejected or countermeasures have to be implemented to mitigate against the deviation.

There will be no credit or payment of premium if actual values are better than guaranteed values.

3.26 Training of Purchaser's staff

The *Contractor* shall propose an appropriate and cost effective training program for the operating, maintenance and engineering staff of the *Purchaser*. This shall include the nomination of an appropriate venue and duration of the training period.

If the proposed training involves travelling and accommodation and subsistence away from the *Purchaser*'s home country, the *Purchaser* shall be responsible for all the direct travelling and subsistence expenses involved for a maximum number of four (4) of the *Purchaser*'s staff.

The *Purchaser* shall have the option at his own expense, to add a further two (2) staff members.

The *Contractor* shall provide a complete and detailed broken down schedule of the training events but is not expected that formal training should last less than 5 consecutive working days nor more than 10 consecutive working days.

The *Contractor* shall advise the *Purchaser* of the minimum pre-requisite level of education required for the employees to successfully participate in the training programme.

Over and above any formal training, the program shall include as a minimum, an on-site component covering:

- on site preparation for transportation
- loading and off-loading procedure and precautions
- Installation procedures and precautions
- functional testing of tap changers, sensors and protective devices
- vacuum treatment, drying filtering and impregnation
- general maintenance and in-service inspections and checks
- all electrical testing of the completed system to ensure that it is ready for service

Special emphasis shall be placed on quality control processes and the maintenance of the oil and insulation system to keep it in the best possible condition to ensure maximum life for the transformer, as well as the underlying theoretical aspects.

These training requirements shall form part of the hand over for each installation.

The *Contractor* shall make available in electronic form training material that is adequate for the *Purchaser* to execute all handling and maintenance necessary in the future. The copy of such material will form part of the manual.

3.27 Local Support

Potential transformer suppliers shall have an established local technical support base. A Supervisor from the *Contractor* shall be available on site within 24 hours of notification of an emergency by the *Purchaser*.

The supplier shall be fully equipped to attend to emergencies and equipment failures within the guarantee period of the transformer.

3.27.1 Local Support's Requirements

It is required that the local technical support cater for:

- Emergency breakdowns
- Failure investigations
- Maintenance & breakdown spares
- Operational enquiries
- Training

3.28 Safety on Transformers

Safety is very important in Eskom, and this includes when working with transformers. It is important therefore that all transformers designed and manufactured for use in the Eskom network take into consideration the safety needs. This includes but not limited to

- Safety of people working on a transformer, especially on top of the tank. The employees and the contractors should be able to do so with no risk of falling.
- Safety of the people working inside the transformer (e.g. making connections or doing inspections). A worker must be able to safely execute this with no risk of falling as reasonably as possible.
- Safety of people around the transformer when in operation. There must be no possibility of inadvertent contact with live apparatus while on ground level and where this is not achieved, it must be highlighted to the *Purchaser* at the tendering stage.
- Tank designs and components arrangement should be such that as practically reasonable as far as possible, tank rupturing is avoided.

The technology and the materials used in the construction of transformers must support the safety drive of Eskom.

4 Authorisation

This document, in this revision, was distributed to the following managers.

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5 Revisions

Date	Rev.	Compiler	Remarks
Feb 2024	3	NS Mtetwa	Table 2 updated Paragraph 3.4.8 updated to include special requirements for heavy duty/Arc Furnace transformers Paragraph 3.5.2 for core materials revised to include quality and appearance of materials. Paragraph 3.6.4 revised to include specific requirements for EHV and UHV units. Paragraph 3.11.1 revised to include convertor requirements for non-standard voltages. Table 10 revised Paragraphs 3.14.11, 3.17.4, 317.10 removed. CTs changed to PX type on various tables. CT ratios revised in various CT tables Updated Table 18 by extending it.
April 2017	2	NS Mtetwa	On paragraph 3.4.8, the requirments for short circuit withstand capability were revised to include thin conductors, and merged with 3.6.6. of the previous revision. 3.6.6 was then deleted. Table 4 was added on paragraph 3.6. Paragraph 3.8.9.2 revised to include protection at the loss of oil in the tap changer conservator. On paragraph 3.9, the tap changer requirements updated to align with IEC revised standard by eliminating the flag cycle requirement. Furthermore, oil type tap changer was kept as an alternative technology. Paragraph 3.9.8.4 revised. Marshalling kiosk requirements revised on 3.11.2 Requirements for cooler control expanded on 3.14.7 paragraph 3.14.10 added to include self dehydrating breathers. Valves requirements for sections 3.21 revised for the online gas analyser and the online moisture remover. Data concentrator requirements removed on 3.21
June 2014	1	NS Mtetwa	This document was compiled to consolidate the requirements from the previous 3 different divisional specifications and to bring in the new requirements identified through learning since the previous documents.

6 Development team (Working Group)

The following people were involved in the revision of this document:

Lionel Jordaan	Senior Consultant - Power Generation Engineering
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7 Acknowledgements

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PART C2.1 - PRICING INSTR: SEC 5: SCHEDULES OF PARTICULARS AND GUARANTEES

300MVA 275/132/(11 kV stablizing winding) -TRANSFORMER - PARTICULARS

ITEM	MANUFACTURER	PLACE OF MANUFACTURE	PLACE OF TESTING & INSPECTION
Transformers, complete			
Auxiliary transformers, complete			
Core plates			
HV Bushings			
Marshalling Kiosks			
Control panels			
Winding temperature indicators			
Voltage regulating relay			
Copper			
Steel			
Tanks			
Radiators			
Insulating cylinders			
LV bushings			
Porcelain for insulators			
Oil			
Oil Valves			
Oil Piping			
Oil Coolers			
Air Blowers			
Water Pump Motors	NA		
Fan Motors			
Motor Control Gear			
Gas and oil acuated relays			
Ring type current transformers			

PART C2.1 - PRICING INSTR: SEC 5: SCHEDULES OF PARTICULARS AND GUARANTEES

300MVA 275/132/(11 kV stablizing winding) -TRANSFORMER - PARTICULARS

ITEM NO	DESCRIPTION	UNIT	DESIGN REQUIREMENTS	GUARANTEE BY BIDDER
1	Indoor or Outdoor installation		Outdoor	
	Size of transformer area 1 x w	M		
2	Site conditions			
	(a) Altitude above sea level	M	1526	
	(b) Cooling medium temperature:			
	i) °C max.		40	
	ii) °C average.		35	
3	Continuous maximum rated (CMR)			
	(a) HV	kVA	300 000	
	(b) LV	kVA	300 000	
	(c) TER	kVA	40 000	
	ONAN rating			
	(a) HV	kVA	150 000	
	(b) LV	kVA	151 000	
	(c) TER	kVA	40 000	
4	Rated frequency	Hz	50	
5	Rated voltage			
	(a) HV	kV	275	
	(b) LV	kV	132	
	(c) TER	kV	11	
6	System highest voltage			
	(a) HV	kV	300	
	(b) LV	kV	145	
	(c) TER	kV	12	
7	Method of system earthing:			
	(a) HV system		Solid	
	(b) LV system		Solid	
	(c) TER system		Solid*	
8	Method of earthing the transformers			
	(a) HV winding		Solid	
	(b) MV winding		Solid	
	(c) TER winding (open delta)		Solid	
9	Type of cooling		ON AN / ON AF	
10	External cooling medium		Air	
11	Insulation level (full wave 1.2/50 microsecond)			
	under Site conditions			
	(a) HV	kV Crest	1050	
	(b) LV	kV Crest	550	
	(c)TER	kV Crest	95	
	Rated switching impulse			
	ACLD: $U_1 = 1.8\ Um / \sqrt{3}$	kV	850	
	$U_2 = 1.6\ UM / \sqrt{3}$	kV	Yes	
12	Normal ratio of transformation with full HV and LV winding	kV	275/132	
13	Alternative ratio of transformation if required			
	(See Clause 2.14)	kV	-	
14	Continuous ONAF rating of transformer over the whole			
	tapping range (See Clause 2.1)		50% CMR	
15	Continuous maximum rating at alternative ratio of			
	transformation (See Clause 2.14)	kVA	-	
	*One phase of delta winding externally earthed			

PART C2.1 - PRICING INSTR: SEC 5: SCHEDULES OF PARTICULARS AND GUARANTEES

300MVA 275/132/(11 kV stablizing winding) -TRANSFORMER - PARTICULARS

ITEM NO	DESCRIPTION	UNIT	DESIGN REQUIREMENTS	GUARANTEE BY BIDDER
16	Impedance HV/LV			
	(a) Nominal tap 6	%	24,3	
	(b) Min tap 23	%	19,1	
	(c) Pos tap 1	%	25,2	
17	Range of variation of transformation ratio under			
	no load			
	(a) increasing		275kV +7. 3%/132kV	
	(b) decreasing		275kV - 25.5%/132kV	
	(c) catogory of voltage variation		CFVV	
	(d) direction of power flow		HV to MV	
18	Type of on-load tap changer*		Vacutap	
19	Tap changers current rating			
	(a) at nominal ratio		> 900 amperes	
	(b) at decreasing ratio		.900 amperes	
20	Number and size of steps*		22 x 1.5%	
21	Phase connections:			
	(a) HV winding		Star	
	(b) LV winding		Star	
	(c) TER winding		Delta	
	(d) BS vector group reference		YNyn0d1	
22	Tertiary windings:			
	(a) Whether tertiary (LV) winding is required		Yes	
	(b) Whether tertiary windig is to be brought out to a			
	separate terminals (See Clause 2.21)		Yes	
	(c) Maximum continuous external laod to be carried by			
	the tertiary winding (See Clause 2.22)	kVA	40 000*	
	(d) Short circuit MVA available at the HV terminals	kVA	15 000MVA	
	(e) Short circuit MVA available at the LV terminals	kVA	5 700MVA	
	(f) Short circuit MVA available at the TER terminals	kVA	760MVA	
	(g) Connection of TER winding		Delta and earthed	
23	Whether remote electrical, automatic or hand operation		Remote, automatic local and hand	
	"on load" voltage control (See Clause 7)			
24	Whether transformer on/off supervisory and tap			
	change raise/lower supervisory control and			
	indication are required (See Clause 7.39)		Yes	
25	Whether compounding is required with automatic			
	voltage control (See Clause 7)		No	
26	If alternative to Marshalling Kiosk is required (See Clause 10.1)		No	
27	Whether switch sockets should be fitted to Marshalling Kiosk		Yes	
	(See Clause 10.1)			
	Bushing isulators type		Porcelain	
28	Bushing insulators			
	(a) HV (Rated 600A)GOM	BIL	1050	
	(b) LV (Rated 3150A)GOE	BIL	650	
	(c) TER (Tertiary) (Rated 1 250A)	BIL	250	
	(d) Filling medium for cable boxes		AIR	
29	Bushing insulator neutral:	BIL	250	
	(a) HV / MV		Bushing	
	(b) LV		-	
	(c) Filling medium for cable boxes		-	

PART C2.1 - PRICING INSTR: SEC 5: SCHEDULES OF PARTICULARS AND GUARANTEES

300MVA 275/132/(11 kV stablizing winding) -TRANSFORMER - PARTICULARS

ITEM NO	DESCRIPTION	UNIT	DESIGN REQUIREMENTS	GUARANTEE BY BIDDER
30	Voltage to earth for which star points of the transformer			
	windings are to be insulated (See Clause 3.1):			
	(a) 275kV kV		38	
	(b) 132kV kV		38	
31	Whether disconnecting chambers are required			
	HV		No	
	MV		No	
	LV		No	
32	Whether accommodation for current transformers shall be			
	provided on:			
	(a) HV terminals		Yes	
	(b) LV terminals		Yes	
	(c) TER terminals (tertiary)		Yes	
33	Whether tapping shall be brought out from each condenser type			
	bushing insulator to a separate terminal for power factor			
	testing on site, on:			
	(a) HV bushings		Yes	
	(b) LV bushings		Yes	
	(c)TER bushings (tertiary)		Yes	
	(d) Neutral		Yes	
34	Whether anti-vibration pads are required		Normal 10mm damp course	
35	Whether pressure relief device is required		Yes	
36	Whether co-ordinating rod-gaps are required		No	
37	Whether valves for oil filtering require special adaptors		YES 50mm flanged	
	(See Clause 5.35)			
38	Whether wheels are required (See Clause 5.19)		No	
39	Number of copies of Operating and Maintenance Instructions			
	required		3	
40	Multicore cabling:			
	i) all necessary cabling between all releays, temperature devices,			
	tapchanging mechanism, etc. to Marshalling Kiosk		Yes	
	ii) cabling between Marshalling Kiosk and Control Panel		No	
41	Paint Finish:			
	(a) TMK & TRF		Eau=de-Nil Semi-gloss	
	(b) Conservator		White	
42	Whether equipment shall be provided to permit automatic synchrone			
	operation of on-load tap changing equipment in parallel with similar			
	transformers		No	
43	Whether alternative to silica gel breather required		No	

PART C2.1 - PRICING INSTR: SEC 5: SCHEDULES OF PARTICULARS AND GUARANTEES

300MVA 275/132/(11 kV stablizing winding) -TRANSFORMER - PARTICULARS

ITEM NO	DESCRIPTION	DESIGN REQUIREMENTS	GUARANTEE BY BIDDER
44.1.1	HV BUSHING CT's:		
	3 off, (1 per phase) 1 600/1 Class "X"	400 volts approx	
	Knee point voltage	50 mA maximum	
	Magnetising current at Vk	4 ohms maximum	
	Internal secondary resistance	REF protection	
	Purpose		
1,2	LV BUSHING CT's:		
	3 off, (1 per phase) 1 600/1 Class "X"	400 volts approx	
	Knee point voltage	50 mA maximum	
	Magnetising current at Vk	4 ohms maximum	
	Internal secondary resistance	REF protection	
	Purpose		
	3 off (1 per phase) 1 094/1, 10VA, class 10P10 for OC protection		
1,3	TER BUSHING CT's:		
	3 off, (1 per phase) 1 600/1, 15VA, Class for OCEF	10P15	
	protection		
1,4	HV/LV NEUTRAL BUSHING CT's:		
	i) 1 off, 1 200/1 Class "X" for Neutral counter	400 volts approx	
	ii) 1 off, 1 600/1 Class "X"	50 mA maximum	
	Knee point voltage	4 ohms maximum	
	Magnetising current at Vk	REF protection	
	Internal secondary resistance		
	Purpose		
NOTE:	Current transformers for winding temperature devices circulating current		
	control schemes, etc., are excluded from this Schedule.		
1,5	Loose external current transformer for inclusion in earth connection to tertiary		
	phase bushing with the following cores:		
	i) 1 off, 1 000/1, 10VA Class 10) 15 for LVEF protection	Yes	
	ii) 1 off, Ditto, spare	Yes	
	To be supplied and bracket-mounted on the transformer by the transformer		
	contractor		
	NOTES:		
i)	The overall responsibiliy for the protection shceme at the Substation is ves	Yes	
	in other contracts, and as such the Contractor is expected to liaise with other		
	contractors and manufacturers to ensure that current transformers provided are		
	suitable for use with specified protection.		
ii)	All internal bushing current transformers shall be supplied with test windin	Yes	
	in accordance with BS 3938 Appendix "H" except in cases where the		
	addition of a test winding detracts from the required level of main current		
	transformer performance. In such cases Engineer's approval shall be obtained		
	for the commission of test windings.		

PART C2.1 - PRICING INSTR: SEC 5: SCHEDULES OF PARTICULARS AND GUARANTEES

300MVA 275/132/(11 kV stablizing winding) -TRANSFORMER - PARTICULARS

ITEM NO	DESCRIPTION	GUARANTEE BY BIDDER
45	The following is a summary of the supervisory requirements for a substation which	
	affected the power transformer contract and must be catered for on the equipment	
	being supplied and / or the schematic and wiring diagram to be prepared.	
1	SUPERVISORY CONTROLS	
	(a) Supervisory Size Control (Select and Cancel)	
	(b) Raise tapping control	
	(c) Lower tapping control	
	(d) Initiate rapid voltage reduction (optional)	
2	SUPERVISORY ANALOGUES	
	Provided for on other contracts	
3	SUPERVISORY INDICATIONS	
	(a) Tap changing "On Supervisory Control"	
	(b) Tap position indication (16 steps, 17 posistions)	
	(c) Tap change in progress	
	(d) Cooling fans in operation	
4	SUPERVISORY ALARMS	
(a)	Buchholz alarms comprising:	
i)	Main transformer gas	
ii)	Main transformer surge	
iii)	Tap change gas	
(b)	Over-temperature alarms comprising:	
i)	HV winding temperature	
ii)	HV/MV winding temperature	
iii)	LV winding temperature	
iv)	Aux transformer winding temperature	
v)	Main transformer oil temperature	
vi)	Tap change oil temperature	
vii)	To be specified	
(c)	Oil level alarms comprising:	
i)	Main transformer low + high oil	
ii)	Tap change low + high oil	
(d)	Cooler alarms	
i)	Fan / pump supply fail	
ii)	To be specified	
iii)	To be specified	
(e)	Voltage Control alarms comprising:	
i)	Transformers out of step (excessive spill current)	
ii)	Voltage regulating relay fail	
iii)	110 volt regulating supply fail	
iv)	LVAC control supply fail	
v)	To be specified	
(f)	Tap change mechanism alarms comprising:	
i)	Tap change incomplete	
ii)	Tap change lockout	
iii)	Tapping time excessive	
iv)	Drive motor overload trip	
v)	Drive motor supply failure	
vi)	To be specified	
(g)	Miscellaneous	
	To be specified	

PART C2.1 - PRICING INSTR: SEC 5: SCHEDULES OF PARTICULARS AND GUARANTEES

300MVA 275/132/(11 kV stablizing winding) -TRANSFORMER - PARTICULARS

ITEM NO	DESCRIPTION	If Required	Control, Type of Indication and / or Alarm	GUARANTEE BY BIDDER	Operating Supply
46	Control, Operation, Indicating or Alarm Circuits				
	Transformer winding and oil temperature and gas and oil				
	actuated relay	Yes	Trip	Yes	110V DC
	Winding temperature	Yes	Trip	Yes	110V DC
	Main Buchholz gas	Yes	Trip	Yes	110V DC
	Tap changer Buschholz gas	Yes	Trip	Yes	110V DC
	Tank pressue device	Yes	Trip	Yes	110V DC
	Low and high oil level alarm	Yes	Alarm	No	110V DC
	Tap changer overcurrent	Yes	Trip	No	110V DC
	Transformer voltage ratio	Yes	Indicating device	No	110V DC
	Transformer tap change complete	Yes	Audible alarm, flag indication		
			and Supervisory alarm		
			initiation	No	110V DC
	VT Fail	Yes	Illuminated signal (Amber) Audible		
			alarm, flag and supervisory alarm		
			initiation	No	110V DC
	Voltage regulating relay fail	No	Audible alarm, flag indication and		
			supervisory alarm initiation	No	110V DC
	Tap change control circuits	Yes	Control	Yes (local)	110V DC
	Tap change operating motor	Yes	Direct from contractors	Yes	415/240V
					AC
	Electrical winding temperature indication	Yes	Dial indicator (See Clause 9.4)	Yes	110V DC
	Transformer MV indication	Yes	Voltmeter	No	110V AC
	Tap change in progress	Yes	Illuminate signal operated by cam		
			switch	Yes	110V DC

PART C2.1 - PRICING INSTR: SEC 5: SCHEDULES OF PARTICULARS AND GUARANTEES

300MVA 275/132/(11 kV stablizing winding) -TRANSFORMER - PARTICULARS

ITEM NO	DESCRIPTION	UNIT	DESIGN REQUIREMENTS	GUARANTEE BY BIDDER
16	Regulation at 75°C and CMR as actual percentage of nominal voltage			
	(a) At unity power factor	%		
	(b) At 0.8 lagging power factor	%		
17	Impedance at 75°C at 0 tapping (nominal ratio)			
	(a) between HV and LV windings Nom tap 24.3%	%	24,3	
	(b) between HV and LV windings Min tap 19.1%	%	19,1	
	(c) between HV and LV windings Plus tap 25.2%	%	25,2	
18	Ohmic impedance at 75°C (See Clauses 2.26 and 2.27 and Schedule "F" AI(c)):			
18,1	HV/LV			
	(a) at 0% tap position	ohms		
	(b) at + tap position	ohms		
	(c) at - tap position	ohms		
18,2	HV/LV			
	(a) at 0% tap position	ohms		--
	(b) at + tap position	ohms		--
	(c) at - tap position	ohms		--
18,3	MV/LV			
	(a) at 0% tap position	ohms		--
	(b) at +5% tap position	ohms		--
	(c) at -15% tap position	ohms		--
19	Proportion of sum of iron and copper losses at CMR which will be supplied			
	during temperature rise test			
20	Tertiary windings			
	(a) Voltage	kV	11	
	(b) Nominal rating expressed as percentage of main winding rating	%		
	(c) Most onerous fault condition HV of LV (See Clause 2.18)			
	(d) Current density in the winding under fault conditions (c) above	amp/mm²		
	(e) Current density in the winding at 3 second rating (See Clause 2.22)	amp/mm²		
21	Types of windings:			
	HV			
	MV			
	Tertiary LV			
22	Insulation of:			
	(a) Higher voltage windings -termal upgraded paper		Yes	
	(b) Ter voltage windings -termal upgraded paper		Yes	
	(c) Lower voltage windings -termal upgraded paper		Yes	
23	Insulation of:			
	(a) Tapping			
	(b) Tapping connections			
24	Insulation of:			
	(a) Core bolts			
	(b) Core bolt washers			
	(c) Side plates			
	(d) Core laminations			
	(e) Core frames			
25	Calculated thermal time constant:			
	(a) ON AN	hours		
	(b) ON AF	hours		
26	Thickness of transformer tank:			
	(a) Sides	mm		
	(b) Bottom	mm		
27	Thickness of radiator plates and / or cooling tubes	mm		

PART C2.1 - PRICING INSTR: SEC 5: SCHEDULES OF PARTICULARS AND GUARANTEES

300MVA 275/132/(11 kV stablizing winding) -TRANSFORMER - PARTICULARS

ITEM NO	DESCRIPTION	UNIT	GUARANTEE BY BIDDER
28	Equipment for ON AN cooling:		
	(a) Radiators on main tank		
	(b) Separate cooler banks		
29	Auxiliary equipment for forced-air cooling (ON AF)		
	(State (a) of (b)):		
	(a) Fans blowing on radiator or cooler		
	(b) Separate air blast cooler		
30	Total oil required (including cooling system)	litres	
31	Volume of oil to be removed to the level of the top yoke	litres	
32	Oil required to cover windings for shipment	litres	
33	(a) Total volume of conservator	litres	
	(b) Volume of oil in conservator between the highest and lowest visible levels	litres	
34	Volume of oil in radiator bank	litres	
35	Height of oil at maximum level in conservator, above transformer pad level	mm	
36	Mass of copper required in the complete transformer	kg	
37	Mass of core steel required in the complete transformer	kg	
38	Mass of core and winding assembly	kg	
39	Mass of each oil cooler / radiator complete with oil	kg	
40	Total mass of complete transformer including voltage regulating equipment all		
	fittings and oil		
	(a) Quotation estimate	kg	
	(b) Final design calculation	kg	
41	Details of fittings and parts detached for transport		
	See drawing No.		
42	Mass of complete transformer arranged for transport		
	(a) Quotation estimate	kg	
	(b) Final design calculation	kg	
43	Maximum temperature of oil		
	(a) At inlet to cooler / radiator	°C	
	(b) At outlet from cooler / radiator	°C	
	(c) Hot spot		
44	Maximum pressure of oil at the inlet to the radiator under service conditions	kPa	
45	Cooling surface of each cooler / radiator	m²	
46	Distance between cooler / radiator tube plates	mm	
47	Overall dimensions		
	(a) transformer complete but without conservator 1 x w x h	m	
	(b) radiator bank complete but without conservator 1 x w x h	m	
	(c) Maximum conservator height	m	

PART C2.1 - PRICING INSTR: SEC 5: SCHEDULES OF PARTICULARS AND GUARANTEES

300MVA 275/132/(11 kV stablizing winding) -TRANSFORMER - PARTICULARS

ITEM NO	DESCRIPTION	DESIGN REQUIREMENT	GUARANTEE BY BIDDER
1	INSULATION LEVELS		
1,1	Impulse withstand test voltage (1.2/50 micorsecond full wave)		
	(a) HV kV peak	1 050	
	(b) LV kV peak	550	
	(c) TER kV peak	95	
1,2	Switching impulse level:		
	(a) HV phase to ground kV peak	850	
1,3	Applied, power frequency withstand test voltage (60 second duration) to earth		
	(a) HV (neutral end) kV peak rms	38	
	(b) LV (neutral end) kV peak rms	38	
	(c) TER kV peak rms	28	
1,4	Induced overvoltage withstand test:(AC long duration to IEC)		
i)	between line terminals and earth:		
	(a) HV kV	460	
	(b) LV kV	230	
ii)	between line terminals		
	(a) HV kV	460	
	(b) LV kV	230	
	(c) TER kV	44	
iii)	Test frequency Hz	f	
iv)	Test duration seconds	s	
	Note: f x s = 6000 wit s not less than 15 seconds		
2	TERMINAL BUSHINGS:		
2,1	Impulse withstand test voltage at sea level (1.2/50 microsecond full wave)		
	(a) HV kV Crest	1 050	
	(b) LV kV Crest	650	
	(c)TER kV Crest	250	
	(d) HV/MV Neutral kV Crest	250	
2,2	Applied power frequency wet withstand test voltage (60 second duration)		
	(a) HV kV	460	
	(b) LV kV	285	
	(c) TER kV	100	
	(d) HV/MV Neutral kV	100	
2,3	Minimum total creepage distances:		
	(a) HV mm	4 670	
	(b) LV mm	2 900	
	(c) TER mm	750	
	(d) HV/MV Neutral mm	750	
2,4	Minimum protected creepage distances:		
	(a) HV mm	2 350	
	(b) MV mm	1 40	
	(c) LV mm	380	
	(d) HV/MV Neutral mm	380	
3	FAN MOTORS		
	Type of motor		
	Number of fan motors on this contract		
	Voltage V		
	Class of insulation		
	Standard		
	Rated output kW		
	At rated output		
	speed		
	efficiency		
	power factor		
	line current		
	Starting current at		
	rated voltage A		
	Type of bearings		
	Manufacturer of motor		
	Manufacturer of control gear, if provided		

PART C2.1 - PRICING INSTR: SEC 5: SCHEDULES OF PARTICULARS AND GUARANTEES

300MVA 275/132/(11 kV stablizing winding) -TRANSFORMER - PARTICULARS

ITEM NO	DESCRIPTION	UNIT	DESIGN REQUIREMENTS	GUARANTEE BY BIDDER
1	Type of cooling		ONAN ONAF	
2	Number of radiators required per transformer		TBA	
3	Rating of each radiator as percentage of total loss in transformer			
	at CMR	%	TBA	
4	Type of non-load voltage control equipment			
5	Hottest-spot temperature at CMR (averange ambient air temperature			
	30°C)	°C	65	
6	Maximum obervable oil temperature:			
	(a) CMR (average ambient air temperture 30°C) temperature at 1 800m top oil	°C	50	
	(b) ONAN rating (average ambient air temperature 30°C) temperature at 1 800m wind temp	°C	55	
	(c) CMR (average ambient air temperture 30°C) temperature at 1 800m top oil	°C	50	
	(d) ONAN rating (average ambient air temperature 30°C) temperature at 1 800m winding temp	°C	55	
7	Maximum flux density in iron at normal voltage and frequency and at			
	normal ratio			
	(a) Cores	Tesla T	TBA	
	(b) Yokes	Tesla T	TBA	
8	Maximum flux density in iron under the most onerous voltage conditions*			
	at power frequency:			
	(a) Cores	Tesla T	TBA	
	(b) Yokes	Tesla T	TBA	
*either	(a) (load 300 MVA a.f. = 0.8			
	(voltage across MV terminals: 132kV + 7.5%			
	(tap changer on -25.5% tapping			
or	(b) (no load			
	(110% voltage			
	(tap changer on zero tapping			
9	Maximum hot spot temperture in the core at BS rating and under the			
	most onerous voltage conditions at power frequency	°C		
10	Magnetising current (HV winding) at:			
	(a) Rated voltage and normal ratio:			
	approx average amperes			
	(b) 100% of rated voltage and normal ratio:			
	approx average amperes			
11	Current density in winding at 300MVA a.f. 0.8 and nominal voltage			
	132kV at MV terminals			
	(a) HV winding	amp per mm²		
	(b) LV winding	amp per mm²		
12	Maximum current density in windings at 250MVA cos_ = 0.8 amd tap			
	changer on -15% tapping with voltage across HV terminals = 275kV - 5%			
	(a) HV winding	amp per mm²		
	(b) LV winding	amp per mm²		
13	Fixed lossses at normal ration and:			
	(a) CMR, including input ot cooling plant (if any)	kW	82	
	(b) ON AN rating	kW		
14	Load losses at 75°C and normal ratio and:			
	(a) CMR including input to cooling plant (if any)			
	at 0% tap position	kW	922,3	
	at +5% tap position	kW	754,2	
	at -15% tap position	kW	974,7	
	(b) ON AN rating			

	at 0% tap position	kW		
	at +5% tap position	kW		
	at -15% tap position	kW		
15	Efficiency at normal ratio and CMR			
	(a) At unity power factor	%		
	(b) At 0.8 lagging power factor	%		

SECTION 5: PARTICULARS & GUARRANTEES

PART 12.1: PROTECTION & CONTROL EQUIPMENT

SPECIFICATION No: Infranet – PS05-002SZ – Rev 10

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
12A	**SUBSTATION CONTROL SYSTEM**			
	Where has the system, as tendered, been installed in a similar environment?			
	Where may the system, as tendered, be demonstrated?			
12B	**BAY ICAP & CONTROL CUBICLES** (See Section 4 Part 12.1 for general specifications)			
	Height of bay ICAP cubicle	mm	Max 2 100 including kick-flat	
	Height of bay SMMI cubicle	mm	Max 2 400 including kick-flat	
	Width of cubicle	mm	600 to 800	
	Depth of cubicle	mm	700	
	Access to Bay ICAP cubicle		Front door, swing frame	
	Access to Control cubicle			
	Mass of the heaviest, fully equipped cubicle	kg		
	Thickness of sheet steel used for cubicle	mm	2.0	
	General arrangement drawings to be provided for : a) Control/protection cubicle b) Busbar protection cubicle c) Cubicle(s) for SMMI, printer, etc.		 Provide drawing numbers Provide drawing numbers Provide drawing numbers	
	Type of door lock and door latch		Two latches for padlock	
	Type of lamp and fitting for cubicle interior illumination		Edison-type lamp fitting	
	Voltage of cubicle lamp	V	230 AC	
	Type of switch used to control cubicle interior illumination		Door switch	
	Cubicle arranged for bottom cable entry		Yes	
	Mounting height of gland plate	mm	Minimum 200	
	Unobstructed space required above gland plate	mm	Minimum 300	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	Material of which gland plate is made		Sheet steel	
	Thickness of gland plate	mm	Minimum 2.0	
	Gland plate size (area available for cable glands) : a) Length b) Width	 mm mm		
	Access to cable (below cubicles)		Covered inspection hole	
	Size of earth bar fitted : a) Length b) Width c) Thickness	 mm mm mm	 Minimum 30 Minimum 3.5	
	Provision for connecting station earth		Yes	
	Material of which labels are made, size and method of fixing to cubicles : a) Main labels on top of relay/control cubicle suite b) Other designation labels on protection/control cubicles c) Labels for individual items of equipment on cubicles d) Labels for individual items of equipment inside cubicles e) Terminal labels			
	Type and size of lettering a) Main labels on top of relay/control cubicle suite b) Other designation labels on protection/control cubicles c) Labels for individual items of equipment on cubicles d) Labels for individual items of equipment inside cubicles e) Terminal labels			
	Provision for mounting of equipment		Standard 19” rack	
	Name and standard number of paint finish to be applied on cubicle exteriors		Cloud Grey SABS F48	
	Name and standard number of paint finish to be applied on cubicle interiors		Cloud Grey SABS F48, removable back plates white	
12C	**LINE DIFFERENTIAL PROTECTION RELAY**			
	Manufacturer			
	Device name			
	Part ordering code			
	Device supports communication and interrogation by SMMI		Yes	
	Analogue values and detailed device status and operation are uploaded to		Yes	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	the SMMI			
	Communication protocol		DNP 3 level 3 (Parts of), IEC61850, Ethernet	
	Communication medium to SMMI		External to cubicle: optic fibre Internal to cubicle: optic fibre or screened twisted pair copper	
	Device supports complete re-programming of configuration and protection settings via the SMMI and E-LAN		Yes	
	Number of user-definable protection setting groups available on relay		2	
	Device has integral event recording with 1ms accuracy		Yes	
	General device ratings: a) Nominal rated current b) Nominal supply voltage c) Rated frequency d) Tripping mode e) Setting range f) Insulation test voltage g) Impulse test voltage (surge) h) Relay operating time for in-zone fault i) Output relay make and carry for 0,2s j) Output relay carry continuously k) Output relay break (DC) l) Output relay break (AC)	 A AC V DC Hz kV ms A A W VA	 1 110 50 3 phase To suit given system 2 kV for 1 minute 5 5 - 10 30 5 50 (R), 25 (R/L) ($^{L}/_{R}$ = 0,04s) 1250	
	Auxiliary communications channel for transfer trip signalling, with external input activation.		Yes	
	Facility to communicate with remote terminal directly over dedicated single mode optic fibres		Yes	
12D	**TRANSFORMER COMBINED BIASED DIFFERENTIAL, OVER CURRENT EARTH FAULT & RESTRICTED EARTH FAULT PROTECTION RELAY**			
	Manufacturer			
	Device name			
	Part ordering code			
	Device supports communication and interrogation by SMMI		Yes	
	Analogue values and detailed device status and operation are uploaded to the SMMI		Yes	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	Communication protocol		DNP 3 level 3 (Parts of), IEC61850, Ethernet	
	Communication medium to SMMI		External to cubicle: optic fibre Internal to cubicle: optic fibre or screened twisted pair copper	
	Device supports complete re-programming of configuration and protection settings via the SMMI and E-LAN		Yes	
	Number of user-definable protection setting groups available on relay		2	
	Device has integral event recording with 1ms accuracy		Yes	
	General device ratings: a) Nominal rated current b) Nominal supply voltage c) Rated frequency d) Setting range e) Insulation test voltage f) Impulse test voltage (surge) g) Relay operating time for in-zone fault h) Output relay make & carry for 0,2 s i) Output relay carry continuously j) Output relay break (DC) k) Output relay break (AC)	 A AC V DC Hz kV ms A A W VA	 1 110 50 To suit given system 2 kV for 1 minute 5 < 40 30 5 50 (R), 25 (R/L) ($^L/_R$ = 0,04s) 1250	
12E	**275kV AND 132kV LOW IMPEDANCE BUSBAR PROTECTION SCHEME**			
	Manufacturer			
	Device name			
	Part ordering code			
	Device supports communication and interrogation by SMMI			
	Communication protocol		DNP 3 level 3 (Parts of), IEC61850. Ethernet	
	Communication medium to SMMI		External to cubicle: optic fibre Internal to cubicle: optic fibre or screened twisted pair copper	
	Device supports complete re-programming of configuration and protection settings via the SMMI and E-LAN			
	Number of user-definable protection setting groups available on relay			
	Device has integral event recording			

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	with 1ms accuracy			
	General device ratings: a) Nominal rated current b) Nominal supply voltage c) Rated frequency d) Setting range e) Insulation test voltage f) Impulse test voltage (surge) g) Tripping arrangement h) Differential current sensitivity i) Relay operating time for in-zone fault j) Output relay make & carry for 0,2 s k) Output relay carry continuously l) Output relay break (DC) m) Output relay break (AC)	 A AC V DC Hz kV ms A A W VA	 1 110 50 To suit given system 2 kV for 1 minute 5 Individual trip relays, dual trip ccts ± 20 % of nominal rated current 5 - 15 30 5 50 (R), 25 (R/L) ($^{L}/_{R}$ = 0,04s) 1250	
12F	**COMBINED BAYCONTROLLER WITH OVER-CURRENT, STANDBY EARTH FAULT AND EARTH FAULT PROTECTION RELAY/FUNCTION**			
	Manufacturer			
	Device name			
	Part ordering code			
	Device supports communication and interrogation by SMMI		Yes	
	Analogue values and detailed device status and operation are uploaded to the SMMI		Yes	
	Communication protocol		DNP 3 level 3 (Parts of), IEC61850	
	Communication medium to SMMI		External to cubicle: optic fibre Internal to cubicle: optic fibre or screened twisted pair copper	
	Device supports complete re-programming of configuration and protection settings via the SMMI and E-LAN		Yes	
	Number of user-definable protection setting groups available on relay		2	
	Device has integral event recording with 1ms accuracy		Yes	
	Number of control inputs		Minimum 8	
	Number of control outputs		Minimum 5	
	Default display analogue values can be selected		Yes	
	General device ratings: a) Nominal rated current	 A AC	 1	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	b) Nominal rated voltage	V AC	110	
	c) Nominal supply voltage	V DC	110	
	d) Rated frequency	Hz	50	
	e) Setting range		To suit given system	
	f) Insulation test voltage		2 kV for 1 minute	
	g) Impulse test voltage (surge)	kV	5	
	h) Output relay make & carry for 0,2 s	A	30	
	i) Output relay carry continuously	A	5	
	j) Output relay break (DC)	W	50 (R), 25 (R/L) ($^L/_R$ = 0,04s)	
	k) Output relay break (AC)	VA	1250	
12G	**DISTANCE PROTECTION RELAY**			
	Manufacturer			
	Device name			
	Part ordering code			
	Device supports communication and interrogation by SMMI		Yes	
	Analogue values and detailed device status and operation are uploaded to the SMMI		Yes	
	Communication protocol		DNP 3 level 3 (Parts of), IEC61850	
	Communication medium to SMMI		External to cubicle: optic fibre Internal to cubicle: optic fibre or screened twisted pair copper	
	Device supports complete re-programming of configuration and protection settings via the SMMI and E-LAN		Yes	
	Number of user-definable protection setting groups available on relay		2	
	Device has integral event recording with 1ms accuracy		Yes	
	General device ratings:			
	a) Nominal rated current	A AC	1	
	b) Nominal supply voltage	V DC	110	
	c) Rated frequency	Hz	50	
	d) Setting range		To suit given system	
	e) Insulation test voltage		2 kV for 1 minute	
	f) Impulse test voltage (surge)	kV	5	
	g) Output relay make & carry for 0,2 s	A	30	
	h) Output relay carry continuously	A	5	
	i) Output relay break (DC)	W	50 (R), 25 (R/L) ($^L/_R$ = 0,04s)	
	j) Output relay break (AC)	VA	1250	
12H	**TRANSFORMER VOLTAGE REGULATING RELAY**			

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	Manufacturer			
	Device name			
	Part ordering code			
	Device supports communication and interrogation by SMMI		Yes	
	Analogue values and detailed device status and operation are uploaded to the SMMI		Yes	
	Communication protocol		DNP 3 level 3 (Parts of), IEC61850, Ethernet	
	Communication medium to SMMI		External to cubicle: optic fibre Internal to cubicle: optic fibre or screened twisted pair copper	
	Device supports complete re-programming of configuration and protection settings via the SMMI and E-LAN		Yes	
	Device has integral event recording with 1 ms accuracy		Yes	
	General device ratings:			
	a) Nominal rated current	A AC	1	
	b) Nominal supply voltage	V DC	110	
	c) Rated frequency	Hz	50	
	d) Setting range		To suit given system	
	e) Insulation test voltage		2 kV for 1 minute	
	f) Impulse test voltage (surge)	kV	5	
	g) Output relay make & carry for 0,2 s	A	30	
	h) Output relay carry continuously	A	5	
	i) Output relay break (DC)	W	50 (R), 25 (R/L) ($^L/_R$ = 0,04s)	
	j) Output relay break (AC)	VA	1250	
12I	**SYNCHRONISM CHECK RELAY**			
	Manufacturer			
	Device name			
	Part ordering code			
	Device supports communication and interrogation by SMMI		Yes	
	Analogue values and detailed device status and operation are uploaded to the SMMI		Yes	
	Communication protocol		DNP 3 level 3 (Parts of), IEC61850, Ethernet	
	Communication medium to SMMI		External to cubicle: optic fibre Internal to cubicle: optic fibre or screened twisted pair copper	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	Device supports complete re-programming of configuration and settings via the SMMI and E-LAN		Yes	
	Device has integral event recording with 1 ms accuracy		Yes	
	General device ratings:			
	a) Nominal rated voltage	V AC	110	
	b) Nominal supply voltage	V DC	110	
	c) Rated frequency	Hz	50	
	d) Insulation test voltage		2 kV for 1 minute	
	e) Impulse test voltage (surge)	kV	5	
	f) Output relay make & carry for 0,2 s	A	30	
	g) Output relay carry continuously	A	5	
	h) Output relay break (DC)	W	50 (R), 25 (R/L) ($^L/_R$ = 0,04s)	
	i) Output relay break (AC)	VA	1250	
12J	**AUTOMATIC RECLOSE RELAY**			
	Manufacturer			
	Device name			
	Part ordering code			
	Device supports communication and interrogation by SMMI		Yes	
	Analogue values and detailed device status and operation are uploaded to the SMMI		Yes	
	Communication protocol		DNP 3 level 3 (Parts of), IEC61850, Ethernet	
	Communication medium to SMMI		External to cubicle: optic fibre Internal to cubicle: optic fibre or screened twisted pair copper	
	Device supports complete re-programming of configuration and settings via the SMMI and E-LAN		Yes	
	Device has integral event recording with 1 ms accuracy		Yes	
	General device ratings:			
	a) Nominal rated voltage	V AC	110	
	b) Nominal supply voltage	V DC	110	
	c) Rated frequency	Hz	50	
	d) Insulation test voltage		2 kV for 1 minute	
	e) Impulse test voltage (surge)	kV	5	
	f) Output relay make and carry for 0,2s	A	30	
	g) Output relay carry continuously	A	5	
	h) Output relay break (DC)	W	50 (R), 25 (R/L) ($^L/_R$ = 0,04s)	
	i) Output relay break (AC)	VA	1250	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	The relay shall have the following time settings: a) Close pulse b) Dead time 1 c) Dead time 2 d) Dead time 3 and 4 e) Reclaim time	 s s s s s	 0,1 to 2 0,25 to 180 1 to 180 10 to 200 1 to 180	
12K	**POWER FACTOR CORRECTION RELAY**			
	Manufacturer			
	Device name			
	Part ordering code			
	Device supports communication and interrogation by SMMI		Yes	
	Analogue values and detailed device status and operation are uploaded to the SMMI		Yes	
	Communication protocol		DNP 3 level 3 (Parts of), IEC61850	
	Communication medium to SMMI		External to cubicle: optic fibre Internal to cubicle: optic fibre or screened twisted pair copper	
	Device supports complete re-programming of configuration and protection settings via the SMMI and E-LAN		Yes	
	a) Number of user-definable protection setting groups available on relay		2	
	Device has integral event recording with 1ms accuracy		Yes	
	Number of control inputs		Minimum 8	
	Number of control outputs		Minimum 5	
	Default display analogue values can be selected		Yes	
	General device ratings: l) Nominal rated current m) Nominal rated voltage n) Nominal supply voltage o) Rated frequency p) Setting range q) Insulation test voltage r) Impulse test voltage (surge) s) Output relay make & carry for 0,2 s t) Output relay carry continuously u) Output relay break (DC)	 A AC V AC V DC Hz kV A A W	 1 110 110 50 To suit given system 2 kV for 1 minute 5 30 5 50 (R), 25 (R/L) ($^{L}/_{R}$ = 0,04s)	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	a) Output relay break (AC)	VA	1250	
12N	**INTER-TRIP RECEIVE REPEAT RELAYS**			
	Manufacturer			
	Device name			
	Part ordering code			
	General device ratings: a) Nominal supply voltage b) Rated frequency c) Insulation test voltage d) Impulse test voltage (surge) e) Output relay make & carry for 0,2 s f) Output relay carry continuously g) Output relay break (DC) h) Output relay break (AC) i) Operating time	 V DC Hz kV A A W VA ms	 110 50 2 kV for 1 minute 5 30 5 50 (R), 25 (R/L) ($^L/_R$ = 0,04s) 1250 < 10	
12O	**BAY CONTROLLER (BYC)**			
	Manufacturer			
	Device name			
	Part ordering code			
	Number of events which may be stored on the BYC			
	Memory available for programs			
	Estimated memory required for this implementation (worst case)			
	Number of primary elements status which may be presented on the on-board mimic display		7	
	Number of primary elements which may be controlled by the on-board mimic display		7	
	General device ratings: a) Nominal supply voltage b) Insulation test voltage c) Impulse test voltage (surge) d) Output relay make & carry for 0,2 s e) Output relay carry continuously f) Output relay break (DC) g) Output relay break (AC)	 V DC kV A A W VA	 110 2 kV for 1 minute 5 30 5 50 (R), 25 (R/L) ($^L/_R$ = 0,04s) 1250	
12P	**POWER QUALITY METER**			
	Manufacturer			
	Device name			
	Part ordering code			
	Device supports communication and interrogation by SMMI		Yes	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	Detailed device status and operation are uploaded to the SMMI		Yes	
	Communication protocol		DNP 3 level 3 (Parts of), IEC61850	
	Communication medium to SMMI		External to cubicle: optic fibre Internal to cubicle: optic fibre or screened twisted pair copper	
	Device supports complete re-programming of configuration and Settings via the SMMI and E-LAN		Yes	
	Device has integral event recording with 1ms accuracy		Yes	
	Default display analogue values can be selected		Yes	
	General device ratings: a) Nominal supply voltage b) Insulation test voltage c) Impulse test voltage (surge)	 V DC kV	 110 2 kV for 1 minute 5	
12Q	**TEST TERMINALS**			
	Manufacturer			
	Device name			
	Part ordering code			
12R	**LOW RESOLUTION DISTURBANCE RECORDER (PREFERABLY INTEGRAL TO COMBINED OVER-CURRENT & EARTH FAULT PROTECTION RELAY)**			
	Manufacturer and model			
	Number of binary inputs		Minimum 8 general inputs	
	Number of analogue inputs		Minimum 4	
	Disturbance recorder sampling rate	Hz	400	
	Disturbance recorder recording bandwidth			
	Over- and under-current triggering		Yes	
	Over- and under-voltage triggering		Yes	
	Pre-fault time	ms		
	Post-fault time	ms		
	Limit time	ms		
	Number of stored disturbance records			
	Voltage channels a) Dynamic range b) Resolution c) Accuracy			

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	Voltage channels a) Dynamic range without DC offset b) Dynamic range with full DC offset c) Resolution d) Accuracy			
	Minimum total disturbance recording time with 10 analogue and 48 digital signals recorded			
	Built-in clock/calendar, setable via substation network			
12S	**MEDIUM RESOLUTION DISTURBANCE RECORDER**			
	Manufacturer and model			
	Number of binary inputs			
	Number of analogue inputs			
	Sampling rate	Hz	1 kHz effective, fixed	
	Recording bandwidth	Hz	5 - 300	
	Over- and under-current triggering		(0.00 to 50) x I_r	
	Over-voltage triggering		(1.00 to 2.00) x U_r	
	Under-voltage triggering		(1.00 to -1.00) x U_r	
	Pre-fault time	ms	50 to 300	
	Post-fault time	ms	100 to 3000	
	Limit time	ms	2 000 to 5 000	
	Number of recorder disturbances		Minimum 10, fixed	
	Voltage channels a) Dynamic range b) Resolution c) Accuracy		 (0.1 to 110) x U_r 0.1% ≤ 2.5% x U_r	
	Current channels dynamic range a) Without DC offset b) With full DC offset c) Resolution d) Accuracy		 (0.01 to 110) x I_r (0.01 to 60) x I_r 0.1% x I_n ≤ 2.5% x I_n	
	Minimum total recording time with 10 analogue and 48 digital signals recorded	s	10	
	Built-in clock/calenar		For 30 years with leap years	
12T	**SUBSTATION CONTROL COMPUTER**			
	Processor		NX9420 Intel® Core™ Duo T2600 2.16GHz 667FSB 2048K Processor	
	Motherboard and auxiliary cards		Energy Star compliant Industrial type	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	Case and power supply		19” rack mount	
	IP rating of case, all equipment installed			
	Monitor		17”	
	Hard disk drive		Dual mirrored hard disk drives, at least 200 Gb formatted capacity	
	Random access memory (RAM)		2048kb	
	Mouse		Optical	
	Printer		Laser auto feed paper	
	Keyboard		101 key QWERTY keyboard with dust-proof interchangeable membrane cover	
	Connectors		Non-corrosive Gold-plated	
	MTBF: a) Motherboard b) Auxiliary cards c) Power supply d) Monitor e) Hard disk drive f) DVD ROM writer			
	Operating system			
	MMI application software			
	a)			
	b)			
	Interlocking programming software			
	Engineering software			
	Other software packages required to allow complete user configuration and setting : a) b) c) d) e)			
	Global positioning system for accurate time synchronisation			
	Control computer and peripherals power supply unit			
	Supply standby time in event of AC supply failure	h	8.0	
	Facility on Computer to automatically shut down the monitor		Yes	
	Trending data archiving facilities for later retrieval		Yes	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	Number of cubicles			
	Size of cubicle(s)			
	Description of cubicle(s)			
	Cubicle(s) fan and filter		Accessible for service personnel	
	Installation position of substation control computer			
	Number of control module inputs			
	Number of control module outputs			
	Inputs for time synchronisation			
	Total system boot up time after emergency power-down			
12U	**SUBSTATION NETWORK AND COMMUNICATION EQUIPMENT**			
	Substation local network a) Architecture b) Redundancy at network supervisor level c) Power supply redundancy d) Route redundancy		Provide network architecture drawing	
	Method of connection to SCADA system			
	Remote engineering workstation connection			
	Communications protocols : a) Substation LAN (S-LAN) b) Engineering LAN (E-LAN) c) SCADA		IEC61850, ETHERNET, DNP 3 level 3 as specified	
	Network communication medium : a) Substation LAN (S-LAN) b) Engineering LAN (E-LAN)		Optic Fibre, ETHERNET RG-58 coaxial cable	
12V	**OPTIC FIBRES**			
	Optic fibres for connection of equipment to OPGW		Single Mode (SM) Armoured cable	
	Optic fibre connectors for connection to patch panels		ST-type	
	Optic Fibre for S-LAN		Armoured where installed in trench	

SECTION 5: PARTICULARS & GUARANTEES

PART 13.1: LV AC CHANGE-OVER & DB'S

j

SPEC NO:

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	Low Voltage Alternating Current Wall Mounted Panel			
1	Applicable Standards :			
1,1	Board according to drawings C			
1,2	Breakers			
2	Size of board h x w x d	mm	735 x 1300 x	
3	Mass of board	kg		
4	Mounting		Wall	
5	Protection class			
6	Make of :			
6,1	auto changeover switch			
6,2	supervision relay / type			
6,3	MCB's			
6,4	terminals		KLIPPON RSFI or equivalent	
7	Sheet steel cubicle manufacturer			
8	Sheet steel, thickness	mm	2	
9	Number x ratings of MCB's :			
9,1				
9,2				
9,3				
9,4				
9,5				
9,6				
10	Continuous current rating of incomers and busbars	A	200	
11	Short time rating, 3 second	kA	5	
12	Section of busbars (mm by mm)	mm^2		
13	Busbar material			
14	Number of separate gland plates		13	
15	Gland plate size			
16	Paint finish required		Cloud grey F48 to SABS 1091 1975	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
			Numsell ref. 2.5 PB 7,5/2	

SECTION 5: PARTICULARS & GUARRANTEES

PART 13.2: BATTERY CHARGER & DC DB

SPEC NO:

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	Battery Charger Unit with Distribution Board			
1	**BATTERY CHARGERS**			
1.1	Is a DC distribution board to be supplied?		Yes (See A1)	
1.2	Application for which chargers are required		Floating and trickle charging of station batteries	
1.3	Type of load connected		Relays, control modules, instruments, indications, solenoids, motors,	
1.4	Are chargers to operate in		No	
1.5.1	Type of battery and number of cells for which charger is required		52 lead-acid cells	
1.5.2	Amp hour ratings	AH	352AH @ 10Hr	
1.5.3	Specific Gravity		1.250 @ 25 C	
1.6	Nominal battery voltage	V	110	
1.7	Type of battery chargers		Rectifier, automatic	
1.8	AC supply :			
1.8.1	Number of phases		Three or single-phase	
1.8.2	Nominal AC supply voltage	V	400/230	
1.8.3	Nominal system frequency	Hz	50	
1.9	Limits of AC supply variations expressed as a percentage of nominal values of 400/231 V AC :			
1.9.1	Maximum supply voltage	%	110	
1.9.2	Minimum supply voltage	%	90	
1.9.3	Variation in system frequency	%	2	
1.10	Insulation material used on transformer windings			
1.11	Insulation class		-	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
1.12	Is an earthed shield provided between primary and secondary windings?		-	
1.13	Transformer nominal primary	V	-	
1.14	Transformer nominal secondary voltage	V	-	
1.15	Voltage ratio of transformer on :			
1.15.1	Principal tap		-	
1.15.2	Tap		-	
1.15.3	Tap		-	
1.15.4	Tap		-	
1.16	Is a centre tap secondary winding employed?		-	
1.17	VA rating of transformers	VA	-	
1.18	Type of rectifier element used (i.e. rectifying diode, thyristor etc.)			
1.19	Rectifier rated current as a percentage of the designated circuit current	%	300 minimum	
1.2	Material of which rectifier element(s) are made		Silicon	
1.21	Connection arrangement of rectifier elements (i.e. bridge,		-	
1.22	Forward voltage rating of rectifier element	V	-	
1.23	Maximum working peak inverse voltage or rectifier element	V	-	
1.24	Maximum continuous forward current of rectifier element	A	-	
1.25	Maximum peak forward current of rectifier element	A		
1.26	Leakage current of rectifier	A		
1.27	Type and method of surge suppression employed			
1.28	Maximum 1/50 micro-second lightning impulse voltage that charger will withstand	kV (peak)		
1.29	Maximum 1/2 000 micro-second lightning impulse voltage that charger will withstand	kV (peak)	-	
1.3	Maximum over voltage that charger will withstand for 0,5	V	-	
1.31	Type of voltage regulator used and principle of operation			

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
1.32	Type of voltage / current sensing element used (transductor, transistor, etc.)			
1.33	Type of regulation element used (thyristor, transistor, etc.)			
1.34	Limits of voltage regulation (expressed as a percentage of no-load output voltage with nominal input with nominal input voltage supplied) with :			
1.34.1	Nominal input voltage at full load	%	-	
1.34.2	90% nominal input voltage at :			
	a) No load	%	-	
	b) Full load	%	-	
1.34.3	110% nominal input voltage at :			
	a) No load	%	-	
	b) Full load	%	-	
1.35	Is constant output voltage			
1.36	Limits of adjustment of output voltage:			
1.36.1	Maximum output voltage	V	132,0	
1.36.2	Minimum output voltage	V	101,75	
1.37	Output voltage setting for supplying the load and battery specified under 1 and 2 above	V	123,75	
1.38	Maximum ripple voltage peak-to-peak when :	%	0.4	
1.38.1	Battery disconnected no-load	mV		
1.38.2	Battery connected no-load	mV		
1.38.3	Battery connected, charger delivery maximum output current	A		
1.39	Limit of electromagnetic interference level	dB(A)	20	
1.40	Rated output current of charger	A		
1.41	Maximum output current for :			
1.41.1	float charge	A		
1.41.2	boost charge	A		
1.41.3	equilize charge	A		
1.41.4	initial charge	A		
1.41.5	No. of output circuits			
	a) 20A		10	
	b) 10A		8	
1.41.6	Maximum output current into short circuit	A		
1.42	Method of current limiting			

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
1.43	Output current of charger at nominal voltage when supplying load plus discharged battery	A		
1.44	Time taken to recharge battery under condition 3.42 above	h	< 24 hours	
1.45	Type of protection and setting provided on input side			
1.46	Type of protection and setting provided on output			
1.47	Means of isolation on input side			
1.48	Means of isolating load from			
1.49	Type of charger fail protection			
1.5	Type of undervoltage relay			
1.51	Type of earth relay			
1.52	Voltage setting range undervoltage relay	V		
1.53	Current consumption of :			
1.53.1	Undervoltage relay	mA		
1.53.2	Associated alarm equipment	mA		
1.54	Minimum leakage current required to operate earth fault relay	mA		
1.55	Principle and type of earth fault		-	
1.56	Current consumption of earth fault alarm	mA		
1.57	Type of ammeter used to indicate charger output		Analogue Prefered	
1.58	Length of ammeter scale and angle of deflection	mm/ degs		
1.59	Type of voltmeter used to indicate battery terminal voltage		Analogue Prefered	
1.6	Length of voltmeter scale and angle of deflection	mm/ degs		
1.61	Are boost charging facilities provided on charger?		Manual/SCADA	
1.62	Earthing arrangement		Battery centre tap earthed through high resistance	
1.63	Method of indicating abnormal operating conditions		Both visual and audible	
1.64	Is a test facility for LEDs required?		Yes	
1.65	Are alarm indications to remain until manually reset?		Yes	
1.66	Audible alarm requirements		By beeper	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
1.67	Type of alarm display required orproposed by the supplier, e.g.LCD, VDUs, print-outsSupervisory alarms and indicatorsrequired(Listed as a, b,		As proposed by supplier	
1.67.1	(a) number of alarm changeover contacts required		One	
1.67.2	(b) type of contacts		N/C N/O	
1.67.3	(c) rating of contacts		5A/DC	
1.67.4	Supervisory alarms and indicatorsrequired(Listed as a, b, c, etc., of clause 4.3.13)		a, b, c, f, g, J, n	
1.68	Overall dimensions of cubicle :			
1.68.1	Overall height	mm	1 950 maximum	
1.68.2	Overall length	mm	900 maximum	
1.68.3	Overall depth	mm	600 maximum	
1.69	Type of cubicle		Free standing floor mounted over cable duct	
1.70	Width of cable duct	mm	300 to 400	
1.71	Position of cable duct		Nearest edge 500 mm from back	
1.72	Position of cable entry		bottom	
1.73	Position of cable gland plate		bottom	
1.74	Maximum number of 4mm2/2-core PVC insulated wire-armoured cables that can be accommodated on a cable gland plate section			
1.75	Number of removable gland plate sections			
1.76	Dimensions of a single gland plate section	mm	-	
1.77	Type of access to charger for maintenance:		lift-off hinged door	
1.77.1	Front, rear, side or all		front	
1.78	Is enclosure to be lockable?		Yes	
1.79	Is forced ventilation acceptable?		No	
1.80	Thickness of sheet steel of which cubicle is made	mm	2	
1.81	Mass of cubicle with charging equipment	kg	-	
1.82	Finish of cubicle		Cloud Grey F48 to SABS 1091 of 1975	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
1.83	Is reversed battery connectionprotection required?If YES, details of protectionmethod.		Yes	
1.84	Which unusual service conditionsapply (list a, b, etc.)?		b, j, l, q, s	
1.85	Type tests required (list (a), (b),(c), etc., as detailed in the text)		b, c, d, f, g, j	
1.86	Other routine tests required		a, b, c, d	
2	**DC DISTRIBUTION BOARD**		Separate wall mounted unit	
2.1	Minimum size of copper conductor between battery/charger unit and DC distribution board	sq. mm	25	
2.2	Size of DC busbars			
2.3	Busbar material			
2.4	Conductor type and size of outgoing cables		2 core 4 sq mm Cu PVC SWA	
2.5	Number of poles and rating of main incoming moulded case circuit-breaker on distribution		Double pole 80 A DC minimum	
2.6	Current rating of double pole moulded case circuit breakers to be provided on distribution board for outgoing circuits			
2.7	Type and rating of MCB for			
2.8	Type and rating of MCB for		20 A - DC	
2.9	Number of circuit-breakers to be provided for immediate use on each busbar circuit :		10 A - DC	
2.9.1	20 A		10	
2.9.2	10 A		8	
2.10	Number of blank labels to be provided on distribution board for outgoing DC circuits on each		10	
2.11	Number of spare outlet circuit-breakers to be provided for future use		0	
2.12	Current rating of MCB's for spare outlets		N/A	
2.13	Dimensions of DC distribution board h x w x d	mm		

SECTION 5:   PARTICULARS & GUARRANTEES

PART 13.2:   BATTERY CHARGER & DC DB

SPEC NO:

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	Battery Charger Unit with Distribution Board			
1	**BATTERY CHARGERS**			
1,1	Is a DC distribution board to be supplied?		Yes (See A1)	
1,2	Application for which chargers are required		Floating and trickle charging of station batteries	
1,3	Type of load connected		Relays, control modules, instruments, indications, solenoids, motors,	
1,4	Are chargers to operate in		No	
1.5.1	Type of battery and number of cells for which charger is required		52 lead-acid cells	
1.5.2	Amp hour ratings	AH	352AH @ 10Hr	
1.5.3	Specific Gravity		1.250 @ 25 C	
1,6	Nominal battery voltage	V	110	
1,7	Type of battery chargers		Rectifier, automatic	
1,8	AC supply :			
1.8.1	Number of phases		Three or single-phase	
1.8.2	Nominal AC supply voltage	V	400/230	
1.8.3	Nominal system frequency	Hz	50	
1,9	Limits of AC supply variations expressed as a percentage of nominal values of 400/231 V AC :			
1.9.1	Maximum supply voltage	%	110	
1.9.2	Minimum supply voltage	%	90	
1.9.3	Variation in system frequency	%	2	
1,10	Insulation material used on transformer windings			
1,11	Insulation class		-	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
1,12	Is an earthed shield provided between primary and secondary windings?		-	
1,13	Transformer nominal primary	V	-	
1,14	Transformer nominal secondary voltage	V	-	
1,15	Voltage ratio of transformer on :			
1.15.1	Principal tap		-	
1.15.2	Tap		-	
1.15.3	Tap		-	
1.15.4	Tap		-	
1,16	Is a centre tap secondary winding employed?		-	
1,17	VA rating of transformers	VA	-	
1,18	Type of rectifier element used (i.e. rectifying diode, thyristor etc.)			
1,19	Rectifier rated current as a percentage of the designated circuit current	%	300 minimum	
1,2	Material of which rectifier element(s) are made		Silicon	
1,21	Connection arrangement of rectifier elements (i.e. bridge,		-	
1,22	Forward voltage rating of rectifier element	V	-	
1,23	Maximum working peak inverse voltage or rectifier element	V	-	
1,24	Maximum continuous forward current of rectifier element	A	-	
1,25	Maximum peak forward current of rectifier element	A		
1,26	Leakage current of rectifier	A		
1,27	Type and method of surge suppression employed			
1,28	Maximum 1/50 micro-second lightning impulse voltage that charger will withstand	kV (peak)		
1,29	Maximum 1/2 000 micro-second lightning impulse voltage that charger will withstand	kV (peak)	-	
1,3	Maximum over voltage that charger will withstand for 0,5	V	-	
1,31	Type of voltage regulator used and principle of operation			

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
1,32	Type of voltage / current sensing element used (transductor, transistor, etc.)			
1,33	Type of regulation element used (thyristor, transistor, etc.)			
1,34	Limits of voltage regulation (expressed as a percentage of no-load output voltage with nominal input with nominal input voltage supplied) with :			
1.34.1	Nominal input voltage at full load	%	-	
1.34.2	90% nominal input voltage at :			
	a) No load	%	-	
	b) Full load	%	-	
1.34.3	110% nominal input voltage at :			
	a) No load	%	-	
	b) Full load	%	-	
1,35	Is constant output voltage			
1,36	Limits of adjustment of output voltage:			
1.36.1	Maximum output voltage	V	132,0	
1.36.2	Minimum output voltage	V	101,75	
1,37	Output voltage setting for supplying the load and battery specified under 1 and 2 above	V	123,75	
1,38	Maximum ripple voltage peak-to-peak when :	%	0,4	
1.38.1	Battery disconnected no-load	mV		
1.38.2	Battery connected no-load	mV		
1.38.3	Battery connected, charger delivery maximum output current	A		
1,39	Limit of electromagnetic interference level	dB(A)	20	
1,40	Rated output current of charger	A		
1,41	Maximum output current for :			
1.41.1	float charge	A		
1.41.2	boost charge	A		
1.41.3	equilize charge	A		
1.41.4	initial charge	A		
1.41.5	No. of output circuits			
	a) 20A		10	
	b) 10A		8	
1.41.6	Maximum output current into short circuit	A		
1,42	Method of current limiting			

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
1,43	Output current of charger at nominal voltage when supplying load plus discharged battery	A		
1,44	Time taken to recharge battery under condition 3.42 above	h	< 24 hours	
1,45	Type of protection and setting provided on input side			
1,46	Type of protection and setting provided on output			
1,47	Means of isolation on input side			
1,48	Means of isolating load from			
1,49	Type of charger fail protection			
1,5	Type of undervoltage relay			
1,51	Type of earth relay			
1,52	Voltage setting range undervoltage relay	V		
1,53	Current consumption of :			
1.53.1	Undervoltage relay	mA		
1.53.2	Associated alarm equipment	mA		
1,54	Minimum leakage current required to operate earth fault relay	mA		
1,55	Principle and type of earth fault		-	
1,56	Current consumption of earth fault alarm	mA		
1,57	Type of ammeter used to indicate charger output		Analogue Prefered	
1,58	Length of ammeter scale and angle of deflection	mm/ degs		
1,59	Type of voltmeter used to indicate battery terminal voltage		Analogue Prefered	
1,6	Length of voltmeter scale and angle of deflection	mm/ degs		
1,61	Are boost charging facilities provided on charger?		Manual/SCADA	
1,62	Earthing arrangement		Battery centre tap earthed through high resistance	
1,63	Method of indicating abnormal operating conditions		Both visual and audible	
1,64	Is a test facility for LEDs required?		Yes	
1,65	Are alarm indications to remain until manually reset?		Yes	
1,66	Audible alarm requirements		By beeper	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
1,67	Type of alarm display required orproposed by the supplier, e.g.LCD, VDUs, print-outsSupervisory alarms and indicatorsrequired(Listed as a, b,		As proposed by supplier	
1.67.1	(a) number of alarm changeover contacts required		One	
1.67.2	(b) type of contacts		N/C N/O	
1.67.3	(c) rating of contacts		5A/DC	
1.67.4	Supervisory alarms and indicatorsrequired(Listed as a, b, c, etc., of clause 4.3.13)		a, b, c, f, g, J, n	
1,68	Overall dimensions of cubicle :			
1.68.1	Overall height	mm	1 950 maximum	
1.68.2	Overall length	mm	900 maximum	
1.68.3	Overall depth	mm	600 maximum	
1,69	Type of cubicle		Free standing floor mounted over cable duct	
1,70	Width of cable duct	mm	300 to 400	
1,71	Position of cable duct		Nearest edge 500 mm from back	
1,72	Position of cable entry		bottom	
1,73	Position of cable gland plate		bottom	
1,74	Maximum number of 4mm2/2-core PVC insulated wire-armoured cables that can be accommodated on a cable gland plate section			
1,75	Number of removable gland plate sections			
1,76	Dimensions of a single gland plate section	mm	-	
1,77	Type of access to charger for maintenance:		lift-off hinged door	
1.77.1	Front, rear, side or all		front	
1,78	Is enclosure to be lockable?		Yes	
1,79	Is forced ventilation acceptable?		No	
1,80	Thickness of sheet steel of which cubicle is made	mm	2	
1,81	Mass of cubicle with charging equipment	kg	-	
1,82	Finish of cubicle		Cloud Grey F48 to SABS 1091 of 1975	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
1,83	Is reversed battery connectionprotection required?If YES, details of protectionmethod.		Yes	
1,84	Which unusual service conditionsapply (list a, b, etc.)?		b, j, l, q, s	
1,85	Type tests required (list (a), (b),(c), etc., as detailed in the text)		b, c, d, f, g, j	
1,86	Other routine tests required		a, b, c, d	
2	**DC DISTRIBUTION BOARD**		Separate wall mounted unit	
2,1	Minimum size of copper conductor between battery/charger unit and DC distribution board	sq. mm	25	
2,2	Size of DC busbars			
2,3	Busbar material			
2,4	Conductor type and size of outgoing cables		2 core 4 sq mm Cu PVC SWA	
2,5	Number of poles and rating of main incoming moulded case circuit-breaker on distribution		Double pole 80 A DC minimum	
2,6	Current rating of double pole moulded case circuit breakers to be provided on distribution board for outgoing circuits			
2,7	Type and rating of MCB for			
2,8	Type and rating of MCB for		20 A - DC	
2,9	Number of circuit-breakers to be provided for immediate use on each busbar circuit :		10 A - DC	
2.9.1	20 A		10	
2.9.2	10 A		8	
2,10	Number of blank labels to be provided on distribution board for outgoing DC circuits on each		10	
2,11	Number of spare outlet circuit-breakers to be provided for future use		0	
2,12	Current rating of MCB's for spare outlets		N/A	
2,13	Dimensions of DC distribution board h x w x d	mm		

SECTION 5: PARTICULARS

PART 13.3: BATTERY 110V & STAND

SPEC NO:

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	110V Batteries and Battery Stands			
1	**GENERAL INFORMATION**			
1,1	Scope of supply		2 batteries banks with 2 chargers and dual distribution boards	
1,2	Duration of peak current loading	sec	1,0 sec	
1,3	Location of batteries		Battery room	
1,4	Battery stand or a battery cabinet?		Battery stand	
1,5	Battery stand material			
1,6	Battery stand Drawing number			
1,7	Battery designation(s)		Protection batteries	
1,8	Particulars of load connected to battery/charger unit busbars			
1,9	Battery deterioration factor		0,8	
1,10	Battery capacity required	A-h	>110	
1,11	Maximum peak current to be supplied by battery / charger unit at any time	A	80 minimum	
2	**BATTERIES**			
2,1	Purpose for which batteries are required		Station/protection batteries	
2,2	Capacity range of battery		Medium capacity	
2,3	Type of operating duty		Protection stationary	
2,4	Period of discharge	hours	8	
2,5	Battery charging mode and duty (BS 440 Clause 2.15)		Float trickle charge	
2,6	Number of batteries		2	
2,7	Nominal voltage of battery	V	110	
2,8	Number of cells in battery		52	
2,9	Type of cell		Lead acid	
2,10	Type of plate		Plante	
2,11	Type of plate construction (e.g. flat plate, pasted plate, tubular plate)			
2,12	Number of plates in cell			

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
2,13	Material of which plate straps are made		-	
2,14	Type of plate separator and material of which separator is made		-	
2,15	Method of supporting element in jar		-	
2,16	Clearance between plates and bottom of jar	mm	-	
2,17	Material of which jar or container is made		-	
2,18	Is jar transparent?		Preferred	
2,19	Overall dimensions of jar :			
2.19.1	Height	mm	-	
2.19.2	Width	mm	-	
2.19.3	Depth	mm	-	
2,20	Overall height of cell including vent and terminal post	mm	-	
2,21	Cell centre distance	mm	-	
2,22	Approximate quantity of electrolyte in cell at 25øC	litres	-	
2,23	Height of electrolyte above plates:	mm		
2,24	Total mass of cell complete with electrolyte	kg	-	
2,25	Rating of positive plates (see BS 440 Clause 5)	A-h	-	
2,26	Ampere-hour rating of battery at 25C on 8-hour discharge period	A-h	To be determined by the Tenderer (>350)	
2.26.1	Estimated continuous load :			
	a) Total continuous discharge current including inverter (including all filter and present equipment)	A	To be determined by the tenderer for his specific equipment	
	b) Allow 30% safety factor of estimated load	A-h	- do -	
	c) Battery capacity required to supply continuous loads	A-h	- do -	
2.26.2	Estimated intermittent loads over a 10-hour period :			
	a) Intermittent load	A-h	- do -	
	b) Average of total intermittent load over 8 hours on battery	A-h	- do -	
2.26.3	TOTAL DRAIN EFFECT ON BATTERY	A-h		
2,27	Battery voltage when fully charged	V DC		
2,28	Battery voltage at 25C on 8-hour discharge at rated 8-hour current	V DC		
2.28.1	Operation voltages :			
	a) Discharged	V/cell	1,85 minimum	
	b) Normal float	V/cell	2,24	

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	c) Boost charge	V/cell		
2.29.1	Internal resistance of battery at 25C when fully charged (new condition) :			
2.29.2	Per cell	milli-ohms	-	
2,29	Complete battery	milli-ohms	-	
2,30	Ampere-hour efficiency of battery when new	%	-	
2,31	Watt-hour efficiency of battery when new	%	-	
2,32	Maximum recommended charging current	A	-	
2,33	Minimum trickle charging current to keep battery fully charged	A	-	
2,34	Life expectancy of battery assuming maintenance is carried out in accordance with manufacturer's recommendation	Years	20	
2,35	Guarantee period of battery only	Years	-	
2,36	Battery manufactured by		-	
2,37	Place and country of manufacture		-	
2,38	Make type / model number of cell		-	
2,39	What accessories are to be supplied with battery:			
2.39.1	Intercell connections		Yes	
2.39.2	Instruction card		Yes	
2.39.3	Maintenance record book		Yes	
2.39.4	Hydrometers		No	
2.39.5	Cell voltmeter		No	
2.39.6	Electrolyte test tube		No	
2.39.7	Electrolyte thermometer		No	
2.39.8	Cell bridging connector		Yes	
2.39.9	Additional electrolyte		No	
2.39.1(	Distilled water		No	
2,40	In what condition is battery to be supplied?		Fully charged	
2,41	Recommended maintenance program - Description number			
3	**BATTERY STAND**			
3,1	Material of Stand		Wood/Plastic	

SECTION 4 : SPECIFICATION

PART 14.1 :

STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS

ISSUED BY:	
The General Manager Water & Sanitation P O Box 1022 PRETORIA 0001	The General Manager Roads & Stormwater P O Box 1409 PRETORIA 0001

DOCUMENT CAN BE DOWNLOADED FROM CITY OF TSHWANE WEBSITE

ITEM NO	DESCRIPTION	SPECIFIED REQUIREMENTS	OFFERED AND GUARANTEED	
14,1	**CIVIL WORKS**		YES	NO
	All Civil works must adhere to City of Tshwane metropolitan municipality standard specifications for municipal civil engineering works and National Building Regulations form part of the specification.			No will lead to disqualification.
14.1	All Civil works mentioned in scope of work and bill of quantities including and not limited to : new parapit walls,all roof trusses and assosiated roofing to be of metal (Steel) type,foundations ect. Will be approved by sighned off by ECSA registered Civil / structural engineer that the Tenderer shall employ.	Professional Civil / structural Engineer to approve and sign off		

Attach proof of ECSA Civil / Structural Engineering registration.

SECTION 5: PARTICULARS & GUARRANTEES

PART 15.1: ELECTRICAL INSTALLATION

SPEC NO:

ITEM		UNIT	REQUIREMENTS	OFFERED
	Electical Installation of Substation Building, Yard Lighting and Lightning Protection			
1	**DISTRIBUTION BOARD**			
1,1	Type		Semi-recessed with door	
1.1.1	Rating	kA	10	
1.1.2	Manufacturer			
1,2	Main Switch		60 Amp S.P. with solidly bolted	
1.2.1	Manufacturer and Cat. No.			
1,3	Earth		60 Amp Single phase	
1.3.1	Manufacturer and Cat. No.		M&G	
1,4	Busbars	A	60	
1,5	Lighting circuit-breakers	A	10	
1.5.1	Manufacturer and Cat. No.		M&G	
1,6	Socket outlet circuit-breakers	A	30	
1.6.1	Manufacturer and Cat. No.		M&G	
1,7	Fan circuit-breaker	A	5	
1.7.1	Manufacturer and Cat. No.		M&G	
1,8	Outside Lighting circuit-breaker	A	5	
1.8.1	Manufacturer and Cat. No.		M&G	
1,8	Photocell Bypass circuit-breaker	A	5	
1.8.1	Manufacturer and Cat. No.		M&G	
2	**LAMPS**			
2,1	Switchgear room		2 Tube, 65 Watt Industrial fluorescent type A	
2.1.1	Manufacturer			
2,2	Battery room		2 Tube, 65 Watt Class 1, Div 1, fluorescent Type B	
2.2.1	Manufacturer			
2,3	Control room		2 Tube, 65 Watt Industrial fluorescent Type A	
2.3.1	Manufacturer			
2,4	Outside lamps		22 Watt, high freq. flourescent Lascon Britelite 11 or equivalent Type D	
2.4.1	Manufacurer			
2,5	Toilets and passage		22 Watt, high freq. flourescent Lascon Britelite 11 or equivalent Type D	
2.5.1	Manufacturer			

ITEM		UNIT	REQUIREMENTS	OFFERED
3	**SOCKET OUTLETS**			
3,1	Manufacturer			
3,2	Switchgear room		16 Amp, 3 pin, flush mounted	
3,3	Control room		16 Amp, 3 pin flush mounted	
4	**LIGHT SWITCHES**			
4,1	Manufacturer			
4,2	Switchgear room:			
4.2.1	2-way			
4.2.2	1-way			
4,3	Battery room		1-way, Ex proof	
4,4	Control room			
4.4.1	2-way			
4.4.2	1-way			
5	**FLEXIBLE CONDUIT**			
5,1	Battery room		Flexible weatherproof between fan and wall outlet and fluorescent and ceiling outlet	
6	**EXTRACTOR FAN**			
6,1	Type		Built in wall extractor fan, Ex proof, Fan to be continuous rated	
6,2	Fan diameter		250mm	
6,3	Make			
6,4	kW Rating			
6,5	Voltage rating		240 V AC single phase	
6,6	Continuous current rating			
6,7	Starting current			
8	**OTHER**			
8,1	Floodlighting		LED 400W	
8,2	Photocell and accessories		National or similar	
8,3	Welding outlet		63 A 4- pole and switch socket	
8,4	Lightning protection masts - Complete		As per Specification	

SECTION 5: PARTICULARS & GUARRANTEES

PART 16.1: GANTRIES - STEEL LATTICE

SPEC NO:

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	STEEL LATTICE PORTAL TYPE GANTRIES			
1	**Material**			
1,1	Rolled steel angles		Yes	
1,2	Hot dip galvanized		Yes	
2	**Dimensions**			
2,1	Angle section dimensions	mm x mm		
2,2	Span	m		
2,3	Loading	kN		
2,4	Safety factor			
3	**Drawings and descriptions**			

SECTION 5: PARTICULARS & GUARRANTEES

PART 17.1: OPTICAL FIBRE BASED TELEPHONE PROTECTION & COMMUNICATION EQUIPMENT

SPEC NO: Txfot697.wpd/ss

ITEM	DESCRIPTION	REQUIREMENTS	OFFERED
1.	**ENVIRONMENTAL CONDITIONS (applicable to all equipment)**		
1.1	Operating temperature range	-10/C to 50/C	
1.2	Transport temperature range	-40/C to 70/C	
1.3	Storage temperature range	-25/C to 55/C	
1.4	Humidity	Up to 95%	
1.5	EMC	According to EN55022 or better	
1.6	Safety	According to EN60950 or better	
2.	**TELEPROTECTION**		
2.1	**Power Supply**		
2.1.1	Type	Chopper type power supply	
2.1.2	Power	50 Watts	
2.1.3	Input Voltage range	90-264V_{ac} at 47-440Hz 88-230V_{dc}	
2.2	**Multiplexer**		
2.2.1	Current consumption	50mA @ 5V_{dc} 15mA @ 15V_{dc}	
2.2.2	Frame length	32 bits	
2.2.3	Frame characteristic	Adaptive Delta Modulation	
2.2.4	Multiplex signal bit-rate	2048kbits/s @ ±50ppm	
2.2.5	Frame repetition rate	64kHz	
2.2.6	Channel bit-rate	64kbits/s	
2.2.7	Data bits per frame	20 bits	
2.2.8	Synchronizing bits per frame	8 bits	
2.2.9	Signalling bits per frame	4 bits comprising of 1 Parity bit, 1 Control bit, 1 Remote alarm transfer bit and 1 8 kHz super frame	
2.2.10	Frame loss verification	For each frame	
2.2.11	Clock switch over	Automatic switch over	
2.2.12	Maximum switch over time for 2	16ms	

ITEM	DESCRIPTION	REQUIREMENTS	OFFERED
	Mbit/s signal		
2.2.13	Alarms	Synchronization loss Frame bit-error rate; Failure of Drop/Insert clock; Parity error; Total outage of transmit clock; AIS in Main and Standby path.	
2.2.14	Common alarms	Priority and deferred alarm; Remote-alarm from demultiplexer; Remote-alarm from Drop/ Insert; Operation blocking. Alarm/oscilator unit	
2.2.15	Current consumption	580mA @ 5Vdc 20mA @ -5V_{dc} 20mA @ 15V_{dc}	
2.2.16	Voltage monitoring - At 5V_{dc} - At - 5V_{dc} - At 15V_{dc}	 4.3V_{dc} - 4.3V_{dc} 13.5V_{dc}	
2.3	**Optical Transmission Interface**		
2.3.1	Optical code	MCMI	
2.3.2	Optical bit rate	4096kb/s	
2.3.3	Type of fibre	Single mode (9/125µm)	
2.3.4	Operating wavelength	1300nm	
2.3.5	Optical connector	FC	
2.3.6	Optical transmitter power	≥20dBm	
2.3.7	Receiver sensitivity	≤ 40dBm	
2.4	**Digital Protection Interface**		
2.4.1	Power supply voltage	15V_{dc}, 0.5V	
2.4.2	Current consumption	20-30mA	
2.4.3	Transmit command input voltage	24, 48, 110, 220 or 250V_{dc}	
2.4.4	Receive command input voltage	Solid state output relay 250V_{dc}, 1A	
2.4.5	Command transmission time	<2ms	
2.4.6	Command prolongation	20ms (standard), adjustable from 1-200ms	
2.4.7	Protection	Direct and indirect tripping blocking	
2.4.8	Isolation test voltage	IEC 255-5, Series C	
2.5	**Asynchronous Data Interface**		
2.5.1	Supply voltage	15V_{dc}, ±0.5V	

ITEM	DESCRIPTION	REQUIREMENTS	OFFERED
2.5.2	Current consumption	45mA, ±5mA	
2.5.3	Asynchronous modulation rate	4800 Baud, normal operation, 9600 Baud, maximum operation	
2.5.4	Input interface	CCITT V.28 single/double current	
2.5.5	Input impedance	1kΩ, 5kΩ, 7.8kΩ and 11kΩ	
2.5.6	Switching threshold	+2.5V_{dc} to -2.5V_{dc} with a hysteresis of 1.2V_{dc}	
2.5.7	Output interface	CCITT V.28 single/double current, ±10V @ 20mA, CCITT V.10 single/double current, ±5V @ 20mA	
2.5.8	Maximum phase carrier delay	1ms (±4 bits @ 4800 baud)	
2.5.9	Telex without carrier	±20V @ ±20mA, ±10V @ ±40mA	
2.6	**Binary Interface**		
2.6.1	Power supply voltage	5V_{dc}, ±0.3V @ <50mA 15V_{dc}, ±0.3V @ <280mA	
2.6.2	Input logical levels - Logic 0 - Logic 1	 $-72V \leq V_{in} \leq 7.2V$ $9V \leq V_{in} \leq 72V$	
2.6.3	Input current range	$3mA \leq I_{in} \leq 10mA$	
2.6.4	Auxiliary voltage source	12V, ±5 % @ 80mA, short-circuit protected and not galvanically isolated	
2.6.5	Total inputs/outputs	8	
2.6.6	Switching delay time	<15ms	
2.6.7	EMC immunity	According to IEC 870-3	
2.7	**Back Plane**		
2.7.1	Local Clock Source : Frequency Output Impedance	2048kHz, ± 50ppm HCMOS compatible	
2.7.2	External Clock Input : Compatibility Frequency Permissible level variation@2048kHz Impedance Reflected Attenuation Isolation test Voltage Impulse Voltage withstand	 ITU-T Reg. G.703 2048kHz, ± 50ppm ≤ 6dB 120Ω symmetrical ≥ 15dB 0.5kVAC/1min 0.5kV Differential mode 1kV Common mode	
2.7.3	Relay Outputs : Switching Voltage Switching Current Contact Power Rating Drop off Delay Pick up Delay	≤250VAC & ≤ 250VDC ≤ 1A mean & ≤ 16A peak AC ≤ 100VA, DC ≤ 100W typically 5s typically 100ms 1.5kVAC / 1min	

ITEM	DESCRIPTION	REQUIREMENTS	OFFERED
	Isolation test voltage Impulse Voltage withstand	1kV differential mode, 2.5kV common mode	
2.8	**Mechanical Design**		
2.8.1	Construction	19" rack mountable	
2.8.2	Protection class of housing	IP54	
2.8.3	External connections	Screw Terminals	
3.	**COMMUNICATIONS**		
3.1	**Power supply**		
3.1.1	Type	Chopper type power supply	
3.1.2	Power output rating	26.5Watts	
3.1.3	Input voltage range	90-264V_{ac} at 47-440Hz, or 88-230V_{dc}	
3.1.4	Output voltage	±5V Regulated -3%...+6%	
3.1.5	Output current +5V -5V	 4.2A maximum 1.1A maximum	
3.1.6	Efficiency	≥65% @ full load	
3.2	**64kb/s Data Interface**		
3.2.1	Bit Rate	64kb/s synchronous	
3.2.2	Interface	CCITT X.21, adaptable for RS232	
3.2.3	Number of Channels	4	
3.3	**Universal Data Interface**		
3.3.1	Synchronous Data Interfaces Definition Electrical Rates	 X.21/X.24 V.11 0.6....n*64kb/s	
3.3.2	Asynchronous Data Interfaces Definition Electrical Rates	 V.24 V.28 (RS232) 0.6....38.4kb/s	
3.3.3	Number of Circuits	4	
3.4	**Telephone Subscriber Interface**		
3.4.1	CODEC Coding	CCITT A-Law (G.711)	
3.4.2	Input	-5dBr to +4dBr	
3.4.3	Output	-7.5dBr to -3dBr (in 0.5dB increments)	
3.4.4	Crosstalk Attenuation	70dB minimum	
3.5	**Telephone Exchange Interface**		

ITEM	DESCRIPTION	REQUIREMENTS	OFFERED
3.5.1	CODEC Coding	CCITT A-Law (G.711)	
3.5.2	Input	-5dBr to +4dBr	
3.5.3	Output	-7.5dBr to -3dBr (in 0.5dB increments)	
3.5.4	Crosstalk Attenuation	65dB minimum	
3.5.5	Functions Supported	Seizure, Ringing and Ring Tripping	
3.6	**Ring Generator**		
3.6.1	Output voltage	$66V_{AC}$ - $70V_{AC}$	
3.6.2	Output frequency	25Hz ± 3Hz	
3.6.3	Output current	0 to $460mA_{AC}$	
3.6.4	Power consumption : Quiescent Full load	 8W 50W	
3.7	**Optical Transmission Interface**		
3.7.1	Multiplexing method	CCITT G.742	
3.7.2	Transmission code	MCMI	
3.7.3	Input sensitivity	-46dBm	
3.7.4	Optical power output	-3dBm minimum	
3.7.5	Number of ports	2	
3.8	**2Mb/s Interface**		
3.8.1	CCITT Recommendation	G.703, G.704, G.823	
3.8.2	Bit Rate	2048kb/s	
3.8.3	Number of Ports	2	
3.8.4	Line Code	HDB3	
3.8.5	Impedance	120Ω balanced or 75Ω unbalanced	

Txfot697.wpd/ss

SECTION 5: PARTICULARS & GUARRANTEES

PART 18.1: SCADA INTERFACE

SPEC NO:

ITEM	DESCRIPTION	UNIT	REQUIREMENTS	OFFERED
	SCADA INTERFACE			
1	Type of interface		Harris D20++	
2	Protocol offered at the SCADA Access Point on the SMMI			
3	Mounting of SCADA Interface Unit		In 19" Communication Equipment rack	
4	Modes of Operation		Polled Report by Exception Operation	
5	Testing		Contractors responsibility to the front end processor at Capital Park	
6	Pre-testing Contractors must pre- test there SCADA equipment with the TSHWANE system to prove compatibility		Contractors to pre-test and sign doc YES	

Portable THREE PHAS

No	Description
1	**General**
	Manufacture
	Type
2	**Applications**
	Electrical tests on power transformers
	Pure Three Phase testing
	Perform tan-delta and capacitance tests on bushings and power transformers
3	**General**
4	**Power Supply**
	Nominal Voltage
	Permissible Voltage Range
	Nominal Frequency
	Permissible Frequency Range
	Power Consumption
	Connection
5	**Dimensions and Weight**
	Size (W x H x D)
	Volume
	Weight
6	**Environment**
	Operating Temperature
	Storage Temperature

	Humidity
	Altitude
7	**Certificates**
	Vibration
	Shock
	CE
	Safety
	Independent Test Laboratory
8	**Hardware Specifications**
8,1	**Frequency**
8,2	**Voltage Outputs**
	AC Range 1
	AC Range 2
	AC Range 3
8,3	**Current Outputs**
	DC Range 1
	DC Range 2
	DC Range 3
8,4	**Voltage Inputs**
	AC range
	Other AC ranges
	AC amplitude accuracy
	DC range
	Other DC ranges
	DC amplitude accuracy
8,5	**Current Inputs**
	AC range
	Other AC ranges
	AC amplitude accuracy
	DC range
	Other DC ranges
	DC amplitude accuracy
8,6	**Ratio Measurements**
	Main Range
	Other ranges
	Ratio accuracy
8,7	**Resistance Measurements**
	Range 1

	Range 2
	Range 3
8,8	**Tan-delta / Capacitance Measurements**
	Output voltage
	Output current
	Frequency
	Accuracy Tan-delta
	Capacitance Range
	Accuracy Capacitance
9	**Functional Tests**
9,1	**Supported Assets**
9,2	**Ratio Test**
9,3	**Static Winding Resistance**
9,4	**Short Circuit Impedance**
9,5	**Demagnetization**
9,6	**Dynamic Winding Resistance**

9,7	**Tan-Delta / Capacitance Tests**
10	**Software**
	Operating System
	Data Management Functions:
11	**Accessories**
	High voltage and low voltage test leads
	Tap changer control lead
	Connection clamps
	Grounding cable
	Other accessories:
	Hardcover Transport case
12	**Local Support**
	Local on-site presentation and demonstration
	Hotline support hours

	Email support
	Number of units in operation in South Africa
	No of back-up units available in South Africa
	Calibration facility available in South Africa
	Guaranteed turnaround time for repairs and calibration
	Product training offered in South Africa
	Warranty on Hardware

Technical Specifications

E Power Transformer Test System for Transmission Transf

Requirement
Yes
Yes
Yes
Equipment with accessories must be portable and able to fit in the boot of a compact hatch-back or sedan car
The weight of each individual unit should not exceed 23kg. One average person on his own should be able to handle and carry the test system.
Tests are to be performed manually or automatically (user selectable).
The test system shall have BOTH THREE independent phases of AC voltage output as well as a THREE independent phases of DC current outputs.
The voltage and current outputs shall be stabilized and regulated, i.e. the wave shape of the currents and voltages in terms of amplitude and frequency shall be independent of the quality of the mains supply. The unit shall be operable from a portable generator. Units utilizing an internal variac are not permissible.
The unit shall include adequate precautions for safety: Emergency Off, bright ON and OFF lights, keyboard lock, earth wire connection check, optional facility for Deadman button, .
The unit shall have optionally a front-panel control with back-lit colour and touch-sensitive LCD screen.
Test reports are to be generated on-line and automatically and to be user customizable.
The test system shall be controllable from PC in order to achieve fully automatic tests.
100 V - 240 V
85 V - 264 V
50 Hz / 60 Hz
45 Hz - 65 Hz
<3500VA at 230V continuous
IEC320/C20
580mm x 386mm x 229mm
max. 52 litre
max. 20 kg
-10 °C ... +55 °C
-30 °C ... +70 °C

5 % ... 95 % r.h. (non-condensing)
up to 2,000m operating, up to 12,000m storage
IEC60068-2-6 - frequency range from 10Hz to 150Hz, continuous acceleration 2g, 20 cycle per axis
IEC60068-2-27, 15g / 11ms, half-sinusoid, each axis
CE Conform (89/336/EEC)
IEC61010-1; EN60950; EN50191, IEC61010-1 produced and tested in an EN ISO 9001 certified company
Copies of test certificates from independent test laboratories proving compliance with the above standards are to be supplied together with the tender
Frequency of AC Signal shall be variable from 15 to 599Hz independent of the mains supply frequency
Output frequency shall be regulated and independent of mains frequency and/or quality of mains supply
3x 0..230V L-N; I_{load} = 100mA
3x 0..80V L-N; I_{load} = 16A
3x 0..40V L-N; I_{load} = 33A
3x 0..16A; V_{max} = 113V
3x 0..33A; V_{max} = 56V
1x 0..100A; V_{max} = 56V
0..300V
30V, 3V, 300mV
0.012% reading + 0.003% range
0..424V
42V, 4.2V, 420mV
0.01% reading + 0.02% range
0..40A
4A
0.04% reading + 0.02% range
0..56A
5.6A
0.04% reading + 0.03% range
1:1 to 1:10
1:10..100; 1:100..1000; 1:1,000..10,000
0.03% reading + 0.05% range
0.1Ω..100Ω with up to 3Adc; Accuracy <0.1% reading + 0.3% range

0.1mΩ..10Ω with up to 30Adc; Accuracy <0.05% reading + 0.05% range
30µΩ..30mΩ with up to 100Adc; Accuracy <0.05% reading + 0.05% range
0 .. 12kV
up to 300mA for up to 2min
up to 100mA steady state
15Hz.. 500Hz
< 0.1% of reading + 0.005% " (for readings of 0..10%, 45..70Hz, I<8mA)
1pF … 80nF at 12kV; 1pF…3µF at reduced voltage
< 0.05% of reading + 0.1pF for I<8mA
Three phase and single phase transformers
Auto transformers with or without tertiary
All kinds of vector groups: YD, DY, ZD, DZ, 1..12
Phase-shifting transformers
All measurements to be performed on all three phases simultaneously and automatically
All tap positions to be measured with the tap-changer controlled automatically from the test set for all tapping up and tapping down operations
Measurements: Voltage ratio measurement, vector group phase shift and excitation current
Calculations: Ratio deviation
Assessment: Automatic assessment according to IEC, i.e. pass is when the ratio deviation <0.5%
Graphics: VTR vs. tap position, VTR deviation vs. tap position, vector group phase angle vs. tap position, excitation current vs. tap position
All measurements to be performed on all three phases simultaneously and automatically
All tap positions to be measured with the tap-changer controlled automatically from the test set for all tapping up and tapping down operations

Measurements: Winding resistance vs. tap position
Assessment: Automatic assessment according to IEC, i.e. pass is when the resistance between the phases deviated by >2%
Graphics: Static winding resistance
Short Circuit Impedance to be measured for a number of taps (typically minimum, nominal and maximum tap).
No need to apply an external short circuit on the LV winding of the transformer, i.e. the short circuit should be applied internal to the test equipment, with allowance made for the test leads.
Frequency Response of Stray Losses (FRSL) measurement to be possible
Test equipment to be able to demagnetize the core of a power transformer. A measurement of the magnetization level before and after de-magnetization is to be displayed.
All tap positions to be measured with the tap-changer controlled automatically from the test set for all tapping up and tapping down operations

Test routine is to automatically monitor the charging of the winding inductance and only take a measurement once measured values have stabilized. Also the test routine shall discharge the winding inductance of ALL charge after the test.
Measurements: Winding resistance, ripple of tap change current
Assessment: Automatic assessment according to IEC, i.e. pass is when the resistance between the phases deviated by >2%
Graphics: OLTC Scan for each tap transition superimposed on top of each other; Static winding resistance vs. tap position; ripple vs. tap position
Two independent measurement inputs should be provided
GST and UST tests should be possible for both inputs / switching unused inputs to guard.
Tip-up test by varying the voltage in a range of 2kV to 12kV
Frequency dependency: Varying the frequency in a range of 15Hz to 400Hz while performing the capacitance and tan-delta measurement.
Graphics: Capacitance and Tan-Delta vs. frequency
Windows 10 (32bit and 64bit)
Automatic Testing Database for HV plant assets
Data management functions for locations of assets
Data management functions for all primary assets (e.g. power transformers, current transformers, circuit breakers, etc.)
Data management of testing jobs to be done on all primary assets
Provision of automatic connection diagrams for each type of test
Flexible tools to select specific tests ON and OFF
Automatic generation of reports including automatic Pass/Fail assessments
Back-up of primary assets database with test results.
Optional centralized database to which multiple users can synchronize their location, asset and job data and test results.
15 m combination lead for all three phases and neutral, colour-coded RED, YELLOW and BLUE
15m combination lead for tapping up and tapping down signal.
4x Red & 4x Black Kelvin clamps
1 x 9 m; 6 mm² with connection clamp
Power cord
Connection lead from test set to PC
Trolley with large soft wheels
Hardcover carrying cases for test hardware with retractable handle and wheels
Instruction Manual
Software for report downloading and configuration as well as offline test sequence generation.
A hardcover transport case is to be provided for the test equipment for shipment / courier purposes.
LOCALLY based engineers (i.e. from the Southern African region) are to present and demonstrate the equipment to our engineers at our companies substation on our own test application to prove its suitability to operate in local environmental conditions as well as to be able to test our test objects adequately.
Local telephonic support to be offered in the hours of 07h00 - 20h00 South African time.

Email support to be offered with a guaranteed turnaround time of 1 business day.
10 units in Southern Africa (separate list of users with contact details to be provided)
1
Yes
< 5 working days
Standard training offered every three months in Johannesburg
In-house / On-site training to be offered on request
FIVE years from date of delivery

...ormers incl. Tan Delta Measurements

Tenderer Proposal, Comments

Camera’s specifications

Description	Technical requirements
32 Channel Internet Protocol 4HDD network video recorder	• 32 Internet Protocol channels • 256 Mbps incoming / 200 Mbps outgoing • dual HDMI 4K 50Hz output; 1 VGA; 2 USB 3.0 ports • supports H.264/H.265+/MPEG • 12MP resolution per channel • 4 × Serial Advance Technology Attachment up to 64TB each • dual Local Area Network • Interoperability Open Network Video Interface Forum compliant • Wi-Fi compatible. • 12V DC ±10% • operating range -10°C to 55°C.
18TB Hard drive	• (3.5” SATA III surveillance-grade HDD; • 18TB capacity. • 6Gb/s interface; • 7200 RPM. • 260MB/s; • workload ≥180TB/year; • MTBF ≥2 million hours; • suitable for continuous 24/7 operation) • startup current at 12V (2A) • Average operating power 8w • Idle average power 5.3w • Channel number 32 • Voltage rating 12V and ±10% tolerance

8MP Pan-Tilt-Zoom Network Dome Camera	• 1/2.8″ Complementary Metal Oxide Semiconductor. • Resolution 8MP (3840×2160); 2.8–16mm Viewfinder (VF) lens; 5× optical zoom; • Image Sensor 1/3" Progressive Scan CMOS • Max. Resolution 2688 × 1520 • Min. Illumination Color: 0.001 Lux @ (F1.0, AGC ON), B/W: 0 Lux with IR • Shutter Time 1/3 s to 1/100,000 s • Day & Night IR cut filter • Angle Adjustment Pan: 0° to 355°, tilt: 0° to 75°, rotate: 0° to 355° • Lens Type Fixed focal lens, 2.8mm • Focal Length & FOV 2.8 mm, horizontal FOV 100.2°, vertical FOV 54.7°, diagonal FOV 119.7° 4 mm, horizontal FOV 81.1°, vertical FOV 44.7°, diagonal FOV 94.6° • Lens Mount M12 • Iris Type Fixed • Depth of Field • 2.8 mm: 1.9 m to ∞ • 4 mm: 2.5 m to ∞ • Supplement Light Type IR • Supplement Light Range Up to 30 m • IR Wavelength 850 nm • Video Compression Main stream: H.265/H.264/H.265+/H.264+ Sub-stream: H.265/H.264/MJPEGThird stream: H.265/H.264 • Integrated infrared range ≥60m; • 120dB Wide Dynamic Range ; • Waterproofing IP67 • Illumination Color: 0.005 Lux, B/W: 0.001 Lux, 0 Lux with IR • Durability IK10 (vandal-proof) • motion detection • smart tracking. • H.264+/H.265+; PoE+ or 24V AC; • Wi-Fi compatible. • storage microSD up to 512 GB

8MP Network Bullet Camera	• 1/2.8″ Complementary Metal Oxide Semiconductor • 8MP (3840×2160) • 2.8–16mm Viewfinder lens; 5× optical zoom • Integrated infrared range ≥60m; • 120dB Wide Dynamic Range; • Waterproofing IP67 • Durability IK10 (vandal-proof) • motion detection. • smart tracking. • IR wavelength 850nm • Supplement Light Type IR • Supplement Light Range Up to 60 m • Smart Supplement Light Yes • Image Sensor 1/3" Progressive Scan CMOS • Max. Resolution 2688 × 1520 • Min. Illumination Color: 0.001 Lux @ (F1.0, AGC ON), B/W: 0 Lux with IR • Shutter Time 1/3 s to 1/100,000 s • Day & Night IR cut filter • Angle Adjustment Pan: 0° to 360°, tilt: 0° to 90°, rotate: 0° to 360° • Compression Mainstream: H.265/H.264/H.264+/H.265+, Sub-stream: H.265/H.264/MJPEG, Third stream: H.265/H.264, • Power over Ethernet+ or 12DC; • mounting accessories. • Wi-Fi compatible. • storage microSD up to 512 GB • video bit rate 32 Kbps to 8 Mbps • H.264 Type Baseline Profile, • Main Profile, High Profile

	• H.265 Type Main Profile • Bit Rate: Control CBR, VBR • Scalable Video Coding: (SVC) H.264 and H.265 encoding
50 Inch Monitor	• 50″ LED 4K UHD (3840×2160); • ≥400 cd/m² brightness; • 4000:1 contrast; 50Hz; 2×HDMI, • 1×VGA, • 1×DP; • 24/7 rated; ≤120W; • wall/VESA mount.

South Africa does not have a single, dedicated national law or set of technical specifications specifically for PTZ cameras or bullet and dome; instead, general **CCTV system standards are provided as best practice guidelines** by the South African National Standards (SANS) and are governed by broader laws like the **Protection of Personal Information Act (POPIA)**.

Technical Specifications & Standards

While manufacturers provide specific technical data sheets for their products, South African standards focus more on application and legal compliance.

- **SANS Guidelines:** The primary guidelines for CCTV surveillance systems for security applications are outlined in the SANS 0222 series (e.g., SANS 0222-5-1, SANS 0222-5-1-1 to 5). These cover operational requirements, system design, installation, maintenance, and application. It is important to note these were written some time ago and are considered best practice guidelines rather than mandatory, legally enforceable standards, though they are still used to judge the standard of an installation.

- **SANS 60950 series or SANS 62368 series** (Safety of information technology equipment): NVRs, as electrical information technology equipment, must comply with general safety standards to be sold in South Africa. The relevant international standards (IEC) are typically adopted as SANS.
- **SANS 214-1/CISPR 14-1** (Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus - Part 1: Emission) and related EMC standards: Electronic devices need to meet EMC requirements to ensure they don't cause or are not susceptible to undue electromagnetic interference.
- **SANS 10222-5-1 series** (CCTV surveillance systems for use in security applications): This is a set of best practice guidelines that covers the design, installation, and maintenance of the overall CCTV system, within which an NVR operates. While these are guidelines and not mandatory standards, they are widely used in professional installations to ensure the system provides footage suitable for investigations and legal proceedings.
- **SANS 10222-5:** General requirements for CCTV installations.
- **SANS 10222-5-1:** Covers CCTV surveillance systems specifically for security applications.
- **SANS 10222-5-1-1:** Deals with operational requirements, such as image quality sufficient for monitoring, detection, recognition, or identification.
- **SANS 10222-5-1-2:** Outlines system design requirements.
- **SANS 10222-5-1-3:** Focuses on installation planning and implementation, including factors like environmental operating conditions (e.g., weather resistance for outdoor cameras, often indicated by an **IP67** rating).
- **SANS 10222-5-1-4:** Specifies testing, commissioning, and handover requirements.
- **SANS 10222-5-1-5:** Covers maintenance requirements.

- **Interoperability:** Public tender documents often specify that cameras must be **ONVIF compliant** (an international standard for IP-based security products) to ensure interoperability with existing network video recording systems.
- **Environmental Ratings:** Cameras, especially those for outdoor use, are expected to have an appropriate IP (Ingress Protection) rating, such as IP65 or IP66, to protect against dust and water in the local environment.
- **Connectivity:** Modern specifications often require Power over Ethernet (PoE or PoE+) connectivity and support for various IP streaming and control protocols like RTMP, RTSP, NDI|HX, and SRT for easy integration and remote control.
- **Quality:** Images must be "sharp, clear and stable and of a quality suitable for Monitoring, Detection, Recognition or Identification as specified in the Operational requirement".
- **Installation:** The South African Intruder Detection Services Association (SAIDSA) issues a certificate of compliance for CCTV installations, ensuring that basic installation guidelines (e.g., cable management, power supplies, earthing) are followed.

Key IEC standards relevant to PTZ cameras include:

- **IEC 62676 Series (Video surveillance systems for use in security applications)**: This is the main series of standards for CCTV and VSS applications.
    - **IEC 62676-4** provides guidelines for the selection, planning, installation, operation, and maintenance of video surveillance systems.
    - **IEC 62676-5** (and its parts, e.g., IEC 62676-5-1) defines the measuring methods and specifications for performance values and image quality for camera devices, including dynamic range, resolution, and sensitivity, under various environmental conditions.

- **IEC 60950-1 / IEC 62368-1 (Safety standards)**: These standards cover the safety of information technology and audio/video equipment to ensure the product is safe for use.
- **IEC 61000 Series (Electromagnetic Compatibility - EMC)**: PTZ cameras, especially those for outdoor or industrial use, must meet specific EMC requirements to avoid interference. Examples include standards for electrostatic discharge (IEC 61000-4-2) and fast electrical transients (IEC 61000-4-4).
- **IEC 60529 (IP Code)**: This standard is used to rate the ingress protection (IP) of the camera's enclosure against dust and water (e.g., IP66 or IP68 ratings are common for outdoor PTZ cameras).
- **IEC 60079 (Explosive atmospheres)**: For cameras used in hazardous (Ex-proof) environments, adherence to these specific safety standards is required.
- **ONVIF (Open Network Video Interface Forum) Standard**: While not an IEC standard, compliance with ONVIF (Profile S, G, T, etc.) is a critical industry standard for the **interoperability** of IP-based PTZ cameras with network video recorders (NVRs) and video management systems (VMS), which defines the communication protocols for PTZ control.

Joystick controller Specification

Description	Technical requirements
Joystick Controller	• 3-axis joystick. • compatible with RS-485/RS-232/USB; • supports Pelco-D/P, • Interoperability Open Network Video Interface Forum compliant • LCD display; • 12V DC or USB powered; • durable ergonomic housing.

The product must comply with broader, internationally aligned South African National Standards (SANS) related to **general electrical safety and electromagnetic compatibility (EMC)**.

The only specific SABS standards related to "joystick controllers" are for **heavy-duty industrial equipment** (like those used for cranes and material handling) and **gaming/gambling machines** in licensed establishments.

For Consumer/PC Joystick Controllers

For general-purpose joysticks (e.g., for PC or console gaming), compliance typically involves:

- **SANS 60335-1** (Household and similar electrical appliances – Safety – Part 1: General requirements), or relevant parts of the **SANS 60950/SANS 62368 series** (Safety of information technology equipment), depending on the device's power source and classification.

- **SANS 61000 series** (Electromagnetic compatibility - EMC), ensuring the device neither causes nor is susceptible to excessive electromagnetic

- For joysticks that are part of a commercial gaming or gambling machine in a licensed venue, they must comply with the specific **SANS 1718** series of standards, which cover the integrity and performance of gambling equipment to ensure fairness and security.

Page **1** of **2**

PART C2.2

ACTIVITY, QUANTITIES & BILL SCHEDULES

CONTENTS

Page **2** of **2**

Contract: **EEBU XXXX-2025.26 TENDER FOR THE SUPPLY, DELIVERY, INSTALLATION, TESTING AND COMMISSIONING OF 1x300MVA POWER TRANSFORMER AT KWAGGA 275/132KV SUBSTATION WITH ASSOCIATED EQUIPMENT FOR A PERIOD OF THREE (3) YEARS**

PART C2.2 – SECTION 7 - ACTIVITIES, QUANTITIES & BILL SCHEDULE

PART	DESCRIPTION	APPLICABLE

PART C2: PRICING DATA

PART C2.2: ACTIVITY SCHEDULE (AS), QUANTITIES (QTY) & BILL (R) SCHEDULES

Kwagga 275/132kV SUBSTATION **TENDER EEBU 07- 2025/26**

ITEM NO	DESCRIPTION	UNIT	IMPORTED CONTENT		LOCAL CONTENT			TOTALS		
	Please do not quote where is greyed out		FOB (Port of shipment) (a)	Currency (b)	FOR (SA factory) (c)	All S.A. transport to site (d)	Installation & Commissioning (e)	Total unit price (exl. VAT) (f) sum(a..e)	**Estimated quantity (g)**	Total price (ex. VAT) (h) (f x g)
1	**GENERAL:**									
1.1	**<u>Preliminary & general</u>:** Site establishment, services not listed under any other specific items.									
1.1.1	**Civil:**	**sum**							**1**	
1.1.2	**Structural:**	**sum**							**1**	
1.1.3	**Electrical:**	**sum**							**1**	
1.2	**<u>Site meetings</u>:** Weekly meetings of which one is a Monthly meeting where minute must be kept by the contractor. Also provide for a monthly detail project schedule (Gantt) and cash-flow schedule.	**sum**							**1**	
1.3	**<u>Site inspections</u>:** Regular (weekly) inspections of equipment and work progress.	**sum**							**1**	
1.4	**<u>Site office</u>:** Site office,sanitary facilities, table and chairs to accommodate at least 15 people. Provide drawing rails, white board, air conditioner.	**sum**							**1**	
1.5	**<u>Storage of equipment</u>**									
1.5.1	Safe and protected storage on site of all items (including free-issue items) must be provided. Existing and new buildings may not be used for storage.	**sum**							**1**	
1.5.2	Safe and protected storage off site of all items (including free-issued items) must be provided.									
1.6	**<u>Labeling & Signs:</u>**									
	<u>Equipment labeling</u>: All equipment, bays, busbars, etc in the 132kV and 275kV yards, equipment/panels in the buildings must be labeled including the buildings. See label									
1.6.1	Type 1.1: Bay identification	**each**							**30**	
1.6.2	Type 1.2: 132kV Equipment identification	**each**							**30**	
1.6.3	Type 1.3: Transformer identification, buildings, etc.	**each**							**20**	
1.6.4	Type 1.4: Phase R Y B identification	**each**							**20**	
1.6.5	Type 2.1: Line indentification	**each**							**20**	
1.6.6	Type 2.2: Tower indentification	**each**							**20**	
1.6.7	Type 1.2: 275kV Equipment identification	**each**							**30**	
1.7	**<u>Safety signs</u>:** See drawings in part C4.									

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1.7.1	Type NC75: Outside building doors	**each**							**30**	
1.7.2	Type NC1: Inside doors	**each**							**10**	
1.7.3	Type NC58 & NC60: Fire Extinguisher	**each**							**20**	
1.7.4	Type NC76: Battery room	**each**							**5**	
1.7.5	Type MV5,9&10: Battery room	**each**							**5**	
1.7.6	Type WW23: Sub Yard Gate	**each**							**5**	
1.7.7	Type NC2: Sub Yard Gate	**each**							**5**	
1.7.8	Type NC7, 70 & PV4, 8: 275& 132kV Yard Gates	**each**							**5**	
1.7.9	Type WW23: Sub outside fences	**each**							**100**	
1.7.10	Building entry and access doors	**each**							**16**	
1.8	**Implementation Plan:** A plan with a work-breakdown structure with at least three levels of detail (1st - Overview of main elements, 2nd - each main element broken up into sub-elements, 3rd - detail description of each sub-element / works-order).	**each**							**1**	
1.9	**Healthy &Safety**									
1.9.1	**Safety training & supervision:** Provision must be made to comply with the Occupational Heath and Safety Act (Act 85 of 93) and the Construction Regulation 2014 (GNR 1010 of 18/7/2003) or the latest updated acts/regulations or the replacement thereof.	**sum**							**1**	
1.9.2	**Safety officer:** For duration of the project (36months)	**each**							**2**	
1.9.3	**Safety plan**	**each**							**1**	
1.9.4	**Safety implementation plan:**	**each**							**1**	
1.9.5	**OHS file**	**each**							**1**	
1.9.6	**Safety nets, earths & signs:** Provision must be made to fence off working (dead/switched-out) areas from live areas and put up warning signs. Contractor supply all nets, earths and signs. Nets must be minimum 1.8m high PVC orange colored for safety and Green for screening off construction site. The contractor must erect the nets, earths and signs after the CoT Operator give the instruction. Portable earths must be applied to equipment to be worked on. The placing of the nets, earths and warning signs must be approved by the CoT Operator before a permit will be issued. The Contractor must maintain the nets, earths and warning signs at all times until instructions are received from the CoT Operator.	**sum**							**1**	
1.10	**Environmental Management Plan (EMP):** As per specification.	**each**							**1**	
1.11	**Commissioning & testing:** Supply all test equipment and labour for testing, commissioning and adjustments of the final installation as well as being in attendance for any inspections and test which CoT engineer or project manager my request.									

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1.11.1	**Commissioning & testing:** 275/132kV (300MVA) Transformer bay complete including all equipment	**each**							**5**	
1.11.2	**Commissioning & testing:** 132kV Line/Incomer bay complete including all equipment	**each**							**4**	
1.11.3	**Commissioning & testing:** 132kV Bus-coupler/section bay complete including all equipment	**each**							**1**	
1.11.4	**Commissioning & testing:** 275kV Bus-coupler/section bay complete including all equipment									
1.11.5	**Commissioning & testing:** 132kV Buszone complete including all equipment	**each**							**2**	
1.11.6	**Commissioning & testing:** 275kV Switchgear panels and to the bay controllers complete including all equipment	**each**							**84**	
1.11.7	**Commissioning & testing:** 275kV Bay controllers complete including to all equipment	**each**							**4**	
1.11.8	**Commissioning & testing:** Substation equipment and remote-end equipment protection and control complete including all auxiliary equipment. All line inter-trips, auto-reclosing, etc.	**sum**							**1**	
1.11.9	**Commissioning & testing:** Substation Micro-Scada, Remote (Capital Park) Scada control and monitoring system complete including all equipment (communication).	**sum**							**1**	
1.12	**Operating & Maintenance Manuals (O&M M's):** Provide for O&M Manuals including "As-Built" drawings, test certificates, etc. Also include the existing equipment in the O&M Manuals. Specific equipment manuals can be obtained from CoT Maintenance Sections and/or Capital Park O&M M Library if available. All the technical drawings (SLD,GA, Schematics,etc) & data of the equipment must be supplied in electronic format (DWG & PDF) of the existing and new equipment.	**set**							**4**	
1.13	**Substation furniture:**									
1.13.1	**Cabernets:** Steel cabinet to file one set of O&M Manuals, A1 drawings, etc.	**each**							**2**	
1.13.2	**Table & chairs:** Fixed steel table with drawers for A1 plans and 4 chairs (approximately 1.2m high).	**set**							**1**	
1.13.3	**Drawing rails:** Provide for 6m long drawing rail mounted on the wall to be indicated by the Engineer. Include as built A0, one each, laminated single line and yard lay-out drawings.	**each**							**5**	
1.13.4	**Air conditioner:** Supply & Install in control/relay room (24000BTU).	**each**							**2**	
1.14	**Security:**									
1.14.1	**Security Services:** Provide for 24hour security services during the construction work with armed response. The security company must be registered with PSIRA. The security guards must be grade B and C. Four armed-guards at night with 1 dog (1 Grade B and 3 Grade C) and three armed-guards during the day (1 Grade B and 2 Grade C). Provide for guard house for duration of the project.	**sum**							**5**	
1.14.2	**Security system:** Supply, install and commision 24 hour security surveilance system which must cover all areas in the substation inside and outside (see scope of wok 1,8)	**sum**							**1**	
1.14.3	32 channel IP 4HDD Network Video Recorder. **(see C2.1.5.19.1)**	**each**							**2**	
1.14.4	60TB hard drive (see C2.1.5.19.1)	**each**							**3**	
1.14.5	8 MP Pen-Tilt - Zoom (PTZ) Dome camera **(see C2.1.5.19.1)**	**each**							**20**	

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1.14.6	8 MP Network Bullet Camera **(see C2.1.5.19.1)**	**each**							**36**	
1.14.7	Joystick controller **(see C2.1.5.19.2)**	**each**							**2**	
1.14.8	50 inch monitor **(see C2.1.5.19.1)**	**each**							**3**	
1.14.9	Ethernet Cable / Cat 7 including trenching , steel conduits (25mm) **(See C2.1.4.17.1)**	**metre**							**4000**	
1.14.10	Optic fibre cable with 32mm sleeve pipe (Single-mode armoured OS2 fibre; 6-core; PE black UV-resistant jacket; SWA; 32mm HDPE sleeve with draw rope; buried at 450mm depth with marker tape.) (See C2.1.4.17.1)	**metre**							**4000**	
1.15	**Inspections and witness testing:**									
1.15.1	Routine and tests witnessing of all equipment outside Gauteng area: All costs for 4 technical staff members from CoT or appointed consultants by CoT (contractor travel, accommodation and food) to carry out inspections.	**each**							**4**	
1.16	**Additional items:** Any items that the Tenderer may wish to detail and price:									
1.16.1										
1.16.2										
1.16.3										
	Total of Item 1 (Total to Price Summary)									**200**
2	**275KV & 132KV CIRCUIT-BREAKERS: OUTDOOR**									
2.1	**132KV CIRCUIT-BREAKERS (C2.1.5.02.1.1)**									
2.1.1	**132kV Outdoor Circuit-breakers** The supply, deliver, installation, 6FS gas-filling, integration and commissioning (including O&MM's).	**each**							**9**	
2.1.2	**Support structures:** Support structure and fittings for the 132kV Outdoor Circuit-Breakers.	**sum**							**9**	
2.1.3	**Plinths:** Digging to the bottom of the foundation, compact with G5-soil 150mm per layer, install reinforcing and cast concrete plinth.	**sum**							**9**	
2.1.4	**Commissioning of Circuit breaker** : gas-filling, time testing and commissioning (not part of 2.1.1)	**each**							**9**	
2.1.5	**Overhead conductors and associated equipment:** All conductors and clamps for this bay.	**lot**							**1**	
2.2	**275KV CIRCUIT-BREAKERS (C2.1.5.02.1.2)**									
2.2.1	**275kV Outdoor Circuit-breakers** The supply, deliver, installation, 6FS gas-filling, integration and commissioning (including O&MM's).	**each**							**12**	
2.2.2	**Support structures:** Support structure and fittings for the 275kV Outdoor Circuit-Breakers.	**sum**							**12**	
2.2.3	**Plinths:** Digging to the bottom of the foundation, compact with G5-soil 150mm per layer, install reinforcing and cast concrete plinth.	**sum**							**12**	

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2.2.4	**Commissioning of Circuit breaker** : gas-filling, time testing and commissioning (not part of 2.2.1	each							12	
2.2.5	**Overhead conductors and associated equipment:** All conductors and clamps for this bay.	lot							1	
	Total of Item 2 (Total to Price Summary)									
3	**275kV & 132KV DISCONNECTORS & EARTH SWITCHES**									
3.1	**132KV DISCONNECTORS & EARTH SWITCHES 2500A (Conventional type) (C2.1.5.02.03.1.1)**									
3.1.1	With 2 earthing switches 2500A (Conventional type): Standard Disconnector including motor drive mechanisim.	set							9	
3.1.2	Support structures: Support structure and fittings for the 132kV Disconnectors with 1 and/or 2 Earthing-switches.	set							9	
3.1.3	Plinths: Digging to the bottom of the foundation, compact with G5-soil 150mm per layer, install reinforcing and cast concrete plinth.	sum							3	
3.1.4	Motor drive mechanism :2500A	each							3	
3.1.5	**Overhead conductors and associated equipment:** All conductors and clamps for this bay.	lot							1	
3.2	275kV DISCONNECTORS & EARTH SWITCHES									
3.2.1	275KV DISCONNECTORS & EARTH SWITCHES 2500A (Conventional type) (C2.1.5.02.03.1.2)								3	
3.2.2	With 2 earthing switches 2500A (Conventional type): Standard Disconnector including motor drive mechanisim.	set							9	
3.2.3	Support structures: Support structure and fittings for the 275kV Disconnectors with 1 and/or 2 Earthing-switches.	set							9	
3.2.4	Plinths: Digging to the bottom of the foundation, compact with G5-soil 150mm per layer, install reinforcing and cast concrete plinth.	sum							9	
3.2.5	Motor drive mechanism :2500A	each							3	
3.2.6	**Overhead conductors and associated equipment:** All conductors and clamps for this bay.	lot							1	
	Total of item 3 (Total to Price Summary)									
4	**275kV & 132KV SURGE DIVERTORS /ARRESTORS & INSULATING BASES**									
4.1	**132kV Surge diverters (C2.1.5.04.1.1)**									
4.1.1	**132 kV Surge diverters**: Free-standing type	each							21	
4.1.2	**Structures**: For free-standing surge diverters	each							9	
4.1.3	Plinths: Digging to the bottom of the foundation, compact with G5-soil 150mm per layer, install reinforcing and cast concrete plinth.	sum							9	
4.1.4	**Transformer brackets**: For surge diverters (alternative to plinth/wall & structure) for existing TRF's.	each							9	
4.2	275kV SURGE DIVERTORS /ARRESTORS & INSULATING BASES									

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4.2.1	275 kV Surge diverters**:** Free-standing type **(C2.1.5.04.1.2)**	**each**							**15**	
4.2.2	Structures**:** For free-standing surge diverters	**each**							**15**	
4.2.3	Plinths: Digging to the bottom of the foundation, compact with G5-soil 150mm per layer, install reinforcing and cast concrete plinth.	**sum**							**15**	
4.2.4	Transformer brackets**:** For surge diverters (alternative to plinth/wall & structure) for existing TRF's.	**each**							**15**	
	Total of item 4 (Total to Price Summary)									
5	**275kV & 132KV INSTRUMENT TRANSFORMERS: OUTDOOR**									
5.1	**132kV Voltage Transformers (VT's): Outdoor (C2.1.5.05.1.1)**									
5.1.1	**132kV Outdoor VT':** Line bays.	**each**							**12**	
5.1.2	**132kV Outdoor VT's:** Main & Reserve busbars	**each**							**3**	
5.1.3	**Support structures & fittings:** Each VT structure requires a galvanised junction box with terminals/links on the middle structure.	**each**							**3**	
5.1.4	Plinths: Digging to the bottom of the foundation, compact with G5-soil 150mm per layer, install reinforcing and cast concrete plinth.	**sum**							**12**	
5.1.5	**Overhead conductors and associated equipment:** All conductors and clamps for this bay.	**lot**							**1**	
5.2	**275KV INSTRUMENT TRANSFORMERS: OUTDOOR**									
5.2.1	**275kV Voltage Transformers (VT's): Outdoor (C2.1.5.05.1.2)**								**12**	
5.2.2	**275kV Outdoor VT':** Line bays.	**each**							**9**	
5.2.3	**275kV Outdoor VT's:** Main & Reserve busbars	**each**							**3**	
5.2.4	**Support structures & fittings:** Each VT structure requires a galvanised junction box with terminals/links on the middle structure.	**each**							**3**	
5.2.5	Plinths: Digging to the bottom of the foundation, compact with G5-soil 150mm per layer, install reinforcing and cast concrete plinth.	**sum**								
5.2.6	**Overhead conductors and associated equipment:** All conductors and clamps for this bay.	**lot**							**1**	
5.3	**132kV Current Transformers (CT's): Outdoor (C2.1.5.05.2.1)**									
5.3.1	**132kV Outdoor CT's-6 Core:** Bus-coupler bay , Line bays	**each**							**12**	
5.3.2	**132kV Outdoor CT's-6 Core:** Transformer bays	**each**							**12**	
5.3.3	**Support structures & fittings:** Outdoor CT's. Each set of three CT structures requires a galvanised junction box with terminals/links on the middle structure.	**each**							**12**	

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5.3.4	Plinths: Digging to the bottom of the foundation, compact with G5-soil 150mm per layer, install reinforcing and cast concrete plinth.	sum							12	
5.3.5	**Overhead conductors and associated equipment:** All conductors and clamps for this bay.	lot							1	
5.4	**275kV Current Transformers (CT's): Outdoor (C2.1.5.05.2.2)**									
5.4.1	**275kV Outdoor CT's-6 Core:** Bus-coupler bay , Line bays	each							6	
5.4.2	**275kV Outdoor CT's-6 Core:** Transformer bays	each							6	
5.4.3	**Support structures & fittings:** Outdoor CT's. Each set of three CT structures requires a galvanised junction box with terminals/links on the middle structure.	each							6	
5.4.4	Plinths: Digging to the bottom of the foundation, compact with G5-soil 150mm per layer, install reinforcing and cast concrete plinth.	sum							6	
5.4.5	**Overhead conductors and associated equipment:** All conductors and clamps for this bay.	lot							1	
5.5	**132kV INSULATORS (C2.1.5.07.1.1)**									
5.5.1	**Post insulators:** For Line type busbar for bays with clamps & accessories	each							24	
5.5.2	**String insulators with clamps & accessories:** (Composite) Main and Reserve overhead flexible conductors busbars	each							24	
5.5.3	Three phase Support structures: Support structure and fittings for the 132kV Insulators.	set							24	
5.5.4	Single Phase Support structures: Support structure and fittings for the 132kV Insulators.	set							24	
5.6	**275kV INSULATORS (C2.1.5.07.1.2)**									
5.6.1	**Post insulators:** For line busbar for bays with clamps & accessories	each							9	
5.6.2	**String insulators with clamps & accessories:** (Composite) Main and Reserve overhead flexible conductors busbars	each							9	
5.6.3	Single phase Support structures: Support structure and fittings for the 275kV Insulators.	set							9	
5.6.4	Single Phase Support structures: Support structure and fittings for the 275kV Insulators.	set							9	
5.6.5	Single Phase Support structures: Support structure and fittings for the 275kV Insulators.	set							9	
	Total of Item 5 (Total to Price Summary)									
6	**INSULATED CABLES**									
6.1	**11kV Cables Main Feeder including terminating & terminations:** Installation must include labour, trenching, compacting and backflling									
6.1.1	**11kV Main Feeder Cables**									
6.1.1.1	150mm 3 Core, Paper insulated	m							300	
6.1.1.2	70mm 3 Core, Paper insulated	m							300	
6.1.2	**11kV Cable Joint-kits:**									
6.1.2.1	150mm Copper three-core.	each							20	
6.1.2.2	70mm Copper three-core.	each							20	

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6.1.3	**11kV Terminations per terminal:**									
6.1.3.1	150mm Copper three-core.	**each**							**20**	
6.1.3.2	70mm Copper three-core.	**each**							**20**	
6.2	**Multi-core Control Cables: Underground, PVC-Insulated:** Where multicore cables runs in 11kV cable trenches it must be strapped on cable racks/trays.									
6.2.1	**2,5 mm² multi-core cable:**									
	- 2 core	**m**							**300**	
	- 4 core	**m**							**2000**	
	- 7 core	**m**							**3000**	
	- 12 core	**m**							**6000**	
	- 19 core	**m**							**10000**	
	- 27 core	**m**							**2000**	
	- 37 core	**m**							**2000**	
6.2.2	**4 mm² multi-core cable :**									
	- 4 core	**m**							**2000**	
	- 7 core	**m**							**2000**	
6.2.3	**6 mm² multi-core cable :**									
	- 3 core	**m**							**500**	
	- 4 core	**m**							**500**	
6.2.4	**16 mm² multi-core cable :**									
	- 2 core	**m**							**500**	
	- 4 core	**m**							**1000**	
6.2.5	**35 mm² multi-core cable :**									
	- 4 core	**m**							**1000**	
6.2.6	**Galvanized cable tray :**									
	- 100 mm wide	**m**							**300**	
	- 150 mm wide	**m**							**300**	
	- 300 mm wide	**m**							**300**	
	- 500 mm wide	**m**							**300**	
6.2.7	**Multi-core cable identification and testing**									
	- 2 core	**cable**							**40**	
	- 3 core	**cable**							**40**	
	- 4 core	**cable**							**40**	
	- 7 core	**cable**							**40**	
	- 12 core	**cable**							**40**	
	- 19 core	**cable**							**40**	
	- 27 core	**cable**							**40**	
	- 37 core	**cable**							**40**	
6.2.8	**Multi-core cable termenation and gland**									
	- 2 core	**end**							**40**	
	- 3 core	**end**							**40**	
	- 4 core	**end**							**40**	
	- 7 core	**end**							**80**	
	- 12 core	**end**							**80**	
	- 19 core	**end**							**80**	
	- 27 core	**end**							**80**	
	- 37 core	**end**							**80**	
6.2.9	**Obsolete cables**									
6.2.10	Trace and removal of obsolete LV cables, tranport and offload at CoT stores	**P/ton**							**10**	

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6.2.11	Trace and removal of obsolete MV cables, tranport and offload at CoT stores	**P/ton**							**40**	
	Total of Item 6 (Total to Price Summary)									
7	**EARTH SYSTEM**									
7.1	**Earth Grid:** Earth grid installation must include, excavation, trenching and backfilling.									
7.1.1	Bare solid Cu Conductor 10mm.	**m**							**3000**	
7.1.2	**Steel** Cu plated rod 16mm thick and 1m long. Additional earthing at various point as required on the earth grid (this is not a connection to equipment structures)	**m**							**500**	
7.1.3	Connections to structures and equipment above-ground must be of **steel** Cu plated rods 16mm thick. Two connections per structure as a set. Including all steel Cu plated rods and connections.	**set**							**500**	
7.2	**Soil Resistivity:** Substation soil resistivity test	**sum**							**1**	
7.3	**Earth Grid Survey:** Inspect and test Substation existing earth grid resistivity.	**sum**							**1**	
7.4	**Lightning mast with earth mat.** 30degree protection/coverage. A minimum height of 21m. Complete including plinths, earthmat and 4 connections to the substation earth grid. According to SANS spec.	**Each**							**8**	
7.5	**Welding connections**									
7.5.1	Exothermic weld connection	**each**							**1000**	
	Total of Item 7 (Total to Price Summary)									
8	**CONTROL & PROTECTION (C&P) EQUIPMENT**									
8.1	**132kV Overhead Line C&P System IEC61850 enabled:**								**42**	
8.1.1	**Panel:** Complete panel, wiring, assembly and configuration of all devices including the fo	**each**								
	(a) Bay controller: With integrated switchgear mimic control diagram.									
	(b) Main protection: Distance Protection / Differential Protection multifunctional Relay with optic fibre/ethernet communication.									
	(c) Back-up protection: Combined directional over-current and earth fault.									
	(d) Check-synchronisation:									
	(e) Automatic reclose:									
	(f) Local controls: Included with Mimic/Bay controller.									
	(g) 8 x Test Blocks: Multi CT/VT connections.									
	(h) Maximum Demand Ammeter: In BYC.									

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	(i) Medium resolution disturbance recorder:									
	(j) Intertrip receive repeat relay or functionallity:									
	(k) Emergency trip button:									
	(L) Power Quality Meters installation on all 132kV lines									
8.2	**132kV Bus-Coupler C&P System IEC61850 enabled:**								**8**	
8.2.1	**Panel:** Complete panel, wiring, assembly and configuration of all devices including the following functionalities.	**each**								
	(a) Bay controller: With integrated switchgear mimic control diagram.									
	(b) Protection: Overcurrent and Earth Fault Multifunctional with optic fibre/ethernet communication.									
	(c) Check synchronisation:									
	(d) Trip circuit supervision:									
	(e) Local controls: Included with Mimic/Bay controller.									
	(f) 4 x Test Blocks: Multi CT/VT connections.									
	(g) Maximum Demand Ammeter: In Bay controller.									
	(h) Medium resolution disturbance recorder:									
	(i) Emergency trip button:									
8.3	**132kV Busbar Protection Scheme IEC61850 enabled:**	**each**							**25**	
8.3.1	**Panel :** Complete central unit, panel, wiring, assembly and configuration of all devices including the following functionalities for all the bay modules:									
	(a) Low impedance busbar protection scheme (Central Units): Configured and wired for zones, and all present and future bays (min 16 bays), implemented with only present bay measuring modules.								**1**	
	(b) Bay Units: Integral in low impedance system.								**24**	
	(c) Distributed system prefered with dead zone protection.									
	(d) Engineering communications to HMI enable.									
	(e) 18 x Test Blocks: Multi CT/VT connections.									
	(f) Medium resolution disturbance recorder:									
	(g) Trip circuit supervision:									
	(h) Emergency trip button:									
8.3.2	**Panel :** Complete central unit, panel, wiring, assembly and configuration of all devices including the following functionalities for all the bay modules:	**each**								

ITEM NO	DESCRIPTION	UNIT	IMPORTED CONTENT		LOCAL CONTENT			TOTALS		
	Please do not quote where is greyed out		FOB (Port of shipment) (a)	Currency (b)	FOR (SA factory) (c)	All S.A. transport to site (d)	Installation & Commissioning (e)	Total unit price (exl. VAT) (f) sum(a..e)	**Estimated quantity (g)**	Total price (ex. VAT) (h) (f x g)
	(a) Low impedance busbar protection scheme: Configured and wired for 2 zones, and all present and future bays (min 16 bays), implemented with only present bay measuring modules.									
	(b) Check zone: Integral in low impedance system.									
	(c) Distributed system prefered with dead zone protection.									
	(d) Engineering communications to HMI enable.									
	(e) 18 x Test Blocks: Multi CT/VT connections.									
	(f) Medium resolution disturbance recorder:									
	(g) Trip circuit supervision:									
	(h) Emergency trip button:									
8.4	**132kV Transformer Incomer C&P System IEC61850 enabled:**								**16**	
8.4.1	**Panel:** Complete panel, wiring, assembly and configuration of all devices including the following functionalities.	**each**								
8.4.2	**(a) Bay controller:** With integrated switchgear mimic control diagram.									
8.4.3	**(b) Main protection:** Combined transformer differential and HV & LV restricted earth fault.									
8.4.4	**(c) LV Standby earth fault:**									
8.4.5	**(d) Back-up protection:** Combined over-current and earth fault protection relay/function.									
8.4.6	**(e) Transformer voltage regulating relay:** With control on relay.									
8.4.7	**(f) Local controls:** Included with Mimic/Baycontroller									
8.4.8	**(g) 6 x Test Blocks:** Multi CT/VT connections.									
8.4.9	**(g) Maximum Demand Ammeter:** In Bay controller.									
8.4.10	**(h) Trip circuit supervision:**									
8.4.11	**(i) Emergency trip button:**									
8.5	**132kV Power Factor Correction C&P System IEC61850 enabled:**								**4**	
8.5.1	Complete panel, wiring, assembly, with integrated switchgear mimic control diagram and configuration of all devices including the following functionalities.	**each**								
8.5.2	**(a) Bay controller:** With integrated switchgear mimic control diagram.									
8.5.3	**(b) Protection:** Multi-function directional over-current, earth fault and power factor elements									
8.5.4	**(c) Medium resolution disturbance recorder:**									
8.5.5	**(d) Test Blocks:** Multi CT/VT connections.									

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8.5.6	**(e) Trip circuit supervision:**									
8.5.7	**(f) Maximum Demand Ammeter:**									
8.5.8	**(g) Voltmeter with selector switch between phases:**									
8.6	**132kV Bus-Sections Panel C&P Equipment System IEC61850 enabled**:								**4**	
8.6.1	Complete panel, wiring, assembly, with integrated switchgear mimic control diagram and configuration of all devices including the following functionalities.	**each**								
8.6.2	**(a) Bay controller:** With integrated switchgear mimic control diagram.						-			
8.6.3	**(b) Maximum Demand Ammeter:**									
8.6.4	**(C) Main protection -** Differential protection relay if it is an interconnector panel									
8.7	**275kV Bus-Coupler C&P Equipment System IEC61850 enabled**:								**4**	
8.7.1	Complete panel, wiring, assembly, with integrated switchgear mimic control diagram and configuration of all devices including the following functionalities.	**each**								
8.7.2	**(a) Bay controller:** With integrated switchgear mimic control diagram.									
8.7.3	**(b) Maximum Demand Ammeter:**									
8.8	**275kV Eskom Line Incomers, transformers and Feeders C&P Equipment System IEC61850 enabled: SCADA comms enabled:**								**24**	
8.8.1	Complete panel, wiring, assembly, with integrated switchgear mimic control diagram and configuration of all devices including the following functionalities.	**each**								
8.8.2	**(a) Bay controller:** With integrated switchgear mimic control diagram.									
8.8.3	**(b) Main protection:** Multifunctional differential protection relay which is IEC61850 enabled, with RS485 or Fibre optic communication connection. Depending on the type of									
8.8.4	**(c) Back-up protection:** Combined direction/non directional over-current and earth fault protection with power reverse, under/over voltage, over/under frequency, high impedance fault detection (for distribution lines) functionalities.									
8.8.5	**(d) Test Blocks:** Multi CT/VT connections.									
8.8.6	**(e) Medium resolution disturbance recorder:**									
8.8.7	**(f) Maximum Demand Ammeter:**									
8.9	**275kV Busbar Protection Scheme IEC61850 enabled:**								**1**	
8.9.1	**Panel :** Complete central unit, panel, wiring, assembly and configuration of all devices including the following functionalities for all the bay modules:								**13**	

ITEM NO	DESCRIPTION	UNIT	IMPORTED CONTENT		LOCAL CONTENT			TOTALS		
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8.9.2	**(a) Low impedance busbar protection scheme (Central Unit):** Configured and wired for 2 zones, and all present and future bays (min 16 bays), implemented with only present bay measuring modules.								**1**	
8.9.3	**(b) Bay Units:** Integral in low impedance system.								**12**	
8.9.4	**(c) Distributed system prefered with dead zone protection.**									
8.9.5	**(d) Engineering communications to HMI enable.**									
8.9.6	**(e) 18 x Test Blocks:** Multi CT/VT connections.									
8.9.7	**(f) Medium resolution disturbance recorder:**									
8.9.8	**(g) Trip circuit supervision:**									
8.9.9	**(h) Emergency trip button:**									
8.10	**Substation control and ancillary equipment (Modification/New RTU):**								**1**	
8.10.1	**Computer, monitor, keyboard and mouse:**	**each**								
8.10.2	**Ethernet Substation LAN network and interface unit:** Including switches Optic Fibre based.	**each**								
8.10.3	**Substation IED:** For common substation IO.	**each**								
8.10.4	**SCADA access port:**	**each**								
8.10.6	**GPS:** For accurate time synchronisation.	**each**								
8.10.7	**Printer:** Laserjet. For event and alarm record printing	**each**								
8.10.8	**Inverter power supplies:** To enable computers and peripherals to operate from the nominal 110 V DC substation supply	**each**								
8.10.9A	**HMI Panel & Wiring with bar/high chair:**	**sum**								
8.10.9B	**HMI Wiring & desk with 2 chairs:**	**sum**								
8.11	**Substation software and configuration:**	**sum**							**1**	
8.11.1	**All necessary software to provide complete substation control functionality, disturbance recording analysis, relay setting and other functions:**	**sum**								
8.11.2	**Configuration of complete substation control system and software to provide complete functionality required:**	**sum**								
8.11.3	**Any additional software required to enable complete reconfiguration of the substation:**	**sum**								
8.12	**Substation Service Aids:**								**1**	
8.12.1	**Configuration of remote engineering workstation:**	**sum**					-			
8.12.2	**Software for system programming, testing, fault evaluation etc:**	**sum**								
8.13	**Spares:**									
8.13.1	**132kV Bay controller/backup relay**	**each**							**2**	

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8.13.2	**132kV Multi-functional power factor correction relay**	**each**							**2**	
8.13.3	**132kV Combined transformer differential & restricted earth fault protection relay:**	**each**							**2**	
8.13.4	**Differential Protection Relay**	**each**							**2**	
8.13.5	**Transformer voltage regulator relay:**	**each**							**2**	
8.13.6	**Distance Protection Relay**	**each**							**2**	
8.14	**132kV panels modification at downstream/remote substation:**									
8.14.1	**Matching relays for downstream substation: Install relays in the primary substation 132kV panel to match the newly installed differential protection relays in downstream substation at Saulsville Sub, Atteridgeville Sub and Pretoria West/Dam Sub**								**6**	
8.14.2	**Matching relays for downstream substation:** Supply & install new relays in the downstream substations to match the newly installed differential protection relays in infeed / primary substation. The contractor must wire differential protection relays to FOX/RTU Panels with all newly installed communication protocol. City of Tshwane to	**each**							**6**	
8.14.3	**(C2.1.5.10.3B)20MVA 132/11 KV Transformer : Supply, install and commission Complete with NEC/R/Aux .**									
	Total of Section 8 (Total to Price Summary)									
9.1.2	**Dual DC board with selector switch:** To be connected to two chargers and two battery banks.	**each**							**2**	
9.1.3	**Yard marshalling kiosks: (Include Specification)**	**each**							**20**	
9.2	**110V Batteries & Battery Stands:**									
9.2.1	**110V Lead acid battery (54 cell) >352 A/H:**	**P/Bank**							**4**	
9.2.2	**110 V Battery Stands:**	**P/Stand**							**4**	
9.3	**110V Battery Charger:**									
9.3.1	**Battery charger unit:** Dual chargers each rated output 50A. Including DC load distribution panel	**each**							**2**	

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9.3.2	**Inverter -** 220V/AC to 110V/DC	**each**							**2**	
9.4	**<u>Pilot Cable Termination Panel</u>:**									
9.5.1		**each**							**2**	
	Pilot cable termination cubicle:									
10	**CIVIL WORKS**									
10.1	**<u>275kV, 132kV Yards & Common area arround Buildings</u>:**									
10.1.1	**Cable Trenches/Ducts for multi-core cables (500mm x 500mm):** Bricked Concrete trenches with reinforced concrete covers. The covers must be covered by 150mm layer of concrete screed with a smooth finish.	**m**							**3000**	
10.1.2	Replace old asbestors covers with concrete slabscovers	**m**							**150**	
10.1.3	**Cable Trenches/Ducts for multi-core cables:** Multi-core cables laid direct in ground including danger tape covered with soil.	**m**							**1500**	
10.1.4	**Cable Culvert (900 × 1100mm) for multicore cables:** Concrete steel reinforced culverts with 150mm concrete floors including 2 manhole with covers on either side must be constructed as indicated on the yard layout drawing.	**each**							**200**	
10.1.5	**Cable Culvert (900 × 1200mm) for transformer cables:** Concrete steel reinforced culverts with 150mm concrete floors including 2 manhole with covers on either side must be constructed as indicated on the yard layout drawing. Detail A	**each**							**200**	
10.1.6	**150mm dia. PVC Cable sleeves:**	**m**							**500**	
10.1.7	275kV & 132kV Yards Stoning: The 275kV & 132kV yard must be covered with 25mm crusher-stone approximately 100mm thick. The existing yard stone must be removed from the yard and stockpiled outside the yard during construction work.	**m3**							**250**	
10.1.8	Import and Backfill G7 material in layers of 150mm, compact to 95% MOD AASTO, Switchgear Building Foundation Layers.	**m3**							**200**	
10.1.9	Import and Backfill G5 material in layers of 150mm, compact to 95% MOD AASTO, Switchgear Building Foundation Layers.	**m3**							**200**	
10.1.10	**Earthworks and protection of embankments:** Where necessary embankments must be used to ensure a large enough surface for the 275kV &132kV yards. The embankments must be protected from erosion by paving or concrete. Including all earth works for the yard extension. The 275kV & 132KV yards platform must be 150mm above ground level. The embankment must be reworked to accommodate the new 275kV &132kV yard. It must be similar to the existing including paving.	**m2**							**250**	
10.1.11	**<u>Paving</u>:** Concrete interlocking paving 75mm thick.	**m2**							**600**	
10.1.10	**<u>Perimeter Fence</u>**									

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10.1.10.0	Removal of existing concrete perimeter fence Kwagga	**p/m**							**2500**	
10.1.10.1	**Perimeter Fence:** Build of new concrete slab wall 3.6 metre height with 0.6 anti digging including flat wrap and coil wrap (720mm). Design to be signed off by civil or structural engineer (See C4.7, C4.7.1 and C4.7.1.2 examples of typical design and requirements)	**p/m**							**2500**	
10.1.10.2	Coil wrap 720mm razor wire fixed to the top of concrete fence.	**p/m**							**2500**	
10.1.10.3	Concertina Wire Fixed to bottom of concrete fence. (two runs on on bottom)	**p/m**							**6000**	
10.1.10.4	Supply and installation of battery room door (safe door type) see attached spec **(11.1.10.5)**	**each**							**2**	
10.1.11	Stormwater Outlet Headwall								**25**	
10.1.12	Cable Trenches - 600mm Wide Double Brick Walls	**p/m**							**600**	
10.1.13	All Concrete Culverts Diameter 200 smooth bore HDPE pipe x 4 per crossing - Concrete Encased	**each**							**30**	
10.1.14	Diameter 300 concrete Spigot and Socket Pipe	**each**							**10**	
10.1.15	Kerbing - Type KC 3	**each**							**800**	
10.1.16	**Substation gates**									
10.1.16.1	1m x 1.8m (WxH) Pedestrian Gate	**each**							**2**	
10.1.16.2	5m x 1.8m (WxH) Steel Palisade Double Leaf Swing Gate	**each**							**2**	
10.1.16.3	5m x 1.8m (WxH) Steel Palisade Removable Panel	**each**							**4**	
10.1.17	**Substation Building Doors (Scope of work C3.1.1.10)**									
10.1.17.1	D3 Ablution Door(H =2064mm x W=915mm)	**each**							**5**	
10.1.17.2	D2 Switch/relay Door(H =2064mm x W=915mm)	**each**							**6**	
10.1.17.3	D1 Switch/Relay Door (H =3000mm x W=1830mm)	**each**							**6**	
10.2.4	**Transformer Plinth .**									
10.2.4.1	**Demolish and remove existing Transformer Plinth (TX) and backfill with G5 and compact. (Scope of work C3.1 - 1.3)**	**sum**							**1**	
	Total of Section 10 (Total to Price Summary)									
11	**YARD LIGHTING**									
11.1	**Yard lighting**: Provide a set of four (x24) flood lights fitted to lighting posts or gantries at a height of 8m or including cables,4-way brakect, day-night sensor switch, wiring etc. **Lighting designs to be included in item 1.1**	**each**							**24**	
	Total of Section 11 (Total to Price Summary)									
12	**OPTICAL FIBRE BASED TELEPROTECTION- AND COMMUNICATION EQUIPMENT**									
12.1	**Fibre Optic based Tele-protection Signal equipment:**									

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12.1.2	FOX 615 Utility-grade multiservive multiplexer rack for communication using optical and SHDSL networks, complete with power supply, Central Ethernet Switch unit and fan unit	**each**							**2**	
12.1.3	SAMO2 interface card	**each**							**4**	
12.1.4	TEPI1 interface card	**each**							**8**	
12.1.5	OPIC1 interface card	**each**							**4**	
12.1.6	LEDS1 interface card	**each**							**4**	
12.1.7	LESU1 interface card	**each**							**2**	
12.1.8	LEXI1 interface card	**each**							**2**	
12.1.9	DATI1 interface card	**each**							**2**	
12.1.10	CEPI1 interface card	**each**							**2**	
12.1.11	COSI interface card	**each**							**2**	
12.1.12	EPSI1 interface card	**each**							**2**	
12.1.13	ELET1 interface card	**each**							**2**	
12.1.14	TUPON interface card	**each**							**4**	
12.1.15	DATAR interface card	**each**							**4**	
12.1.16	SYN4E interface card	**each**							**2**	
12.1.17	110 VDC / 48 VDC Power supply converter module	**each**							**4**	
12.1.18	Battery 1150K - 12Vdc (105Ah)	**each**							**16**	
12.1.19	Screened UTP cable	**m**							**200**	
12.1.20	Equipment cabinet, floor mounting, complete with sub racks, marshalling compartment, cable gland plate, ventilation system, panels and doors - swingframe and any accessories to complete a FOX 615 installation.	**each**							**2**	
12.1.21	**Other devices:** To meet overall functionality (Please list):									
12.1.21.1	**Patch Panels**: 48 Way with LC midcouplers	**each**							**6**	
12.1.21.2	**Installation, commissioning and testing** of communication equipment/system.	**sum**							**2**	
12.1.21.3	**Extension of fibre optic cable**: into fibre optic panel inside substation building and termination thereof in patch panel.	**sum**							**2**	
12.1.21.4	**New fibre optic cable**: at the 132kV tower/pylon. Contractor to confirm the number of fibres.	**m**							**200**	
12.1.21.5	**Joining/Splicing existing fibre optic cable to substation**: Contractor to confirm the number of fibres.	**each**							**10**	
	Total of Section 12 (Total to Price Summary)									

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13	**SCADA INTERFACE**									
13.1	**Harris D20 ++ Processor Card**: **OR** **Alternative Intellegent device (gateway):** Specify in a covering letter the detail of the SCADA system offered. Including installation and configuration of all devices and the SCADA Access port of the SMMI. Proof of successful testing in operation with the CoT SCADA system to the Capital Park Control Centre.	sum							1	
	Total of Section 13 (Total to Price Summary)									
14	**275/132 kV Transformers**									
14.10	**(C2.1.5.10.6.1)300MVA 275/132 KV Transformer :** Supply, install and commission Complete with NER. (Scope of work C3.1 - 1.33) CoT reserves the right to free issue from an existing transformer tender if available	sum							1	
14.20	**Decommission,Dismantle, rigging and transport of 300MVA Transformers**. Transport per transformer in Tshwane Supply area within radius of 60km. Provision must be made for off-loading, rigging, assembly and commissioning at delivery site determined by Engineer. (see Scope of Work 1.20)	sum							1	
	Complete electrical high voltage testing of 300MVA 275/132kV power transformer (impedence, open circuit, tan delta, ratio, impulse atleast at 60% of rated voltage, bushing testing including tapchanger full test) and issuing of a comprehensive report with recommendations	per transformer							3	
14.30	**TAP CHANGER - ASEA – UCCRN 550/800 (Complete contact set + gasket set)**	Each							2	
14.40	**TAP CHANGER - MR – TIII Y 1000 (Complete contact set + gasket set)**	Each							1	
14.50	**Supply and install new HV bushing (GOE 650/1600)145KV**	Each							9	
14.51	**TEST - HV bushing (GOE 650/1600)145KV**	Each							9	
14.60	**Supply and install new HV bushing (GOM 1050/725/0.6)275KV**	Each							9	
14.61	**TEST - HV bushing (GOM 1050/725/0.6)275KV**	Each							9	
	Total of Section 14 (Total to Price Summary)									
15	**Unit Rates & Training**									
15.10	Steel reinforcement (3 days)	p/person							15	
15.20	Setting out of works (1 days)	p/person							15	

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15.30	OHRVS training (authorised person)	**p/person**							**15**	
15.40	**Operators** (Switching): Training course for 4 people.	**p/person**							**4**	
15.50	**Maintenance:** Training course for 8 people.	**p/person**							**8**	
15.60	**System Protection:** One day training course for 8 people.	**p/person**							**8**	
15.70	**SCADA:** One day training course for 2 people.	**p/person**							**2**	
15.80	**Communication:** One day training course for 8 people per day	**p/person**							**8**	
15.90	High Voltage Substation Design Course per person	**p/person**							**8**	
15.10	Protection Course per person									
15.11	Introduction to protection	**p/person**							**4**	
15.12	Intermediate protection	**p/person**							**4**	
15.13	Advance protection	**p/person**							**4**	
15.14	Essential Micro Station Course per person	**p/person**							**4**	
15.15	PLC\CADD Course	**p/person**							**4**	
15.16	Planning Course per person	**p/person**							**4**	
15.17	Digsilent course per person	**p/person**							**4**	
	Total of Section 15 (Total to Price Summary)									
16	**Expanded Public Works Programme (EPWP) and Community Liaison Officer (CLO)**									
16.1	Appointment of Commuity Liason Officer (CLO). Allow for an annual increament which is to be inline with City of Tshwane Labour Increment Agreement for the duration of the project. (Current annual Scale is **R 277 918**)	sum							**36**	
	Total of Section 16 (Total to Price Summary)									
17	**ENGINEERING CHANGES: CHANGE CONTROL / VARIATION ORDER (VO's)**									
17.1	**Contingency sum for unforseen and engineering changes: 10% of the total sum of item 2 to 15**	10%							**1**	
	Total of Section 17 (Total to Price Summary)									

PART C3

SCOPE OF WORK

CONTENTS

ANNEXURE A

HEALTH AND SAFETY SPECIFICATIONS

CONTENTS

REFERENCES TO THE SCOPE OF WORKS IN TERMS OF THE OCCUPATIONAL HEALTH AND SAFETY ACT, REGULATIONS AND THE BASELINE RISK ASSESSMENT: HEALTH AND SAFETY SPECIFICATION

1. DOCUMENT PURPOSE AND INTENT

The specifications contained in this document relate to the health and safety requirements pertaining to the **supply, delivery, installation and commissioning of equipment for 275/132kV substation with a 900MVA firm capacity and associated works for the City of Tshwane**, so as to ensure the health and safety of the persons carrying out the associated works for the period of 3 years.

Compliance to the Occupational Health and Safety Act (Act 85 of 1993) and the Regulations shall not be limited to the specifications and definitions contained in this document.

A comprehensive, documented Health and Safety Plan is to be drawn up by the Main Contractor, based on the results of Health and Safety Risk Assessments conducted by him, and the specifications provided, and presented to the engineer for approval prior to commencement of work.

Monitoring of compliance on site shall be to the requirements of the OHS Act and Regulations as well as the contents of the H&S Plan(s) of the Main-Contractor and Sub-Contractors.

2. APPLICATIONS AND INTERPRETATION

This document is to be read and understood in conjunction with the following:

- Occupational Health and Safety Act (Act 85 of 1993).
- All regulations published in terms of the Occupational Health and Safety Act.
- Construction Regulations, 2003.
- SABS codes referred to by the Occupational Health and Safety Act.
- Contract Documents
- Basic Conditions of Employment Act (Act 75 of 1997)
- South African Rail Commuter Corporation Ltd: General conditions and specifications for work on, over, under or adjacent to Railway lines and near High Voltage Equipment. (SPK7/2)

<u>ABBREVIATIONS</u>

- OHS: Occupational Health and Safety
- CEO: Chief Executive Officer
- CR: Construction Regulations
- HCS: Hazardous Chemical Substances
- MSDS: Material Safety Data Sheet
- AIA: Approved Inspection Authority
- HBA: Hazardous Biological Agents
- OEL: Occupational Exposure Limit

3.1 DEFENITIONS

The following definitions from the Occupational Health and Safety Act are listed as follows:

Chief Executive Officer
In relation to a body corporate or an enterprise conducted by the State, means the person who is responsible for the overall management and control of the business of such body corporate or enterprise.

Danger
Means anything that may cause injury or damage to persons or property.

Employee **(**Contractor)
Means, subject to the provisions of Subsection (2), any person who is employed by or works for any employer and who receives or is entitled to receive any remuneration or who works under the direction or supervision of an employer or any other person.

Employer **(**Client / Engineer**)**
Means, subject to the provisions of Subsection (2), any person who employs or provides work for any person or remunerates that person or expressly or tacitly undertakes to remunerate him but excludes a labour broker as defined in Section 1(1) of the Labour Relations Act, 1953 (Act No. 28 of 1956).

Healthy
Means free from illness or injury attributable to occupational causes.

Machinery
Means any article or combination of articles assembled, arranged, or connected and which is used or intended to be used for converting any form of energy to performing work, or which is used or intended to be used, whether incidental thereto or not, for developing, receiving, storing, containing, confining, transforming, transmitting, transferring, or controlling any form of energy.

Medical Surveillance
Means a planned program of periodic examination (which may include clinical examinations, biological monitoring, or medical tests) of employees by an occupational health practitioner or, in prescribed cases, by an occupational medicine practitioner.

Plant
Includes fixtures, fittings, implements, equipment, tools and appliances, and anything which is used for any purpose in connection with such plant.

Properly Used
Means used with reasonable care, and with due regard to any information, instruction or advice supplied by the designer, manufacturer, importer, seller, or supplier.

User
In relation to plant or machinery, means the person who uses plant or machinery for his own benefit or who has the right of control over the use of plant or machinery, but does not include a lessor of, or any person employed in connection with, the plant or machinery.

Reasonably Practicable
Means practicable having regards to:

(a) the severity and scope of the hazard or risk concerned,

(b) the state of knowledge reasonably available concerning that hazard or risk and of any means to remove or mitigate that hazard or risk.
(c) the availability and suitability of means to remove of mitigate that hazard or risk; and
(d) the cost of removing or mitigating that hazard or risk in relation to the benefits deriving there from.

Risk
Means the probability that injury or damage will occur.

Safe
Means free from any hazard.

Standard
Means any provision occurring:
(a) in a specification, compulsory specification, code of practice or standard method as defined in Section 1 of the Standards Act, 1993 (Act No. 29 of 1993); OR
(b) in any specification, code or any other directive having standardization as its aim and issued by an institution or organization inside or outside the Republic which, whether generally or with respect to any article or matter and whether internationally or in any particular country or territory, seeks to promote standardization.

The following definitions from the Construction Regulations are listed as follows:

Agent
Means any person who acts as a representative for a client.

Competent Person
Means any person having the knowledge, training, experience, and qualifications specific to the work or task being performed:
Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training.

Construction
Means any work in connection with:

(a) the erection, maintenance, alteration, renovation, repair, demolition or dismantling of or addition to a building or any similar structure.
(b) the installation, erection, dismantling, or maintenance of a fixed plant where such work includes the risk of a person falling.
(c) the construction, maintenance, demolition or dismantling of any bridge, dam, canal, road, railway, runway, sewer or water reticulation system or any similar civil engineering structure; OR
(d) the moving of earth, clearing of land, the making of an excavation, piling or any similar type of work.

Contractor
Means an employer, as defined in Section 1 of the Act, who performs construction work and includes principal contractors.

Hazard Identification

Means the identification and documenting of existing or expected hazards to the health and safety of persons, which are normally associated with the type of construction work being executed or to be executed.

Health and Safety File
Means a file, or other record in permanent form, containing the information required as contemplated in these regulations.

Health and Safety Plan
Means a documented plan, which addresses hazards, identified, and includes safe work procedures to mitigate, reduce or control the hazards identified.

Health and Safety Specification
Means a documented specification of all health and safety requirements
pertaining to the associated works on a construction site, to ensure the health and safety of persons.

Method Statement
Means a document detailing the key activities to be performed to reduce as reasonably as practicable the hazards identified in any risk assessment.

Principal Contractor (Main Contractor)
Means an employer, as defined in Section 1 of the Act who performs construction work and is appointed by the client to be in overall control and management of a part of or the whole of a construction site.

Risk Assessment
Means a program to determine any risk associated with any hazard at a construction site, to identify the steps to be taken to remove, reduce or control such hazard.

4. NOTIFICATION OF CONSTRUCTION WORK

- The Principal/Main Contractor shall notify by registered mail, the local relevant Provincial Director of the Department of Labour, before commencing with construction work, of the intended work in the form of Annexure A of the Construction Regulations.
- A copy of the completed Annexure A of the Construction Regulations, as well as proof of notification shall be included in the Health and Safety Plan. (Proof of fax or proof of hand delivery)
- A copy of the completed Annexure A is to be kept on site by the principal Contractor.

5. LEGAL DOCUMENTATION/APPOINTMENTS

The following documents must be provided in the Health and Safety Plan:

- Health and Safety Policy signed by CEO.
- Letter of good standing with the Compensation Commissioner, Federated Employers, or similar insurer.
- Health and Safety Organogram (or table), outlining the Health and Safety Team, as well as the appointment(s) they have under the Act and Regulations (reference to specific section/regulation applicable to appointment)

Tom Smith
Section 16(2)
Construction supervisor CR 6(1)

Example:

Dick Smith
Construction vehicle competent person CR 21(1)(j)
Excavation competent person CR 11(1)

Harry Smith
H&S Rep - Section 17(1)

- The competency of each member of the Health and Safety Team must be provided and should` include knowledge, training, experience & qualifications specific to the work or task being performed.

Signed copies of the following legal appointments must be provided in the Health and Safety Plan:

APPOINTMENT	**OHS-ACT / REGULATION REFERENCE**
Section 16.2 appointment	Section 16.2
Health and Safety Representative (if necessary)	Section 17
Health and Safety Committee Members (if necessary)	Section 19
Incident Investigator	GAR 8(2)
First Aiders (Include training certificates)	GSR 3
Fire Fighters	ER 9 & CR 27(h)
Risk Assessor	HC (Incl. Asbestos & Lead); CR 7

The following information must be provided in the Health and Safety Plan:

- Indicate the estimated number of employees to be working on site.
- Indicate the expected number of contractors to be appointed by the Principal/Main Contractor.

The following Competent Persons, **where applicable**, shall be appointed in writing by the Principal/Main Contractor, prior to any work being carried out, and shall adhere to the requirements of the specific sub-regulations.

The competency of each of these appointed competent persons must be provided and should include knowledge, training, experience & qualifications specific to the appointment.

The table below indicates the applicability of the appointments, but contractors should by no means be limited to these indications.

APPOINTMENT	**OHS-ACT / REGULATION REFERENCE**
Construction Supervisor	CR 6 (1)
Assistant Construction Supervisor	CR 6 (2)
Fall Protection Competent Person	CR 8 (1)
Formwork/ Support Work Competent Person	CR 10 (a)
Excavation Work Competent Person	CR 11 (1)
Demolition Work Competent Person	CR 12 (1)
Scaffolding Competent Person	CR 14 (2)
Batch Plant Competent Person	CR 18 (1)
Explosive Powered Tools Competent Person	CR (b) 19
Construction Vehicle and Mobile Plant Competent Person	CR 21 (1)(j)
Electrical Installation Competent Person	CR 22 (d)
Stacking Competent Person	CR 26 (a)
Fire equipment Competent Person	CR 27 (h)
Confined Spaces Competent Person	GSR (5)
Blasting Competent Person	
Safety Officer Full time or part time	CR 6(6)
Traffic Safety Officer	CR 6(6)
General Machinery Competent Person	GMR (2)
Lifting Machines Operators	DMR 18(11)
Pipe Jacking Competent Person	
Competent Person referred to in South African Rail Commuter Corporation Ltd: General conditions and specifications for work on, over, under or adjacent to Railway lines and near High Voltage Equipment. (SPK7/2)	(SPK7/2)

- **Indicate in the H&S Plan, which of these listed appointments are applicable to the construction work in question.**
- no work involving any of the listed appointments may be performed without the knowledge and approval of an appointed competent person.
- The competent person shall be responsible to determine the level of supervision required for each activity.
- The agent/engineer must be informed of any changes made to the above appointments.
- The agent/engineer reserves the right to require from any contractor at any stage to appoint a full or part time construction health and safety officer.

6. GENERAL DUTIES OF PRINCIPAL CONTRACTOR

- The principal contractor will be responsible for co-operation between all contractors to ensure compliance to the OHS–Act and Regulations on site.

- To ensure the above, the Principal/Main Contractor must carry out the following and provide proof of such in his H&S plan:

  - Provide health and safety specifications to Contractors.
  - Appoint Contractors in writing.
  - Proof than Contractors H&S Plan has been approved, implemented, and maintained.
  - Proof that Contractors are registered with the Compensation Commissioner or similar insurer.
  - Proof that Contractors made provision for the cost of Health and Safety measures during the construction process.
  - A comprehensive & updated list of all contractors on site, also indicating the type of work being done.
  - Copies of Section 37(2) agreements with the relevant contractors.

7. SUPERVISION OF CONSTRUCTION WORK

- The agent/engineer must be informed if the Construction Work Supervisor is also appointed as a Construction Supervisor for another site.

8. RISK ASSESSMENT

- Risk assessments of all required activities/hazards shall form an integral part of the Health and Safety plan.

- All risk assessments shall be conducted in terms of an acceptable methodology, prior to commencement of work, according to the provisions of CR 7 and should cover at least the following:

    - Excavations
    - Backfilling in trenches
    - Pipe laying
    - Blasting
      - open trench blasting
      - pipe jack blasting
    - Identification of existing Services

  - Clearing of vegetation
  - Work in the vicinity of houses/buildings
  - Movement of Construction Vehicles
  - Working in confined spaces
  - Demolition
  - Temporary stockpiling
  - Connecting to existing sewer
  - Accommodation of traffic
  - Accommodation of pedestrians
  - Temporary vehicle bridges
  - Control of access of public/pedestrians to excavations
  - Work surrounding live sewage connection

- All health hazards that can be present during any of the above activities and should include individual dusts, gases, fumes, vapors, noise, extreme temperatures, illumination, vibration and ergonomic hazards due to any of the above activities.

- The above list is by no means exhaustive and should not be limited to these activities but must cover all activities that forms part of the said construction work. Each activity must be split down to individual tasks and all associated hazards identified and listed in the risk assessment. This ensures that critical tasks and subsequent critical hazards are not missed.

- The risk assessment to be included in the H&S Plan must clearly indicate:

  - The methodology used to do the risk assessments.
  - Breakdown of processes and activities covered.
  - High risks anticipated.

- All risk assessments are to be conducted by competent persons as appointed under paragraph 5 of this document. The plan must include a declaration in this regard, or the risk assessment must contain the signature(s) of this appointed persons.

- Risk assessments are to be handed to the agent prior to commencement of work.

- The agent reserves the right to stop any work if such work is not conducted in terms of the recommendations of the risk assessment.

- Risk assessments are to **cover safety as well as health and ergonomically hazards.**

9. SAFE WORK PROCEDURES

Safe Work Procedures are to form part of the H&S Plan and **must be compiled for all the above-identified activities.**

The safe work procedures must address the following elements:

- The work method to be followed to conduct work safely

- Mitigation of identified risks
- Reducing and controlling risks and hazards that have been identified

- Responsibilities of competent persons
- Required personal protective equipment
- Correct equipment/tools/machinery to be used
- Reference to relevant registers to be completed
- Reference to applicable risk assessment
- **The following two tables provides information on all factors to be considered when the Risk Assessments and Safe Work Procedures are compiled:**

Physical	**Chemical**	**Biological**	**Mechanical**	**Psycho-social**
Noise	Liquids	Insects	Guards	Stress
Vibration	Dusts	Fungi	Hand tools	Work pressure
Ionizing radiation	Fumes	Bacteria	Machinery	Monotony
Non-ionizing radiation	Fibers	Viruses		Unsociable hours
Health and cold	Mists			Ergonomically:
Electricity	Gases			• Posture
Pressure	Vapors			• Movement
				• Repetitive tasks

System	**Stress/Agency**	**Illness/Disease**
Musculoskeletal	Lifting/loads Repetitive strain Abnormal postures Whole body vibration	Muscular pain syndromes Tenosynovitis Bursitis Osteoarthrosis
Sensory	Noise	Hearing loss
Skin	Cement (chromates), rubber Thinners, epoxies Tar, pitch Solar radiation	Allergic contact dermatitis Irritant contact dermatitis Acne, Skin cancer Keratoses, Cancer
Respiratory	Silica Asbestos Spray paints, woods, epoxies Irritant dusts, welding fumes Organic Solvents	Silicosis, TB Asbestosis, Cancer Asthma Bronchitis Headaches, Dizziness, Cancer
Psychosomatic	Physical stress Psychosocial stress	Head aches Depression Fatigue Substance abuse
Nervous System	Lead Organic solvents	Peripheral and central neuropathy Headaches, Dizziness, Mood disorder, Dementia, Cancer

10. SAFETY OF PUBLIC/PEDESTRIANS

Access to the construction site must be cordoned off as much as possible in all work areas.
All excavations are to be fenced/barricaded to prevent access by public / pedestrians. Barriers must be of an impenetrable nature – barrier tape will not be seen as a sufficient barrier mechanism.
Work must be planned in such a manner as to ensure that the minimum number of trenches is left open after hours or during weekends.
No trenches/excavations are to be left open during any December shutdown period.
Temporary pedestrian crosses over excavations are to be of adequate width and provided with sturdy handrails.

11. FALL PROTECTION

In addition to the requirements of this regulation (CR 8) the following shall apply:

- The fall protection plan is to be prepared by a competent person. This competent person must sign the fall protection plan.
- Contents of the fall protection plan must cover all the requirements as stated in sub-regulation CR 8.
- The fall protection plan is to be handed to the agent before work commences.
- The level of supervision is to be stated in the fall protection plan.
- Medical certificates, work near edges, presence of dew, dangerous walking areas etc. should be addressed in the fall protection plan.

12. REGISTERS

- Examples of the registers listed below must be provided in the Health and Safety Plan.
- All registers must be always available at the site offices for inspection by the agent.
- The list of registers to be kept is by no means exhaustive and the H&S Plan should list all the registers that are applicable and at what frequency they are going to be maintained.

ACTIVITY	FREQUENCY	FORMAT
Form work / Support work	Daily, prior to any shift	
Excavation Work	Daily, prior to any shift, after rain or blasting or after unexpected fall of ground	
Scaffolding	Daily, prior to any shift, after rain or blasting.	
Material Hoist	Daily	
Batch Plants	Daily	
Explosive Powered Tools	Daily Before Use	
Crane(s) Logbook	As per DMR 18	
Construction Vehicles and Mobile Plant	Daily	
Temporary Electrical Installation	Weekly	
Stacking	Weekly	
Fire Extinguishers	Bi – Monthly	
Ablution Facilities	Weekly	
Ladders	Weekly	
Incident Register in terms of GAR 9	As Required	Annex 1 of GAR
Fall Protection Equipment	Daily	
Portable electrical tools	Weekly	
Suspended Platforms	Daily	
Accommodation of traffic	Daily	
Fire fighting equipment	Monthly	

13. TRAINING

Each Health and Safety Plan shall indicate the following regarding training:

- Name and contents of the following training courses which must be conducted:
  - Induction Training
  - Training regarding hazards identified and any corrective measures in place
  - Training regarding all applicable regulations
  - Specific training regarding applicable competencies
- Attendance registers must be kept as proof of training provided
- Method of informing visitors and other persons entering the site of hazards prevalent on site.
- Method of providing personal protective equipment to visitors and non-employees.
- An example of ID training card for each employee (if used).
- Methodology to be used in the issuing and communication of written instructions/safe work procedures.

14. AGENT HEALTH AND SAFETY INSTRUCTION REGISTER

- All Health and Safety instructions will be given via the resident engineer in writing
- The Principal Contractor shall be required to sign the register at the end of each day to acknowledge any instructions issued.

15. GENERAL REQUIREMENTS

- ***Personal Protective Equipment***
  The procedures for issuing and control over PPE shall be indicated in the Health and Safety Plan, as well as the enforcement for the wearing thereof.

- ***Hired Plant***
  The responsibility for the safe condition and use of all hired plant shall be that of the contractor.

- ***Transport of Employees***
  Transport of employees shall be carried out in terms of the National Road Ordinances and the OHS Act - Construction Regulations.
  The Health and Safety Plan shall detail the arrangements and methods of the transportation of workers.

- ***Signs***
  The Principal Contractor shall indicate in his Health and Safety Plan the arrangements regarding the posting of danger signs.

- ***Certificates of fitness***
  The Principal Contractor shall include in his H&S Plan copies of medical fitness certificates for the following:
  - **Crane Operators**
  - **Construction vehicles and Mobile plant operators**
  - **Pipe Jacking employees**

- **Any other medical certificates that might be applicable in terms of the other regulations governing health & safety of construction personnel such as HCS regulations and Noise induced hearing loss etc.**

- ***Site Visitors Register***
    - A site visitor's register is to be kept on site and steps are to be taken to ensure that all visitors sign the visitors' register before entering the site.
    - A sign should also be provided directing all visitors to report to
    - the site officers.

- ***Safety of excavations***
    - Provision should be made for the utilisation of geo technical services monthly to independently evaluate the safety off all excavations
    - All excavations are to be fenced/barricaded to prevent access by inter alia children and other members of the public
    - All barricading is to be maintained and protected against theft and vandalism

- ***Blasting***
    - A separate Health and Safety Plan will be required from the blasting contractor
    - The Health and Safety Plan must also be approved by the relevant Petronet servitude supervisor
    - All the requirements of the Petronet Standard Crossing Conditions and Requirements for underground Services document (Ref P2-18 (CE8)) must be complied with. This document is attached to the back this Health and Safety Specification.

16. HAZARDOUS CHEMICAL SUBSTANCES (including Asbestos and Lead)

In addition to the requirements in the HCS Regulations, the principal contractor must provide proof in the H&S Plan that:

- Material Safety Data Sheets (MSDS's) of the relevant materials/hazardous chemical substances are available prior to use by the contractor. Mention should be made how the principal contractor is going to act according to special/unique requirements made in the relevant MSDS's. All MSDS's shall be always available for inspection by the agent.
- Risk assessments are done at least once every two years.
- Exposure monitoring is done according to OESSM and by an AIA and that the medical surveillance programme is based on the outcomes of the exposure monitoring.
- How records are going to be kept safe for the stipulated period of 30 years.
- How the relevant HCS's are being/going to be controlled by referring to:
    - Limiting the amount of HCS
    - Limiting the number of employees
    - Limiting the period of exposure
    - Substituting the HCS
    - Using engineering controls
    - Using appropriate written work procedures
- The correct PPE is being used.
- HCS are stored and transported according to SABS 072 and 0228.
- Training with regards to these regulations was given.
- The H&S plan should refer to the disposal of hazardous waste on classified sites and the location thereof (where applicable).

17. ASBESTOS

Should asbestos be identified as a hazard **whilst work is carried out**, the following must be included in the health and safety plan:

- Notification to the Provincial Director in writing, prior to commencement of asbestos work.
- Proof of a structured medical surveillance programme, drawn up by an occupational medicine practitioner.
- Proof that an occupational health practitioner carried out an initial health evaluation within 14 days after commencement of work.
- Copies of the results of all assessments, exposure monitoring and the written inventory of the location of the asbestos at the workplace.
- Only proof that medical surveillance has been conducted and not the actual records itself since these areas of a confidential nature.
- How records are going to be kept safe for the stipulated period of 40 years.
- Proof that asbestos demolition (if applicable) is going to be done by a registered asbestos contractor and provide proof that a plan of work for such demolition is submitted to an Approved Asbestos Inspection Authority 30 days prior to commencement of the demolition.
- Provide proof that the plan of work was approved by the asbestos AIA and submitted to the provincial director 14 days prior to commencement of demolition work together with the approved standardised procedures for demolition work

18. LEAD

Besides the requirements listed under par. 15 should lead be identified as a hazard at the workplace, the following must be included in the health and safety plan or as soon as its available:

- Proof that an occupational health practitioner carried out an initial health evaluation within 14 days after commencement of work.
- Copies of the results of all assessments, exposure monitoring and the written inventory of the location of the lead at the workplace.
- Only proof that medical surveillance has been conducted and not the actual records since these are of a confidential nature.
- How records are going to be kept safe for the stipulated period of 40 years.

19. NOISE INDUCED HEARING LOSS

Where noise is identified as a hazard the requirements of the NIHL regulations must be complied with and the following must be included/ referred to in the Health and Safety Plan:

- Proof of training with regards to these regulations.
- Risk assessment done within 1 month of commencement of work.
- That monitoring carried out by an AIA and done according to SABS 083.
- Medical surveillance programme established and maintained for the necessary employees.
- Control of noise by referring to:
    - Engineering methods considered
    - Admin control (number of employees exposed) considered
    - Personal protective equipment considered/decided on
- Describe how records are going to be kept for 40 years.

20. LIGHTING

Where poor or lack of illumination is identified as a hazard the lighting regulations must be complied with, and the following must be included in the H&S Plan:

- How lighting will be ensured/ provided where daylight is not sufficient and /or after hours are worked.
- Planned maintenance programme for replacing luminaries.
- Proof of illumination levels of artificial illumination equipment.

21. HAZARDOUS BIOLOGICAL AGENTS (HBA)

Because of the possible exposure of workers to raw sewage the H&S Plan shall include details of the following:

- The conducting of Risk Assessment specifically aimed at exposure to HBA which shall include the following:
  - Nature and dose of HBA
  - Where HBA may be present and in what physical form
  - The nature of work or process
  - Steps in the event of failure of control measures
  - The effect of the HBA
  - The period of exposure
  - Control measures to be implemented

- Monitoring of exposure of workers shall be conducted to establish whether any worker is infected with an HBA associated with working or being exposed to raw sewage, in terms of the following:
  - By an occupational medical practitioner
  - Before entering the site to establish the worker's baseline
  - During the period of the contract the risk assessment indicate possible exposure
  - After completion of the contract

- Medical surveillance should such be required after the above-mentioned by an occupational health practitioner.

- Indication on how all records of assessment, monitoring, etc will be kept, considering that records have to be kept for a period of 40 years.

- How exposure to HBA is to be controlled

- The provision of personal protective equipment

- What information and training is to be provided to employees regarding the following:
  - The contents of these regulations
  - Potential risks to health
  - Control measures to be implemented
  - The correct use and maintenance of personal protective equipment
  - The results of the risk assessment.

General Notification

This document forms an integral part of the tender document and, in particular, shall constitute the Client's (City of Tshwane.) Occupational Health & Safety Specification, as required by the Construction Regulations, 2014, as promulgated under the Occupational Health and Safety Act (Act no. 85 of 1993).

This 'Health and Safety Specifications' document is governed by the "Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), hereinafter referred to as 'The Act'. Notwithstanding this, cognizance should be taken of the fact that no single Act or its set of Regulations can be read in isolation. Furthermore, although the definition of Health and Safety Specifications stipulates 'a documented specification of all health and safety requirements pertaining to associated works on a construction site, so as to ensure the health and safety of persons', it is required that the entire scope of the Labour legislation, including the Basic Conditions of Employment Act be considered as part of the legal compliance system. With reference to this specification document this requirement is limited to all health and safety issues pertaining to the site of the project as referred to here-in. Despite the foregoing it is reiterated that environmental management shall receive due attention.

Due to the wide scope and definition of construction work, every construction activity and site will be different, and circumstances and conditions may change even on a daily basis. Therefore, due caution is to be taken by the Principal Contractor when drafting the Health and Safety Plan based on these Health and Safety Specifications. Prior to drafting the Health and Safety Plan, and in consideration of the information contained here-in, the contractor shall set up a Risk

Assessment Program to identify and determine the scope and details of any risk associated with any hazard at the construction site, in order to identify the steps needed to be taken to remove, reduce or control such hazard. This Risk Assessment and the steps identified will be the basis or point of departure for the Health and Safety Plan. The Health and Safety Plan shall include documented ‘Methods of Statement’ (see definitions under Construction Regulations) detailing the key activities to be performed in order to reduce as far as practicable, the hazards identified in the Risk Assessment.

Table of Contents

List of Tables

List of Figures

1 Definition of Terms

I. Client - means any person for whom construction work is performed and or undertaken (City of Tshwane for the purposes of this project).

II. Construction site - means a workplace where a construction work is being performed.

III. Construction supervisor - means a competent person responsible for supervising construction activities on a construction site.

IV. Competent person means a person who –

a) Has in respect of the work or task to be performed the required knowledge, training and experience and where applicable, qualifications, specific to that work or task: Provided that where appropriate qualifications and training are registered in terms of the provision of the National Qualification Framework Act 2000 (Act 67 of 2000), those qualifications and that training must be regarded as the required qualification and training and

b) Is familiar with the Act.

V. Principal Contractor - Means an employer, as defined by Section 1 of the OHSACT who performs construction work and is appointed by the client to be in overall control and management of the construction site and works.

VI. Agent - Means a competent person who acts as a representative for a client in this case MIH Projects.

VII. Occupational Health and Safety Specification - Means a documented specification of all Health and Safety requirements pertaining to the associated works on a construction site so as to ensure the health and safety of persons working , visiting, passing, staying and working close to the construction site and or other applicable areas such as the site camp

VIII. Risk - means the probability that injury or damage may occur.

IX. Hazard - means a source of or exposure to danger.

2 Introduction

In terms of the Construction Regulation 5 (1) of the OHS ACT, the client is required to compile an Occupational Health and Safety Specification for an intended project. This specification has an objective to ensure that the principal contractor entering into a contract with the client achieves and maintain an acceptable level of Occupational Health and Safety performance and compliance.

This document forms an integral part of the contract between the client and the principal contractor.

The Principal Contractor and its Contractors shall furthermore implement any reasonable practicable means to ensure compliance to this Occupational Health and Safety Specification and any other applicable legislation on their organization and/or activities performed by or for them.

Compliance with this document does not absolve the principal contractor from complying with any other minimum legal requirement and the principal contractor remains responsible for the health and safety of his employees, those of his mandatories as well as any person coming on site or on adjacent properties as far as it relates to the construction activities

2.1 The Client `s commitment to Occupational Health and Safety Management

City of Tshwane is committed to responsible occupational health, safety management. This commitment is essential to protect the environment, employees, mandatories, visitors and provide a work environment conducive to health and safety.

Scope

This project specific Occupational Health and Safety Specification will cover and address reasonable and foreseeable, risks, exposures and aspects of Occupational Health and Safety as affected by the activities of SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF EQUIPMENT FOR THE UPGRADING OF KWAGGA 132/11kV SUBSTATION – USD EE XX XX XX.

The specification will provide the requirements that the principal contractor and other contractors have to comply with as required by the construction regulations..

2.2 Omissions from OHS Specification

Where any omission from the OHS Specification is identified, applicable legal requirements will constitute the minimum standard for compliance to the relevant omission. The responsibility will be on the Principal Contractor to provide assurance to the client (City of Tshwane) on compliance to the applicable legal requirements related to the activity / task / process.

2.3 Change or Review of Specifications

Whenever the client (City of Tshwane) identifies the need to change or review the OHS Specification, approved changes and revisions will be communicated to the Principal Contractor. A cost analysis on the implementation of the proposed changes / revisions will be calculated through a collaborative process between the Client and the Principal Contractor –

where the approved changes and/or revisions has no cost implication for the Principal Contractor the Principal Contractor will be required to accept the approved changes / revisions and ensure implementation within the OHS Plan.

3 Safety Files

3.1 Preparation and Submission of safety file

The Principal Contractor shall prepare a safety file containing the processes / procedures and templates to be applied during the project period for the scope of work. The Principal Contractor will be evaluated during the contract period against the submitted safety file.
At a minimum the safety file shall contain the following documentation and in accordance with the specification:

1. Construction work permit
2. Scope of work to be performed.
3. Public Liability
4. Personnel list (Principal Contractor employees)
5. OH&S Policy and other procedures
6. Updated copy of the Occupational Health and Safety Act (Act no. 85 of 1993) and its Regulations.
7. Updated copy of the Compensation for Occupational Injuries and Diseases Act (Act no. 130 of 1993) and its Regulations;

8. Proof of valid registration and good standing with the Compensation Commissioner or another licensed Insurer;
9. OHS Plan approved by the Client.
10. Agreement with Mandatory in terms of Section 37(1) &2 of the OHS Act.
11. Approved risk assessments, review and monitoring plans and safe work procedures (method statements);
12. A list of contractors (sub-contractors) including copies of the agreements between the parties and the type of work being done by each contractor;
13. All written designations and appointments for project scope of work (CV and competency copies);
14. Management structure (inclusive of OH&S responsibility & meeting structure);
15. Induction training and site OHS rules;
16. Occupational health and safety training matrix / plan;
17. Arrangements with contractors and/or mandatories;
18. The following registers (as applicable to contract scope of work):
    - Accident and/or incident notifications, investigation & control register;
    - Occupational health and safety representatives inspection register;
    - Construction vehicles and mobile plan inspections;
    - Daily inspections templates of vehicles, plant and other equipment by the operator, driver and/or user;
    - Daily inspections templates of excavations by competent person;
    - Template for entry into confined space;
    - Toolbox talks pro-forma;

- Designer's inspections and structures record template;
- Inspection and maintenance template of explosive powered tools;
- Inspection template of electrical installations (including inspection of portable electrical tools, electrical equipment and other electrical appliances);
- Fall protection inspections template;
- First-aid box content template;
- Record of first-aid treatment template;
- Fire equipment inspection and maintenance template;
- Record of hazardous chemical substances template kept and used on site;
- Ladder inspection template;
- Machine safety inspections template (including machine guards, lock-outs etcetera);
- Inspection templates for lifting machines and –tackle (including daily inspections by drivers/operators);
- Inspection templates of scaffolding;
- Inspection templates of stacking and storage;
- Inspections templates of structures;
- Inspections templates of vessels under pressure;
- Inspection templates of welding equipment; and
- Templates of issuing of Personal Protective Equipment;
- Monthly reporting and recording of statistics templates;

- Keeping of any other record in terms of applicable legislation falling within the scope of OHS Legislation applicable to the project and the Principal Contractor / Contractor's activities and organization.
- Emergency preparedness and response programmes;

3.2 Evaluation of Safety file and approval of OHS plan

The client (City of Tshwane) will conduct an initial inspection and evaluation of the Principal Contractor's OHS file and approval of the OHS plan before commencement of work.
NOTE: The construction work cannot commence until the safety plan is approved.

3.3 Principal Contractor engagement phase

The Principal Contractor shall commence with the construction work after approval of the safety plan. The following processes will be applied to the Principal Contractors monthly for the duration of the contractual period:

- Monthly Compliance Assessments;
- Site Inspections;
- Progress meetings;

An initial site establishment inspection will be conducted by the Client after approval of the safety file / plan.

3.4 Project close-out and submission of consolidated Health & Safety File.

On completion of a construction work/ project the Principal Contractor shall submit all documentation acquired throughout the life span of the project.

4 OHS Specification Requirements

4.1 General Requirements of Health and Safety Plan

Construction Regulation 7 (1) stipulates that the principal contractor must provide and demonstrate to the client a suitable sufficiently documented and coherent site specific health and Safety Plan, based on the client’s documented Health and Safety Specification contemplated in Regulation 5(1) (b), which plan must be applied from the date of commencement of and for the duration of the construction and which must be reviewed and updated by the principal contractor as work progresses.

It is expected from the Contractor to include in his safety plan method statements on how to accomplish the requirements relating to the Construction Regulations, 2014 and related incorporated standards and regulations.

Principal Contractors should describe how their safety management systems will work and what control procedures they plan on using to ensure safety on the construction site

The following generic aspects should be covered in the Safety plan:

- What administrative procedures the Principal Contractor envisages to use in the implementation and maintenance of the safety plan with reference to the construction site
- How continuous assessment of the safety plan will be assessed and implemented with respect to construction site
- What control systems the Principal Contractor envisages to implement on site to support his safety program
- How the Principal Contractor will ensure that he adheres to the construction regulations in respect of competent persons for appointments
- What external resources the Principal Contractor envisages on using to ensure successful implementation and sustainability of the safety plan
- What training to employees the Principal Contractor envisages and how he would go about to execute it
- The Principal Contractor should indicate which competent persons he plans on employing based on the scope of work.

5 Outline of Health and Safety Plan

The Principal Contractor’s Health and Safety Plan prepared in accordance with this specification shall consist of at least the following sections and sub-sections:

1. Aim and Scope of Plan,
2. OHS specifications

3. Risk Assessment,
    a. Alternative Forms of Risk Assessment,
    b. Methodology of Risk Assessment,
    c. Elements of Risk Assessment,
        i. Scope of assessment,
        ii. Risks Identified,
        iii. Risk Analysis,
        iv. Risk Evaluation,
        v. Risk Treatment (safe working procedures)
        vi. Monitoring and reviewing,
4. Resources,
    a. Health and Safety Staffing Organogram,
    b. Employees,
    c. Subcontractors inclusive of their scope of work and their core resources,
    d. Training,
    e. Plant,
    f. Vehicles,
    g. Equipment
5. Materials,
    a. Temporary Materials
    b. Permanent Materials
6. Categories of Work
7. Implementation of Health and Safety Plan,

   a. Administrative systems,
   b. Training,
   c. Reporting,
   d. Monitoring,
   e. Inspections,

8. Auditing,
   a. Self-audits
   b. Contractors' audit reports
9. Emergency procedures and response

6 Risk Assessment

6.1 General

This section of the specification provides guidelines for the Contractor in preparation of risk assessments to ensure compliance with Regulation 9 of the Construction Regulations, 2014. According to SANS 31000:2009, Risk is the overall process of risk identification, risk analysis, and risk evaluation. This section highlights the principles related to the preparation of suitable and sufficient risk assessments. Contractor Staff intending to prepare risk assessments should be trained and suitably experienced in the application envisaged.

A suitable and sufficient risk assessment is an assessment which:

- Accounts for risks that are likely to arise during the construction of the Works,
- Enables the development and implementation of systems to manage the risks,
- Remains valid for a reasonable period of time,
- Provides a basis for training of employees, and

- Improves working procedures and introduce long term controls.

The requirements of the Construction Regulations will not be satisfied by a single risk assessment exercise that holds good for all time. The risk assessment process on the Works is an ongoing process.

The objectives of risk assessments are to:

- Identify the risks that are mostly in need of reduction,
- Identify the various options for achieving such reduction,
- Identify the risks that require careful ongoing management, and
- Identify the nature of the required ongoing attention.

6.2 Forms of Risk Assessment

In order to ensure compliance with the Construction Regulations, the Contractor will be required to carry out the following three forms of risk assessment:

6.3 Activity based risk assessment

The Contractor will be required to carry out activity-based risk assessment before the commencement of construction activities on the Works. This risk assessment will form part of the Contractor's Health and Safety Plan. The risks and hazards to which persons, plant, vehicles and facilities may be exposed during the construction of the Works should be identified and evaluated. Measures to reduce or control these risks or hazards should be defined during this assessment. The effectiveness of the measures defined and the baseline risk assessment prepared shall be monitored and reviewed from time to time to ensure that it remains relevant and accurate.

6.4 Issue based risk assessments

The Contractor shall be required to carry out separate risk assessments during construction of the Works when methods and procedures are varied, for example when:

- Designs are amended,
- New machines are introduced,
- Plant is periodically cleaned and maintained,
- Plant is started-up or shut-down,
- Systems of work change or operations alter,
- Incidents or near-misses occur, or
- Technological developments invalidate prior risk assessments

6.5 Continuous risk assessments

The principal contractor shall continuously conduct risk assessment to the end of the construction work.

6.6 Methodology for the Preparation of Risk Assessments

The Contractor shall in the preparation of risk assessments, follow the following general principles:

- Appoint in writing a suitably competent risk assessor
- The appointed risk assessor shall lead the risk assessment process
- Provide the team with background data, scope of work, potential hazards and underlying causes, and

- Where necessary employ experts for complex risk assessments and aspects of risk assessments that require experiential judgment,
- Institute an ongoing system of identifying aspects of the work that require risk assessment.

6.7 Elements of a Risk Assessment

The process of carrying out a risk assessment consists of a number of well-defined steps. These steps improve decision-making by providing a greater understanding of the risks and their impacts. The main steps or elements of the risk assessment process are as follows:

1) Consider scope and nature or risks involved, determine purpose and physical and legal bounds of assessment and define risk evaluating criteria,
2) Systematically identify risks,
3) Analyze risks with regard to causes, likelihood of occurrence and possible consequences against the background of existing controls and its effectiveness,
4) Evaluate risks in terms of pre-established criteria to determine need and priority for attention,
5) Treat risks through a process of risk elimination, substitution, controlling risk at source, risk mitigation such as training and as far as risk remains, provide personal protective equipment (PPE),
6) Monitor and review progress and performance in terms of management system, and
7) Communicate and consult.

The above steps are as depicted in Figure 1, below.

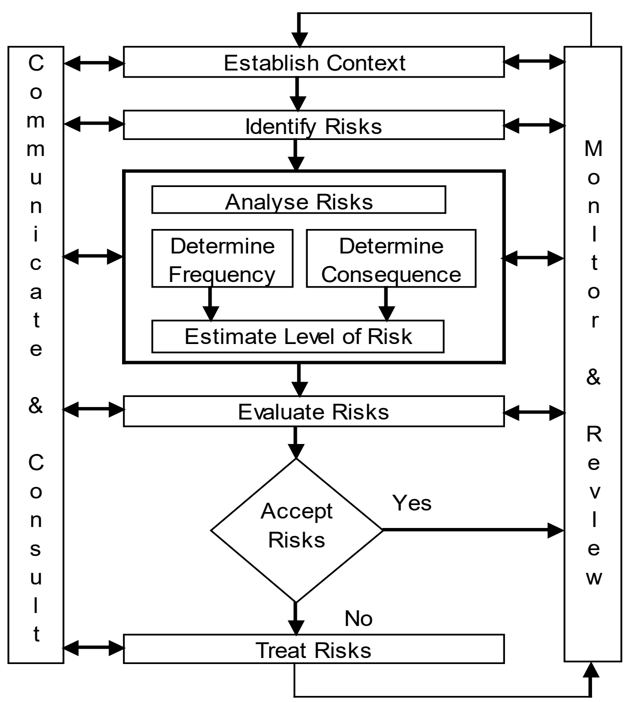

Figure 1: Risk Management Process

The Contractor shall ensure that the risk assessment compiled as part of his Health and Safety Plan contains at least these items.

Refer to Baseline Risk Assessment Annexure 2 of this specification.

6.8 Risk Identification

The Contractor should regard this step of the risk assessment as the most important. Subsequent analysis and evaluation of risks and the development of risk control measures are wasted if the risks or hazards on the Works are not carefully identified.

The Contractor should bear the following principles in mind when identifying the risks:

i) Systematically address all risks or hazards on the Works,

ii) Review all aspects of the work, but consider only those that have a potential to cause harm,

iii) Rank the risks identified in order of importance and then use appropriately advanced techniques to deal with major risks,

iv) Deal mainly with major risks and don’t obscure these with unimportant information, especially minor risks,

v) Address what actually happens in the workplace during the work activity

vi) Consider all persons that may be affected,

vii) Highlight those groups and individuals who may particularly be at risk, and

viii) Review the adequacy and effectiveness of existing safety controls and measures

6.9 Risk Analysis

In this step, the Contractor will be required to analyze the risks identified by determining each risks frequency and magnitude or severity of the consequence of the risk or hazard.

The frequency of occurrence of a hazard may be expressed as the number of times that it may occur in year, decade, lifetime, century, or longer period, according to comparative human experience. The magnitude of the likely consequence of a hazard may be expressed in terms of the degree of incapacitation, number of people or costs involved. The frequency of occurrence of a hazard and the magnitude of its consequence may be compounded as the risk that it poses as shown in the "risk matrix" in Figure 2 below.

Frequency of Occurrence of Hazard	Severity of Consequences of Potential Hazard					
	1 Medically treatable injury	1 Compensable injury	10 Compensable injuries	1 Permanently disabling injury	1 Fatality	10 Fatalities
Frequent; 1 or more occurrences per year	Medium	High	Very high	Severe	Severe	Severe
Several times during a career; 0.1 occurrences per year	Medium-low	Medium	High	Very high	Severe	Severe
Unlikely, but possible during a career; 0.01 occurrences per year	Low	Medium-low	Medium	High	Very high	Severe
Very unlikely during a career; 0.001 occurrences per year	Low	Low	Medium-low	Medium	High	Very high
Barely credible; 0.0001 occurrences per year	Low	Low	Low	Medium-low	Medium	High

Figure 2: Compounded Risk Matrix

The columns in the table represent the likely consequence of the hazard and the rows, the frequency of occurrence. The scales for both quantities represent consistent progressions, able they qualitative. The risks evidently range from low to severe. Note that diagonals in the matrix represent the risks of the identified hazards, taking the effectiveness of controls into consideration.

The table represents a typical risk matrix that need not necessarily be adopted by the Contractor. The Contractor may use an alternative risk matrix provided that it is approved as part of his Health and Safety Plan.

6.10 Risk Evaluation

In this step the Contractor will be required to compare the risks found during the analysis process with similar risks previously experienced for the purpose of deciding how to treat the risk. A useful systematic approach for this purpose is as follows:

- If the assessed risk exceeds similar risks that have occurred in the past and that are considered to be unacceptable, the assessed risk would require treatment depending upon its magnitude as discussed in Section 4.4.5, or
- If the assessed risk exceeds similar historical risks that are acceptable, treatment of the assessed risk will depend on the extent by which it exceeds the historical risks, or
- If the assessed risk is less than historical risks that are unacceptable, treatment of the assessed risk will depend on the extent by which it is less than the historical risks, or
- If the assessed risk is less than historical risks that are acceptable, the assessed risk would also be acceptable and would not require any treatment.

6.11 Risk Treatment

The contractor must select one or more options of modifying risks, and implementing those options. The option(s) selected must be covered in the safety plan and be followed as prescribed. Reference can be made to SANS31000:2009 for different risk treatment options. SANS 31000:2009, clause 5.5.3 may be consulted in preparing and implementing risk treatment plans.

6.12 Reporting and Recording of Risks

The Principal Contractor shall ensure that the risk assessment process is recorded and included in the Health and Safety Plan. The risk assessment document should be easily accessible to the Contractor's employees, their representatives, to inspectors, the Employer or his Safety Agent. The essential contents of the document should be as follows:

- Objectives and expected outcomes,
- Description of the Works under assessment,
- Summary of context of study
- Composition of risk assessment team, (including qualifications and relevant experience),
- Approach used to systematically identify risks,
- Identified risks (ranked in order of priority),
- Method adopted for assessing frequencies and consequences of risks,
- Consequences (ranked in order of magnitude),
- Identification of individuals and groups who may be affected by major hazards and risk and who may especially be at risk,

- Basis for defining safety standards to be achieved,
- Contractor’s resources devoted to risk assessment,
- Actions proposed to reduce unacceptably high risks,
- Review effectiveness of existing safety measures to control risks, and
- Implementation of program of selected treatments (including controls to manage unacceptably high risks).

7 Monitoring and Review

The contractor must indicate in the safety plan the monitoring and review plans to be used during the construction work.

8 Communication and Consultation

The Principal Contractor will be required to communicate and consult with internal and external stakeholders during each step of the risk assessment process. Stakeholders will include the Client or Safety Agent, the Engineer and the Contractor’s employees and consultants.

9 Resources

9.1 General

In this section of his Health and Safety Plan, the Contractor will be required to state how he intends to comply with the requirements of the Occupational Health and Safety Act, 85 of 1993 and all its Regulations and related incorporated standards with regards to the resources and facilities intended for use on the project (construction work).

9.2 Employees

The Principal Contractor shall provide in the Health and Safety Plan their intended Staffing Organogram for the construction work. The organogram should include all applicable legal appointments and supervisors as contemplated in the Construction Regulations 2014.

Copies of the supervisory staffs’ curriculum vitae or portfolio of evidence, proof of competence and their appointment letters should be appended to the Contractor’s Health and Safety Plan.

The Principal Contractor’s Health and Safety Plan should in addition cover at least the following aspects:

- The number of unskilled, semi-skilled and skilled (including Foreman, Charge hands, Artisans, Operators, Drivers, Clerks, Store man and Team Leaders) employees he intends employing on the Works,
- The health and safety training to be provided to the Contractor’s employees,
- The program of the health and safety training,
- Systems for the review of the effectiveness of the training provided, and
- Systems to determine further training requirements throughout the construction period.

The Principal Contractor shall indicate in the Health and Safety Plan all the legal appointments required for the construction work. The Principal contractor may make other additional legal appointments that are applicable to the project.

9.3 Competencies

The Principal Contractor shall appoint competent person to perform duties that require competency and shall provide proof thereof.

9.4 Physical and Psychological Fitness

The principal contractor shall ensure that all employees are in possession of a valid medical certificate of fitness to work in such an environment and issued by an occupational health practitioner in the form of Annexure 3 of the Construction regulations.

9.5 Contractors

The Principal Contractor shall with reference to the use of contractors on the project and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- The steps intended to ensure that his contractors prepare, implement and maintain Health and Safety Plans,
- How health and safety information will be made available to his contractors when changes are brought about to the design,
- How he intends determining that his contractors are registered and in good standing with the compensation fund or with a licensed compensation insurer prior to the commencement of the Works,
- How he intends determining if his contractors have made provision in their tenders for the cost of health and safety measures during the construction of the Works,
- How he intends satisfying himself on the competencies and resources of contractors he intends appointing, and

- How he intends ensuring that his contractors perform risk assessments prior to commencing their respective portions of the Works.

10 Fall Protection Equipment

The principal contractor shall with reference to Section 10: Fall Protection Equipment of the Construction Regulations, 2014, and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- Appoint in writing a competent fall protection planner,
- Compilation of a fall protection plan,
- How the fall protection plan will be implemented and maintained,
- How employees will be screened and declared medically fit to work in areas where fall protection equipment is needed,
- How the safeguarding of persons, plant, vehicles, equipment and facilities on the construction site is contemplated,
- Training of staff working at heights and in the use of fall protection equipment,
- How a continuous assessment of the situation will be executed,
- How fall protection equipment will be inspected for safety, and
- How corrective actions will be implemented
- Emergency plans and procedures for treatment of incidents relating to falls from height.

11 Structures

The Principal Contractor is required to adhere to Section 11: Structures of the Construction Regulations 2014, and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- How the uncontrolled fall of structures will be prevented
- How will maintenance of the structure be carried out

12 Temporary works

The Principal Contractor is required to adhere to Section 12: Temporary works of the Construction Regulations, 2014, and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- How the design of Temporary works will be carried out,
- How will the Principal Contractor ensure competent supervision of Temporary works
- How the erection of Temporary work structures will be managed,
- How the continuous assessment of the safety of Temporary work structures will be done,
- How the loading/moving of Temporary work structures will be managed or limited,
- How he intends to provide safe access for all work to be carried out above the foundation bearing level, and
- How he intends keeping records of the above.

13 Excavation work

Principal Contractor is required to adhere to Section 13: Excavation work, of the Construction Regulations, 2014.

The Principal Contractor must discuss the following in detail in his safety plan:

- How will the Principal contractor ensure competent supervision of excavation work
- How will the Principal Contractor establish the stability of ground prior to excavations,
- What steps will the Principal Contractor follow to ensure that bolstering, shoring and bracing is sufficient to ensure the safety of the excavation, and
- What steps will the Contractor follow to ensure the equipment used to safeguard an excavation is sufficient and safe?

14 Demolition work

Principal Contractors is required to adhere to Section 14: Demolition work, of the Construction Regulations, 2014.

The Principal Contractor shall discuss the following in detail in his safety plan:

- Appoint a competent person in writing to supervise and control all demolition work on site
- Method statement of demolition and demolition certificate
- Briefly explain how he will safeguard people and property during and after demolition works

- Briefly explain how he will protect staff from dangerous situations
- Discuss the methods proposed to safeguard the public and property against harm during demolition works
- Discuss what type of equipment he envisage to use during demolition work
- How will the Contractor ensure the safety of equipment used during demolition work
- What steps will the Contractor deem necessary to take where hazardous materials is encountered
- How he will comply with the explosives legislation where the demolishing work involves the use of explosives
- Dust control measures
- Noise control measures

15 Scaffolding

The Principal Contractor shall with reference to Section 16: Scaffolding of the Construction Regulations, 2014, and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- Appoint competent person in writing for scaffolding operations supervision,
- How compliance with SABS 085 will be ensured,
- How scaffolding in use will be maintained,
- What systems are intended to ensure the safety of scaffolding used,
- What tests will be performed to establish the safety of scaffolding used, and

- Training plan for scaffold erectors and inspectors.

16 Suspended platform

The Principal Contractor shall with reference to Section 17: Suspended platforms of the Construction Regulations, 2014, and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- Appoint in writing a competent person who will supervise all suspended platform works operations.
- What systems he intends using to ensure the safety of all suspended platforms,
- What tests will be performed to establish the safety of suspended platforms,
- How he intends maintaining suspended platforms being used, and
- How he will document the design, testing, maintenance and inspections of the suspended platforms.

17 Material hoists

The Principal Contractor shall with reference to Section 19: Materials Hoist, of the Construction Regulations, 2014, and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- How he intends confirming the construction stability of the material hoists,
- Appoint in writing a competent person to inspect material hoist
- What systems he intends using to ensure the safety of all material hoists,

- How inspections will be carried out daily
- What tests will be performed to establish the safety of all material hoists,
- How he intends maintaining the material hoists being used, and
- How he will document the design, testing, maintenance and inspections of all material hoists and
- Ensure competence of operators of hoist material
- What safety procedures and precautions are envisaged to ensure safe operation of the materials hoists?

18 Bulk Mixing Plant

The Principal Contractor shall with reference to Section 20: Bulk mixing plants of the Construction Regulations, 2014, and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- What systems he intends using to ensure the safety of all bulk mixing plants,
- Appointment in writing of a competent person to supervise the operation of the bulk mixing plant
- How he intends maintaining the bulk mixing plants in use, and
- How he will document the design, testing, maintenance and inspections of bulk mixing plants in use.

19 Explosive actuated fastening Device (if required)

The Principal Contractor shall with reference to Section 21: Explosive actuated fastening device, of the Construction Regulations, 2014, and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- Appointing a competent person for operation, maintenance and use of explosive actuated fastening devices,
- How he intends controlling the issuing of explosive actuated fastening device,
- How he intends implementing safety procedures prior to use of explosive actuated fastening devices, and
- What safety measures will be required during the use of explosive actuated fastening devices?

20 Cranes

This section of the specification shall be read in conjunction with the provisions of the Driven Machinery Regulations, 1988.

The Principal Contractor shall with reference to Section 22: Cranes, of the Construction Regulations 2014 and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- How will environmental factors be taken into account in respect to the use of cranes,
- What systems he intends using to ensure the safety of all cranes in use,
- How he intends maintaining cranes in use,

- What tests will be performed to establish the safety of all cranes in use,
- What safety procedures and precautions are envisaged to ensure the safe operation of all cranes in use,
- How he will proof the medical fitness of the tower crane operators,
- How he will document the design, testing, maintenance and inspections of all cranes in use, and
- The Principal contractor shall proof compliance of the Driven Machinery Regulation, 1988, with reference to the lifting machinery and tackle being used.

21 Construction vehicles and mobile plant

The Principal Contractor shall with reference to Section 23: Construction vehicles and mobile plant of the Construction Regulations, 2014, and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- How he intends ensuring that construction vehicles and mobile plant are:
  - Of acceptable design and construction,
  - Maintained and in good working order,
  - Used according to design specifications, and
  - Are protected from falling into excavations, water or areas lower than the working surfaces,
- How he intends ensuring that workers are competent, authorised and physically fit to operate construction vehicles and mobile plant,

- What traffic arrangements and safety precautions will be implemented to ensure safe operation of construction vehicles and mobile plant on the Works,
- How he intends to comply with the National Road Traffic Act 1996, and
- How he intends safeguarding employees against construction vehicles and mobile plant moving on the construction site.

22 Electrical Installation and Machinery on construction sites

This section of the specification shall be read in conjunction with the provisions contained in the Electrical Installation Regulations, 1992.

The Principal Contractor shall with reference to Section 24: Electrical Installation and machinery on construction sites of the Construction Regulations, 2014, and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- Appointment of competence person for all temporary control and inspection of all temporary electrical installations,
- How he intends safeguarding employees against electrical cables or apparatus under, over or on site, and
- How he will ensure that electrical installations are of adequate strength to withstand working conditions on a construction site.

23 Use and temporary storage of flammable liquids on construction sites

This section of the specification shall be read in conjunction with the provisions for the use and storage of flammable goods as determined in the General Safety Regulations.

The Principal Contractor shall with reference to Section 25: Use and temporary storage of flammable liquids on construction sites of the Construction Regulations, 2014, and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- How flammable liquids will be stored to minimize the risk of fire or explosions,
- How the contractor will identify a flammable store
- What safety precautions will be employed if ventilation of the flammable store is not possible,
- How access to flammable stores will be controlled,
- How empty vessels used for the storage of flammable liquids will be disposed of,
- What quantity of flammable liquids will be stored on the construction site,
- What systems are intended to ensure the safe storage of flammable liquids, and
- What retaining methods will be used to prevent the spreading of any spillage?

24 Water Environments

The Principal Contractor shall be required to adhere to Construction Regulation 26: Water Environments, of the Construction Regulations, 2014.

The Principal Contractor must discuss the following in detail in his safety plan:

- What precautions will the Contractor take to identify dangers where employees may fall into water

- What safety procedures and equipment will the Contractor implement to safeguard employees working at water environments

NB: The principal contractor shall provide the environmental management plan (EMP)

25 Housekeeping and general safeguarding on construction sites

Principal Contractors shall be required to adhere to Section 27: Housekeeping and general safeguarding on construction sites, of the Construction Regulations, 2014.

This regulation must be read in conjunction with the provisions of the Environmental Regulations for Workplaces, 1987 (as amended).

The Principal Contractor must discuss the following in detail in his safety plan:

- How will contractors ensure the neatness of construction sites
- What measures does the Contractor envisage to
  - Store and/or stack materials,
  - Remove debris from site,
  - Prevent unauthorized entrance to the site
  - Protect employees or passers-by from falling objects

26 Stacking and storage on construction site

This section of the specification shall be read in conjunction with the provisions for the stacking of articles contained in the General Safety Regulations.

The Contractor shall with reference to Section 28: Stacking and storage on construction sites of the Construction Regulations, 2014, and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- Who will supervise the stacking and storage of materials on site,
- What systems are intended to ensure the safe stacking and storage of materials on the site ,and
- How he will keep the storage areas neat and under control

27 Fire precaution on construction sites

Principal Contractors will be required to adhere to Section 29: Fire precautions on construction sites, of the Construction Regulations, 2014.

This regulation must be read in conjunction with the provisions of the Environmental Regulations for Workplaces, 1987 (as amended).

The Principal Contractor must discuss the following in detail in his safety plan:

- How the Principal Contractor will minimize the risk of fire on the site
- How the Principal Contractor will identify potential fire hazards
- What prohibitions the Contractor will implement to manage risk areas
- How many employees the Principal Contractor will train in firefighting as per risk assessment
- What organization the Principal Contractor envisage to combat fires on sites

- What precautions and procedures will be followed to evacuate employees in the case of a fire

28 Construction employees' facilities

Principal Contractors shall be required to adhere to Section 30: Construction welfare facilities of the Construction Regulations, 2014.

This regulation must be read in conjunction with the provisions of the Facilities Regulations, 1990 (as amended) and SANS 10400.

The Principal Contractor must discuss the following in detail in his safety plan:

- How will the Principal Contractor establish the amount of facilities required for employees to shower, change, eat and attend to sanitary needs
- What measures will the employer take to house employees on site who lives far from their residences or for the provision of transport?

29 Operational Control of the Construction Site

In this section of the principal contractor's Health and Safety Plan, the PC shall state how they intend to comply with the requirements of the Occupational Health and Safety Act, 1993 and all its regulations and related incorporated standards with regards to the execution of all categories of work.

30 Personnel Safety Equipment and Facilities

The Principal Contractor shall comply with Section 2 of the General Safety Regulations and shall in particular provide all necessary personnel protective equipment for the personnel for the duration of the construction period. To this end the Contractor shall without limiting his obligations indicate in his Health and Safety Plan:

- Identify training requirements in the use and maintenance of personal protective equipment,
- The type of personnel safety equipment he will provide, in line with the identified risks
- How they intends issuing it to their employees, and

How he will maintain the personnel safety equipment issued.

31 Display of substituted notices and Signs

The following notices and signs are, where applicable, compulsory on the construction site as well as the contraction yards.

Area/Activity where construction sign is needed	**Notice or sign required in**
Display of notices and signs	General Safety Regulation 2b
Entry	General Safety Regulation 2 (c)
First Aid box	General Safety Regulation 3 (6)
Toilets and Change rooms	Facilities Regulation 2(5).4 (2) (f)

Hazardous and Chemical Storage area	General Safety Regulation 4 (8) (i) and (ii)
Machinery	General Machinery Regulation 9
Prohibition of smoking and eating or drinking at workplaces where high risk substances are stored or handled	Facilities Regulation 7

Table 1: Notices and signs

32 First Aid, Emergency Equipment and Procedures

The Principal Contractor shall comply with Section 3 of the General Safety Regulations regarding first aid, emergency equipment and procedures.

- How he intends to ensure competence of first aiders and
- What emergency equipment will be used

33 Welding, flame cutting, soldering and similar operations

The Principal Contractor shall comply with Section 9 of the General Safety Regulations, with regards to the welding, flame cutting, grinding, soldering or similar operations associated with pipework.

How the contractor intends it inform employees of the Safe operations and use of equipment and hazards which may arise.

34 Ladders

The Principal Contractor shall with reference to Section13A of the General Safety Regulations and without limiting his obligations, cover at least the following matters in his Health and Safety Plan:

- How he intends ensuring that ladders used are safe and constructed of materials approved for its intended use, and
- What precaution will be made to ensure the stability of ladders in use?

35 Environmental Conditions

The Principal Contractor shall comply with the Environmental Regulations for Workplaces, 1987, and shall address the following aspects as described in the regulations in his Health and Safety plan:

- Thermal requirements,
- Lighting,
- Windows,
- Ventilation,
- Housekeeping,
- Noise and hearing conservation,
- Precautions against flooding, and
- Fire precautions and means of egress.

NB: The principal contractor shall provide the environmental management plan (EMP)

36 Hazardous Chemical Substances

The Principal Contractor will be required to adhere to the Regulations for Hazardous Chemical Substances 1995 as amended in the handling and storage of hazardous chemical substances.

The Principal Contractor must discuss the following in detail in his safety plan in respect of each hazardous chemical substance that will be used in the works:

- Storage of substance
- Handling of substance
- Protective clothing and other devices to be used while handling the substance
- Medical surveillance.
- How will he ensure that employees are adequately and comprehensively informed and trained

37 Implementation of Principle Contractors' Health and Safety Plan

37.1 General

The Principal Contractor shall describe in his Health and Safety Plan how he intends implementing his OHS plan.

The Principal Contractor shall indicate the methods he intends using to ensure accurate record keeping of all critical elements identified in his risk assessment and covered in his Health and Safety Plan.

The Principal Contractor shall indicate:

- How internal audits will be carried out,
- How audit findings will be addressed,
- How he would implement the corrective measures and recommendations of internal audits or inputs of employees.

- How he intends to review the safety plans,
- How he would train staff and keep training records

37.2 Administrative Requirements

The Principal Contractor shall comply with the administrative requirements of the Occupational Health and Safety Act and Regulations 85 of 1993 and other legal requirements. The Principal contractor`s administrative system will without limiting his obligations cover the following:

- Keeping of a safety file on site,
- Maintenance of his Health and Safety plan,
- Procedures to follow for the appointment of competent persons,
- Construction work permits
- Injury on duty [IOD] administration,
- Minutes of safety meetings,
- Inspection checklists/registers,
- Safe keeping of checklists/registers, and
- Internal audits documentation.

The Principal Contractor shall ensure that at least one copy of the Occupational Health and Safety Act, 1993 and its Regulations is available on site.

37.3 Incident Reporting, Investigation and Recording

The Principal Contractor shall comply with Section 9 of the General Administrative Regulations, 1996 and shall (in accordance with section 12) furnish an inspector with information relating to health and safety on the construction site, when requested to do so.

The Principal Contractor shall report all incidents and or occurrences to the Client, investigate and keep record as contemplated by the Occupational Health and Safety Act 85 of 1993 and Regulations and compile incident management procedure.

38 Training

The Principal Contractor shall train all his employees in accordance with the requirements of section 13 of the Occupational Health and Safety Act, 1993. The Principal Contractor shall ensure that every employee is informed of the following:

- The hazards of any work he has to perform or plant machinery or equipment he is permitted to use, and
- The precautionary measures which should be taken regarding the above.

The Principal Contractor shall, without limiting his obligations, indicate in his Health and Safety Plan how he intends:

- Identifying the training needs of the personnel he intends employing, and
- Implementing the training identified

- What proof of induction training will be carried by his employees.

38.1 General induction Training

- All members of the contractor's management as well as all the people appointed as responsible for Occupational Health and Safety in terms of the OHS Act, Construction Regulations and other Regulations are required to attend a general safety Induction
- All employees of the principal contractor and other contractors must be in possession of proof of Induction Training
- All subsequent and newly appointed employees must also be subjected to the Induction Training as soon as possible after the appointment but prior to start work on site.
- All visitors must undergo an induction training on arrival to site

38.2 Site Specific Training

The principal contractor will be required to prepare the Task based training based on the risk assessment for the contract work and train all employees who will be involved in the selected task. All employees must have a proof of such training and copies in the Safety File

38.3 Other Training

1. All operators, drivers and users of construction vehicles and mobile plants must be in possession of a valid proof of training and where applicable licenses and proof of competency

2. All employees in jobs requiring competence in terms of the OHS Act and Regulations must be in possession of valid proof of training.

38.4 Awareness and Promotion

The Principal Contractor is required to have a promotion and awareness program in place to create an Occupational Health and Safety culture within employees as well as contractors. The following are some of the methods that may be used:

- Toolbox Talks
- Posters
- Videos
- Competitions
- Participative activities such as Occupational Health and Safety Circles

39 General Safety awareness meetings

The Principal Contractor shall conduct at least one formal safety meeting per month with employees and shall maintain appropriate records of attendance and meeting content. Such records shall be included in the safety file. The meetings shall address at least the following:

- Accident / safety incidents
- Hazardous conditions
- Hazardous materials / substances
- Job or work projections
- Safe Work procedures

- Protective clothing / equipment
- Housekeeping
- Inspections
- General safety topics

40 Occupational Health and Safety Committees/ meetings

The principal contractor must establish Occupational Health and Safety committees consisting of all designated Occupational Health and Safety Representatives together with a number of management Representatives that are not allowed to exceed the number of Safety Reps on the committee. The members of the Safety Committee must be appointed in writing and the appointment letters must be in the Safety File.

The Safety Committee must meet but at least once a month and consider at least the following agenda items:

- Opening and Welcome
- Members present, apologies and absent
- Minutes of previous meeting
- Matters arising from the previous meeting
- Safety Representatives inspection reports
- Personal Protective Equipment
- Incident and/or accident investigation reports
- Incident, accident and /or injury statistics

- Audit feedback
- Medical surveillance
- Endorsement of legal OHS registers and other statutory documents by a duly authorized representative of the principal contractor
- General
- Close and next meeting

41 Inspections and Monitoring

The Principal Contractor shall be required to inspect each workplace prior to works commencing to ensure that minimum control measures and protective equipment are in place and that by entering the workplace no person will be exposed to any hazard which could affect his health or safety. The Principal Contractor shall without limiting his obligations, indicate the following in his Health and Safety Plan:

- The inspection and monitoring procedures he intends employing to determine the safety of workplaces, and
- Who will be responsible for the checking of each workplace at the commencement of each shift?

The Principal Contractor shall include in his Health and safety Plan all the checklists he intends using during the inspection and monitoring of the implementation of his Health and Safety Plan.

The Principal Contractor can expect inspections of the works by any of the following parties:

- The Client or Safety Agent,

- Department of Labour Inspector or any authorized person appointed by the Minister as Chief Inspector or his representative.

The Client, Safety Agent or his representative will stop the work at any time under the following conditions:

- If the Contractor is not compliant with his Health and Safety Plan
- Imminent threat to the health and safety of any person on site
- Continuous non-conformance to corrective action requests.
- In the occurrence of section 24 incident

42 Auditing

42.1 Internal Audits

The Principal Contractor shall conduct periodic site audits as contemplated in section 7. (1.c.vii) of the Construction Regulations 2014

The Principal Contractor will ensure that the same arrangement detailed above be implemented with his Sub Contractors to ensure his compliance with the Construction Regulations.

43. Covid 19 compliance

The principal contractor shall indicate in their Health and Safety plan, how they will comply with covid 19 regulations of 2020 (as amended). Also include:

- Covid 19 risk assessment
- Covid 19 implementation plan

- Covid 19 positive cases management

The principal contractor shall appoint covid 19 coordinator in writting

44. Baseline Risk Assessment

The baseline risk assessment is in terms of Regulation 5 (1) (a) of the Construction Regulations 2014.

NOTE: The list of potential hazards is by no means intended to be all inclusive and is not limited to this list, and it remains the responsibility of the Contractor to identify all possible unlisted hazards with regards to his scope of work and to put measures in place to mitigate, reduce or control these hazards

CITY OF TSHWANE IGNITING EXCELLENCE	**City of Tshwane: Energy and Electricity Division**	
	Baseline Risk Assessment document	

PROJECT INFORMATION:

CONTRACT NR:	**LOCATION:**	**SCOPE OF WORK:**
EEBU 07-2025.26	KWAGGA 275/132kV SUBSTATION	**TENDER FOR THE SUPPLY, DELIVERY, INSTALLATION, TESTING AND COMMISSIONING OF 1x300MVA POWER TRANSFORMER AT KWAGGA 275/132KV SUBSTATION WITH ASSOCIATED EQUIPMENT FOR A PERIOD OF THREE (3) YEARS**

RISK RATING AND ABBREVIATIONS:

Risk Rating	**Abbreviations**
15-25 EXTREME	**O= OCCUPATIONAL**
8 - 14 HIGH	**H = HEALTH**
4 – 7 MEDIUM	**S=SAFETY**
1 - 3 LOW	

RISKS CONSEQUENCES AND PROBIBILITY:

RISKS		**CONSE-QUENCES**	**PROBIBILITY**				
			Almost Certain	Likely	Possible	Unlikely	Almost Impossible
			5	4	3	2	1
OHS	Multiple fatalities, or significant irreversible effects to >50 persons Serious, long term environmental impairment of ecosystem function Very serious impact on quality of product/service. Definite loss of customer or discontinuation of contract with service provider	5	25	20	15	10	5

OHS	Single fatality and/or severe irreversible disability to one or more persons Serious medium term environmental effects Serious impact on quality of product / Probable loss of customer or discontinuation of contract with service provider	4	20	16	12	8	4
OHS	Moderate irreversible disability or impairment (<30%) to one or more persons. Moderate, short-term effects but not affecting ecosystem function Moderate impact on quality of product / Possible loss of customer or discontinuation of contract with service provider	3	15	12	9	6	3

OHS	Objective but reversible disability requiring hospitalization Minor effects on biological or physical environment Minor impact on quality of product / Minor impact on relationship with customer or service provider	2	10	8	6	4	2
OHS	No medical treatment required. Limited damage to minimal area of low significance Limited impact on quality of product / Minimal impact on relationship with customer or service provider	1	5	4	3	2	1

14	OCCUPATIONAL HEALTH AND SAFETY SPECIFICATION	
	PROJECT LOCATION	Kwagga 275/132kV substation
	PROJECT DESCRIPTION	EEBU 07-2025.26 TENDER FOR THE SUPPLY, DELIVERY, INSTALLATION, TESTING AND COMMISSIONING OF 1x300MVA POWER TRANSFORMER AT KWAGGA 275/132KV SUBSTATION WITH ASSOCIATED EQUIPMENT FOR A PERIOD OF THREE (3) YEARS
	PAGES	Page 60 of 77

PROJECT BASELINE RISK ASSESSMENT:

No:	Task	Step in Process	Tool and Equipment use:	Hazards in Carrying out this Step:	Risk (Harm):	Risk Analyses:					Risk Reduci
						consequences	SHEQ	Severity	Probability	Risk Rating score:	Control Measures:
1	Site Establishment	Clearing of site	TLB (tractor Loader Backhoe)	Inappropriate operation of machinery	Contact with sharp/cutting edge	Multiple Injuries	S	3	1	3	Operator must be certified Machinery must certified Safety talk Supervision
		Offloading containers and equipment	Crane truck slings	Inappropriate operation of machinery Poor communication Damaged/ incorrect slings	Falling load Knocked by swinging load	Multiple Injuries/Death Damage to property	S	4	1	4	Operator must be certified Slings must teste certified Machinery must certified Safety talk Supervision

No :	Task	Step in Process	Tool and Equipment use:	Hazards in Carrying out this Step:	Risk (Harm):	Risk Analyses:					Risk Reduci Control Measures:
						consequen ces	SHEQ	Severity	Probability	Risk Rating score:	
		Connect Electricity	Hand tools	Contact with live wire	Electrocution	Injuries/Death	S	4	1	4	Electrician must b competent and authorised PPE
		Erecting fences and gates	Hand pick Shovels	Inappropriate use of tools	Contact with sharp edge	Injuries	S	2	1	2	Induction
				Incorrect lifting methods	Bending, twisting	Back pains	S	2	1	2	Induction
				Dust	Inhaling dust	Lung irritation	H	2	1	2	PPE

2	**Demolition/Removal of rubble**	Demolishing of walls/plinths/old foundations/floors/roof Removal of rubble	TLB (tractor Loader Backhoe) Hydraulic excavator Tipper truck	Flying debris	Contact with objects	Injuries	S	2	1	2	Method statement/Struct survey Competent Supervision Barricade and saf signs
				Dust particles	Inhaling dust	Lung irritation	H	2	1	2	PPE
				Uncontrolled/unintentional collapse of structure	Being struck	Injuries Damage to propery	S	3	1	3	Method statement/Struct survey Competent Supervision Barricade and saf signs

No:	Task	Step in Process	Tool and Equipment use:	Hazards in Carrying out this Step:	Risk (Harm):	Risk Analyses: consequences	SHEQ	Severity	Probability	Risk Rating score:	Risk Reduci Control Measures:
				Inappropriate operation of machinery Poor communication	In-contact with cutting edges	Injuries	S	4	1	4	Operator must be Certified Supervision
				Noise	Exposure to noise	Ear-ache/hearing loss	H	2	1	2	PPE
				Falling objects	Struck by objects	Injuries	S	4	1	4	Barricade Supervision PPE
				Working on heights	falling	Injuries	S	4	2	8	Safety talk PPE

14	OCCUPATIONAL HEALTH AND SAFETY SPECIFICATION	
	PROJECT LOCATION	Kwagga 275/132kV substation
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	PAGES	Page 64 of 77

No:	Task	Step in Process	Tool and Equipment use:	Hazards in Carrying out this Step:	Risk (Harm):	Risk Analyses:					Risk Reduci Control Measures:
						consequences	SHEQ	Severity	Probability	Risk Rating score:	
3	**Backfill / Compacting**	Backfill / Compacting	TLB (tractor Loader Backhoe) Tipper truck compactor	Inappropriate operation of machinery	Contact with sharp/cutting edge	Injuries	S	3	1	2	Operator must be certified Machinery must l certified Safety talk Supervision
				Dust particles	Inhaling dust	Lung irritation	H	2	1	2	PPE
				Noise	Exposure to noise	Ear-ache/headache/hearing loss	H	2	1	2	PPE

14	OCCUPATIONAL HEALTH AND SAFETY SPECIFICATION	
CITY OF TSHWANE IGNITING EXCELLENCE	PROJECT LOCATION	Kwagga 275/132kV substation
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	PAGES	Page 65 of 77

No :	Task	Step in Process	Tool and Equipment use:	Hazards in Carrying out this Step:	Risk (Harm):		Risk Analyses:				Risk Reduci Control Measures:
						consequen ces	SHEQ	Severity	Probability	Risk Rating score:	
4	**Foundations for buildings and plinths**	Excavation	TLB Shovels Picks	Inappropriate operation of machinery	Contact with sharp/cutting edge	Injuries	S	3	1	2	Operator must be certified Machinery must b certified Safety talk Supervision
				Dust particles	Inhaling dust	Lung irritation	S	2	1	2	PPE
				Open trenches	Falling into the trench	injuries	S	2	2	4	Barricade Safety talk

No:	Task	Step in Process	Tool and Equipment use:	Hazards in Carrying out this Step:	Risk (Harm):	consequences	SHEQ	Severity	Probability	Risk Rating score:	Risk Reduci Control Measures:
							Risk Analyses:				
		Reinforcement	Hand tools	Steel sharp edges	Coming in-contact with sharp edges	Injuries	S	3	3	9	Safety talk PPE
			Electrical hand tools	Sparks from Grinder	Exposure of the sparks	Injuries	S	3	3	9	PPE
				Noise	Exposure to noise	Ear-ache/hearing loss	S	2	1	2	PPE
		Pouring concrete	Ready mix truck	Malfunctioning truck Uncontrollable machinery	Bumping personnel Concrete spillage	Injuries /Death Damage to property	S	4	1	4	Vehicle inspectio Competent opera Supervision Warning systems
				Flying cement particles	Eye contact with particles	Eye Irritation	S	3	2	6	PPE MSDS for Cement must be provided

No:	Task	Step in Process	Tool and Equipment use:	Hazards in Carrying out this Step:	Risk (Harm):		Risk Analyses:				Risk Reduci Control Measures:
						consequences	SHEQ	Severity	Probability	Risk Rating score:	
5	**Building of structure**	Brick laying/plastering/painting	Scaffold/ step ladder Hand tools	Working on heights	Falling from heights	Injuries/Death	S	4	3	12	Fall protection pl
				Falling tools/Bricks	Coming in-contact with falling object	Injuries	S	3	3	9	Training Safety Talk PPE
				Flying cement particles	Eye contact with particles	Eye Irritation	S	3	2	6	PPE MSDS for Cemen Paint must be provided.
		Roof erection/ Placing of Ceiling	Hand-tools Scaffolding Roof trusses Ladders	Working on heights	Falling from heights	Injuries/Death	S	4	3	12	Fall protection pl
				Falling tools	Coming in-Contact with falling object	Injuries	S	3	3	9	Training Safety Talk PPE
		Welding roof trusses/structures	Welding machine/ rods Hand tools	Falling tools	Coming in-Contact with falling object	injuries	S	3	3	9	Certified welder Training Safety Talk PPE

No:	Task	Step in Process	Tool and Equipment use:	Hazards in Carrying out this Step:	Risk (Harm):	Risk Analyses: consequences	SHEQ	Severity	Probability	Risk Rating score:	Risk Reduci Control Measures:
				Working on heights	Falling from heights	Injuries/Death	S	4	3	12	Fall protection pl
				Sparks	Eye contact with particles Skin contact	Eye irritation/Loss of sight Skin burns	S	3	2	6	Barricade PPE
				fumes	Inhaling fumes	Headache/dizziness/eye irritation	S	3	2	6	PPE
6	**Installation/removal of HV and MV equipment**	Installation of Isolators, Circuit breakers, CT, VT, Surge Arrestors, Tubular bus bars Switchgears Transformers cables	Cranes ladders Trolleys Hand Tools Hydraulic Jacks	Inappropriate operation of machinery	Falling load Knocked by swinging load	Multiple Injuries/Death	S	4	1	4	Operator must be certified Machinery must b certified Safety talk Supervision
				Working on heights	Falling from heights	Injuries/Death	S	4	3	12	Fall protection pl

No:	Task	Step in Process	Tool and Equipment use:	Hazards in Carrying out this Step:	Risk (Harm):	Risk Analyses: consequences	SHEQ	Severity	Probability	Risk Rating score:	Risk Reduci Control Measures:
				Falling tools	Coming in-Contact with falling object	Injuries	S	3	3	9	Training Safety Talk PPE
				Open trenches	Falling into trenches	Injuries	S	2	2	4	Safety talk Barricade
7	**Transformer Rigging**	Load/offload Power transformer		Improper use of machinery	Knocked by Swinging load	Injuries Damage to property Death	S	4	1	4	Authorized and qualified rigging personnel
				Using an incorrect sling for the load	Load slipping/damaging slings	Injuries Damage to property Death	S	4	1	4	Authorized and qualified rigging personnel
				Falling load	Personnel Struck by load/ load falling on property	Injuries Damage to property Death	S	4	1	4	Authorized and qualified rigging personnel

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	PROJECT LOCATION	Kwagga 275/132kV substation
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	PAGES	Page 70 of 77

No:	Task	Step in Process	Tool and Equipment use:	Hazards in Carrying out this Step:	Risk (Harm):	Risk Analyses: consequences	SHEQ	Severity	Probability	Risk Rating score:	Risk Reduci Control Measures:
8	**Commissioning/Decommissioning**	Testing of Isolators, Circuit breakers, CT, VT, Switchgear Protection relays Transformer Cables Primary/secondary injection	Testing apparatus ladders	Incorrect lifting methods	Bending, twisting	Back pains	S	2	1	2	Training
				Open trenches	Falling into trenches	Injuries	S	2	2	4	Safety talk Barricade
				High current injection/live wires	Electrocution	Burns/Death	S	4	2	8	Competent perso and authorised Supervision Warning lights
				Working on heights	Falling from heights	Injuries/Death	S	4	3	12	Fall protection pl
9	**Clearing of site**	Remove of all waste and rubble	Truck TLB (tractor Loader Backhoe) Pick and shovels Wheelbarrows	Inappropriate operation of machinery	Contact with sharp/cutting edge	Multiple Injuries	**S**	3	1	3	Operator must be certified Machinery must b certified Safety talk Supervision

No:	Task	Step in Process	Tool and Equipment use:	Hazards in Carrying out this Step:	Risk (Harm):	Risk Analyses: consequences	SHEQ	Severity	Probability	Risk Rating score:	Risk Reduci Control Measures:
				Flying particles	Eye contact with particles	Eye Irritation	S	3	2	6	PPE
				Dust	Inhaling dust	Lung irritation	H	2	1	2	PPE
				Inappropriate use of tools	Contact with sharp edge	Injuries	S	2	1	2	Safety talk
				Incorrect lifting methods	Bending, twisting	Back pains	S	2	1	2	
		Loading Containers	Crane truck slings	Inappropriate operation of machinery	Falling load	Multiple Injuries/Death	S	4	1	4	Operator must be certified Machinery must l certified Safety talk Supervision

43 ANNEXURE 3 MANDATORY AGREEMENT

ANNEXURE 3

MANDATORY AGREEMENT

(SECTION37.2)

ARTICLE OF AGREEMENT IN TERMS OF SECTION 37(2) OF THE
OCCUPATIONAL HEALTH AND SAFETY ACT, 1993 BETWEEN
THE CITY OF TSHWANE METROPOLITAN MUNICIPALITY
(Hereinafter referred to as the “CLIENT”)
AND

....

Herein represented by .... in

his/her capacity as .... duly

authorised by virtue of a resolution dated ....

Attached hereto as Annexure A of the said ....

(hereinafter referred to as the “CONTRACTOR”).

WHEREAS the CONTRACTOR is the mandatory of the CLIENT as contemplated in an agreement in respect of

....

Contract number
....

AND WHEREAS section 37 of the Occupational Health and Safety Act, 1993 (Act 85 of 1993, hereinafter referred to as the “ACT”), imposes certain powers and duties upon the CLIENT.

AND WHEREAS the parties have agreed to enter into an agreement in terms of section 37(2) of the ACT.

NOW THEREFORE the parties agree as follows:

1. The CONTRACTOR undertakes to acquaint the appropriate officials and employees of the CONTRACTOR with all relevant provisions of the ACT and the regulations promulgated in terms thereof.

2. The CONTRACTOR undertakes that all relevant duties, obligations and prohibitions imposed in terms of the ACT and Regulations will be fully complied with: Provided that should the CLIENT prescribe certain arrangements and procedures, that same shall be observed and adhered to by the CONTRACTOR, his officials and employees. The CONTRACTOR shall bear the onus of acquainting himself/herself/itself with such arrangements and procedures.

3. The CONTRACTOR hereby accepts sole liability for such due compliance with the relevant duties, obligations, prohibitions, arrangements and procedures, if any, imposed by the ACT and Regulations and the CONTRACTOR expressly absolves the CLIENT from itself being obliged to comply with any of the aforesaid duties, obligations, prohibitions, arrangements and procedures as the case may be.

4. The CONTRACTOR agrees that any duly authorised officials of the CLIENT shall be entitled, although not obliged, to take such steps as may be necessary to ensure that the CONTRACTOR has complied with this undertaking as more fully set out in paragraphs 1 and 2 above, which steps may include, but shall not be limited to remedy the default of the CONTRACTOR at the cost of the CONTRACTOR.

5. The CONTRACTOR shall be obliged to report forthwith to the CLIENT any investigation, complaint or criminal charge which may arise as a consequence of the provisions of the ACT and Regulations, pursuant to work performed in terms of this agreement, and shall, on written demand, provide full details in writing of such investigation, complaint or criminal charge as the case may be.

Thus signed at PRETORIA for and on behalf of the CLIENT on this the............day of................. ….. 20 ....

AS WITNESSES:

1. ....

2. ....

SIGNATURE

....

NAME AND SURNAME

....
CAPACITY

Thus signed at PRETORIA for and on behalf of the CONTRACTOR on this the

.... day of .... 20 ....

AS WITNESSES:

1. ....

2. ....

....
SIGNATURE
....
NAME AND SURNAME
....
CAPACITY

44 ANNEXURE 4 ACKNOWLEDGEMENT OF RECEIPT OHS SPECIFICATION

ANNEXURE 4

ACKNOWLEDGEMENT OF RECEIPT OHS SPECIFICATION

Acknowledgement of receipt of OHS Specification:

Name of Designer/Contractor

I, the undersigned, hereby acknowledge that I have obtained copies of OHS Specification and confirm full compliance to the conclusion of project or construction work.
Signed at ……………………………on this …….. Day of……………20………

Signature of Designer /Contractor Manager Date

-- ---

Signature of Contractor Supervisor Date

-- --------------------------------------

Witness 1 ……………………. Witness 2 ……………………………….

ANNEXURE B

ENVIROMENTAL MANAGEMENT PLAN

Contents

1. GENERAL

1.1. This plan is to be adhered to by the Contractors for the life of construction operations; this includes rehabilitation of areas as and when required. The Contractors shall ensure that all construction staff, sub-contractors, suppliers, etc. are familiar with, understand and adhere to the Construction Management Plan. In addition, during construction the Contractors must ensure that all personnel are fully aware of any environmental issues relating to the construction activities that are being undertaken on site and the related environmental precautions that need to be taken. Construction supervisors and crews will be trained to recognize ‘chance finds’ during construction, and such finds (i) will not be disturbed, damaged or removed and (ii) will be brought to the immediate attention of the relevant authority.

1.2. The Client (Council) shall order the Contractors to suspend part or all of the works if the Contractors and/or any sub-contractors, suppliers, etc. fail to comply with the Environmental Management Plan.

1.3. Prior to construction the Contractors shall provide layout designs of the site indicating the position of all of the following: offices, ablution facilities, storage areas, workshops, batching plant, stockpile areas (i.e. soil/granular chemicals/cement fines, etc.), waste disposal facilities, hazardous substance storage area, access route, etc. This layout plan is to be submitted to the Client (Council) for acceptance prior to site establishment.

1.4. An “Environmental Site Book’ should be supplied and kept on site. This book will reflect all issues, and proposed actions as noted during site visits. This site book should be in the form of a file wherein all Environmental Status Reports are kept. In addition, a separate file containing the EMP should also be kept on site. A copy of the Scoping Report, the EMP report and construction layout plan are to be available on site.

1.5. To reduce the effect of habitat loss, construction activities must be planned and implemented in a way that facilitates the restoration of plant communities. Specifications for soil preparation, endemic plant/seed mixes, fertilizer, and mulching should be provided for all areas disturbed by construction activities.

1.6. Restoration activities should be accomplished (established) within a year after construction is completed. The minimum vegetation disturbance must be permitted and the removal of vegetation must be managed and monitored to ensure a minimum exposed period. Monitoring must occur to ensure that revegetation was successful, plantings were maintained, and unsuccessful plant materials replaced.

2. ENVIRONMENTAL MANAGEMENT PLAN (CONSTRUCTION)

2.1. Site establishment and preparation

Management Action:

2.1.1. Limit site to existing road and/or already disturbed areas as far as possible.

2.1.2. Demarcate the boundaries of the total works site clearly for site management purposes. The preferred method of demarcation consists of steel droppers placed at regular intervals with nylon rope between the markers.

2.1.3. Fence off entire works area with 2.4m high temporary fence.

2.1.4. The Contractors shall maintain the demarcation line and ensure that materials used for construction on site do not blow or move outside the site and environs, or pose a threat to animals.

2.1.5. The Contractors shall restrict construction activities to within these boundaries. This extends to ensuring that all construction personnel and equipment remain within the demarcated construction site at all times.

2.1.6. Routes for temporary access and haul roads are to be located within the approved demarcated areas and vehicle movement is to be confined to these roads.

2.1.7. Movement of vehicles outside the designated working areas is not permitted.

2.1.8. Clearly indicated which activities are to take place in which areas within the site e.g. the mixing of cement, stockpiling of materials, etc. Limit these activities to single sites only, preferably on the existing road or otherwise on an already disturbed area.

2.1.9. Remove all markers when the construction phase comes to an end.

2.1.10. Fully rehabilitate (e.g. clear and clean area, rake, pack branches, etc.) the disturbed areas and protect them from erosion.

2.1.11. The Contractor shall only prune or remove vegetation where absolutely necessary. No large trees shall be removed. Topsoil should be stockpiled for later use in revegetation efforts.

2.2. **Construction staff**

Management Action:

2.2.1. Demarcate the boundaries of the construction staffs' eating and storage areas by means of a 1.5m diamond mesh fence.

2.2.2. Adequate ablutions must be erected on site for construction staff. It is critical that the services (water and sewerage) be properly monitored to ensure that these services are not overused or overloaded. Adequate provision for water shall be made for construction, drinking and washing.

2.2.3. Construction staff (emergency only) may only be accommodated on site once all the necessary services (water, sewerage and waste) are in place.

2.2.4. Dry chemical toilets must be made available on site.

2.2.5. Chemical toilets shall be cleaned and serviced regularly.

2.2.6. A designated place for food preparation and eating must be established.

2.2.7. An adequate number of refuse bins shall be provided.

2.2.8. No pets allowed on site.

2.2.9. All staff to be identifiable through identity badges.

2.2.10. No explosives (with the exception of blasting requirements) or firearms to be permitted on site.

2.2.11. No open fires will be allowed.

2.3. **Vegetation clearing**

Management Action:

2.3.1. While bush will have to be undertaken in some areas, the areas needing to be cleared and the degree of clearing required will be determined and demarcated prior to construction. Ancillary activities, such as stockpiles, and storage yards, will be demarcated to areas already disturbed or where they will cause minimal disturbance.

2.3.2. Identify areas to be affected by construction and secure plant species/habitat in these areas. Prevent unnecessary harvesting, destruction, and removal of plant material.

2.3.3. No large trees (with trunk diameter exceeding 200mm) are to be removed.

2.3.4. Consider the selective trimming of branches to allow for free vehicle movement before opting to remove any trees.

2.3.5. Remove alien/exotic vegetation, and monitor regularly.

2.3.6. Ensure no exotic vegetation is introduced into the surrounding natural habitat.

2.3.7. All sites disturbed by construction activities shall be monitored for colonization by invasive alien plant species.

2.3.8. The collection of firewood for cooking and other uses is strictly prohibited.

2.3.9. The Contractors may not deface, paint or otherwise mark and/or damage natural feature/vegetation on the site. Any features/vegetation defaced by the Contractors shall be restored.

2.4. **Conservation of topsoil**

Management Action:

2.4.1. The Contractors are required to strip topsoil (as defined in this specification) together with grass/groundcover from all areas where permanent or temporary structures are located, construction related activities occur, and access roads are to be constructed, etc.

2.4.2. Topsoil is to be handled twice only – once to strip and stockpile, and secondly to replace, level, shape and scarify.

2.4.3. Topsoil is to be replaced along the contour.

2.4.4. Topsoil is to be replaced by direct return where feasible (i.e. replaced immediately on the area where construction is complete), rather than stockpiling it for extended periods.

2.4.5. Topsoil stockpiles are not to exceed 1,5m in height and should be protected by a mulch cover. This mulch cover must not contain alien vegetation/seeds.

2.4.6. Topsoil stockpiles are to be maintained in a weed free condition.

2.4.7. Topsoil should not be compacted in any way, nor should any object be placed or stockpiled upon it.

2.4.8. Topsoil, which is to be stockpiled for periods exceeding 4 months, is to be vegetated. A groundcover or grass seeding may be specified.

2.5. **Access roads**

Management Action:

2.5.1. All disturbed areas along the fringes of the road must be rehabilitated once the road is complete.

2.5.2. Contractors will be required to submit a delivery timetable. Strict control is to be exercised over entering and exiting traffic and delivery procedures.

2.5.3. Special attention will be paid to limit the number of deliveries as far as possible.

2.5.4. Any damage caused by the construction activities to the access roads must be rehabilitated completely upon completion of the works.

2.5.5. Proactively protect steep access roads and cuttings against erosion. Mitre drains, Reno mattresses, extended concrete drifts, drainage pipes, etc. should be considered for this.

2.5.6. Any cement and gravel spillage on the roads is to be cleared up completely.

2.5.7. Construction staff should only use authorised paths and roads.

2.5.8. Construction access roads should not be wider than necessary with a maximum of 3m.

2.5.9. If two-way traffic is to take place, passing bays are to be used to prevent access/detours into the surrounding areas, unless otherwise stated. The drivers delivering construction materials to site are to be made aware of this and are to be forced to utilise the passing bays. They may not drive off the road in order to allow another vehicle to pass.

2.5.10. During the contract period, the Contractors shall ensure that all existing water attenuation and drainage structures are maintained in a state in which they can optimally perform their function.

2.5.11. Vehicles used during construction or to transport material or staff on site, should have the minimum impact on the environment (trees, roads or other) or other road users. The size, height and weight of vehicles must be kept in mind; the access route will determine the type of vehicle that can be used.

2.5.12. Construction vehicles are to be maintained in an acceptable state of repair and cleanliness when leaving the site. Sand, dust and spillages from these vehicles that inevitably fall on the main roads should be cleared on a regular basis.

2.5.13. Drivers of all vehicles on site are to be licensed.

2.5.14. Upon completion of the construction period, the Contractors shall ensure that the access roads are returned to a state no worse the prior to construction commencing.

2.5.15. Continual use of dirt access roads by heavy machinery and increased transport loads means they will have to be carefully monitored and regularly graded as soon as potholes or rutting occurs.

2.5.16. Traffic speeds on the site need to be reduced to a maximum of 25km/hour and regular application of water on gravel road surfaces may be required to prevent high dust disturbance.

2.6. **Excavation, backfilling and trenching**

Management Action:

2.6.1. Excavation of sand to solid ground to be done carefully and appropriate drainage incorporated i.e. sand and debris need to be removed and solid rock preferably exposed to ensure proper binding with concrete material.

2.6.2. Construction must preferably be extended over rocky substrate to give maximum anchoring opportunity.

2.6.3. Blasting operations, if required, to be planned by competent specialists, with due regard to adjacent land users. Blasting t be programmed in cooperation with adjacent land owners to result in the most impact limiting operation.

2.6.4. Record to be kept of infrastructure and facility conditions prior to and after the blasting operations.

2.6.5. Consider using any excess rocks or boulders that were excavated from the construction site for any erosion protection work which is required on site. Consider removing the rocks for the packing of gabions at other soil erosion sites.

2.6.6. If need be, spread the rocks in as natural a manner as possible in the veld along the access roads. This should be considered as the last option only and only if a few excess rocks remain.

2.6.7. Similarly, excess sand as a result of excavation activities is not to be dumped along the roadsides.

2.6.8. Removed soil is to be used to backfill areas where required and excess is to be landscaped into natural looking banks that fit the surrounding topography.

2.6.9. During excavation, topsoil is to be conserved.

2.6.10. Excavated material is to be stockpiled along a pipeline trench within the working servitude, unless otherwise authorised.

2.6.11. Deficiency of backfill material shall not be made up by excavation in the protected area. Where backfill material is deficient, it should ideally be made up by importation from an approved borrow pit.

2.6.12. The Contractors shall backfill in accordance with the requirements of progressive reinstatement. ‘Progressive reinstatement’ is defined as: reinstatement of disturbed areas to topsoil profile on an ongoing basis, immediately after selected construction activities (e.g. backfilling of trench) are completed. This allows for passive rehabilitation (i.e. natural re-colonisation by vegetation) to commence.

2.6.13. The following trenching specification shall apply:

2.6.13.1. The trench will be excavated to a depth of 1m where possible. Where shallow bedrock makes this impractical the trench should only then be excavated to the maximum depth possible.

2.6.13.2. Care will be taken to remove the topsoil and then the subsoil and to stockpile these separately.

2.6.13.3. The pipeline/cable should be placed on a 200mm bed of river sand to protect it.

2.6.13.4. The subsoil will then be backfilled.

2.6.13.5. The topsoil will then be replaced and the entire length of the trench compacted.

2.6.13.6. The trench should be compacted to 90-93% AASHTO.

2.6.13.7. Sections of the trench that are excavated in a roadway should be compacted to 98% AASHTO.

2.6.14. Contract personnel at all levels to be made aware of potential archaeological and/or paleontological artefacts/occurrences.

2.6.15. Any discovery of artefacts to be reported immediately to SAHRA.

2.6.16. Works in areas where artefacts are discovered are to cease immediately until the area has been investigated and a go-ahead has been obtained from SAHRA.

2.7. **Levelling**

<u>Management Action</u>:

2.7.1. Excess sand and soil resulting from levelling activities of the work area should be stored in low heaps either on the access road or already disturbed area.

2.7.2. Excess topsoil is to be spread evenly over the area in a manner that blends in with the natural topography.

2.7.3. Excess stockpiled building material is to be removed completely and the areas levelled.

2.7.4. Once heavy machinery has cleared the bulk of these material stockpiles, the disturbed areas should be levelled and cleared of any foreign material manually. It is unacceptable to leave foreign material behind with the knowledge that it will become hidden amongst the rejuvenating vegetation with time.

2.7.5. Regular inspections must be undertaken to monitor and audit the effects and impacts of such removals.

2.8. **Stockpiling of building materials**

<u>Management Action</u>:

2.8.1. Limit to demarcated sites only.

2.8.2. Single sites should be a priority. This may not always be possible for example heaps of topsoil, but should definitely be the case for activities such as the mixing of cement.

2.8.3. Stockpiles of expensive materials such as bags of cement should be such that they can easily be removed from the site over weekends or during rainy weather.

2.8.4. Specific sites should be allocated for waste e.g. empty cement bags, discarded planks, etc. A low temporary fence should possibly be erected around such a site in order to contain the waste and assist the effective removal thereof from the site.

2.8.5. A specific site should be allocated for the storage and handling of diesel, grease, oils, solvents and soap, which create cleaning and disposal issues. This area should be banded, and thus should take place in the area allocated for permanent storage of such materials.

2.8.6. Fuels required during construction shall be stored in a central depot at the construction camp. This storage area must be banded.

2.8.7. Rehabilitate the sites as required.

2.9. **Materials handling and storage**

Management Action:

2.9.1. Tanks containing fuel shall have lids, which are to remain firmly shut.

2.9.2. Fuel stores shall be placed on a concrete, or similar, base surrounded by a brick bund.

2.9.3. The bund shall have a volume of 30% of the volume of the largest tank in the storage area plus 10% of the volume of all other tanks.

2.9.4. The slab shall be sloped towards a sump to enable any spilled fuel and water to be removed.

2.9.5. Any wastewater collected at the sump shall be disposed of as hazardous waste.

2.9.6. Gas and liquid fuel shall not be stored in the same storage area.

2.9.7. No smoking shall be allowed inside the stores or within 3m of a bund.

2.9.8. The Contractors shall ensure that there is adequate fire-fighting equipment at the fuel stores.

2.9.9. Do not store fuels and chemicals under trees.

2.9.10. Exercise extreme care with the handling of diesel and other toxic solvents so that spillage is minimised.

2.9.11. Excess concrete from mixing shall be deposited in a designated area awaiting removal to an appropriate landfill site. Liquid wastes to be treated at an approved facility.

2.9.12. The Contractors shall ensure that all operations that involve the use of cement and concrete are carefully controlled.

2.9.13. Concrete mixing shall only take place in the construction camp or in agreed specific areas on site.

2.9.14. Concrete shall not be mixed directly on the ground. No mixed concrete shall be deposited directly onto the ground prior to placing. A board or other suitable platform/surface is to be provided onto which the mixed concrete can be deposited whilst it waits placing.

2.9.15. All visible remains of excess concrete shall be physically removed immediately and disposed of as waste.

2.9.16. Timber products should be treated off-site prior to use in construction.

2.9.17. Periodic on-site application of timber treatment products (for maintenance purposes) should take place with due care for the nature of the product (toxicity) and for potential spillages that may occur. Areas where timber is to be treated should have secondary containment measures instituted, such as the placement of plastic layer (some form of covering) over soils, beneath the timber structures to prevent contamination of the soil surface.

2.10. Servicing and refueling of construction equipment

Management Action:

2.10.1. The Contractors shall ensure that servicing and/or refuelling of vehicles and equipment takes place within the construction camp.

2.10.2. Should construction vehicles have to serviced on site, it must be done in a designated area with a concrete floor and drain system that will prevent oils and fuels from contaminating the environment.

2.10.3. The ground under the servicing and refuelling areas shall be protected against pollution caused by spills and/or tank overfills (bunded/lined).

2.10.4. All water run-off from these areas shall be collected, contained on site and stored in water-tight containers prior to disposal off-site as hazardous waste

2.10.5. All equipment that leaks shall be repaired immediately or shall be removed from site.

2.10.6. The Contractors shall only change oil or lubricant at agreed and designated locations, except if there is a breakdown or emergency repair, and then any accidental spillages must be cleaned up/removed immediately.

2.10.7. In such instances the Contractors shall ensure that he has Drizit pads or similar, and/or drip trays available to collect any oil or fluid.

2.10.8. The only permitted method of refuelling and refilling lubricants is by means of a pump.

2.11. Solid waste management

Management Action:

2.11.1. If construction workers are to eat on site other than at the construction camp, the Contractors shall designate specific areas for eating and shall provide adequate steel refuse bins at al places. The refuse bins shall be cleaned on a daily basis.

2.11.2. The bins shall be provided with lids and an external closing mechanism to prevent their contents blowing out and shall be scavenger-proof.

2.11.3. The Contractors shall supply steel waste bins/skips throughout the site at locations where construction personnel are working

2.11.4. The Contractors shall not dispose of any waste and/or construction debris by burning, or by burying.

2.11.5. The Contractors shall ensure that all personnel immediately deposit of waste in waste bins for removal by the Contractors.

2.11.6. All waste shall be disposed of off-site at an approved landfill site.

2.11.7. Remove loose building materials and waste from the site and dispose of them at an appropriate waste disposal site.

2.11.8. Old cement mixing bags shall be placed in wind and spill proof containers as soon as they are empty. The Contractors shall not allow closed, open or empty bags to lie around the site.

2.11.9. All waste, which includes cigarette butts, cable ties, paper, plastic, tin, glass, organic waste like fruit pips and peels, planks, wire, tins of grease, etc. must be transported in an appropriate manner (e.g. plastic rubbish bags) to an appropriate waste site.

2.12. Liquid waste management

Management Action :

2.12.1. Construction water refers to all water affected by construction activities.

2.12.2. The Contractors may discharge 'clean' silt laden water overland and allow this water to filter into the ground. However, they shall ensure that they do not cause erosion as a result of any overland discharge.

2.12.3. All washing of plant/equipment/concreting equipment etc. shall take place within the construction camp.

2.12.4. Water from washing operations shall be collected in a conservancy tank removed from site and disposed of in the agreed manner.

2.12.5. The Contractors are encouraged to recycle dirty wash water to minimise the amount to be removed off-site.

2.12.6. Trucks delivering concrete shall not be washed on site.

2.12.7. All washing operations shall take place off-site at a location where wastewater can be disposed of in an acceptable manner.

2.12.8. Adequate ablution facilities to be provided on site, conveniently located near to work areas to avoid localised water pollution from camp sewerage.

2.12.9. Neither the river nor any other natural watercourse is to be used for cleaning of tools or any other apparatus. This includes for purposes of bathing, or washing of clothes etc.

2.12.10. A drainage diversion system is to be installed to divert runoff from areas of potential pollution, e.g. batching area, vehicle maintenance area, workshops, chemical and fuel stores, etc.

2.12.11. No spills may be hosed down into a storm water drain or sewer, or into the surrounding natural environment.

2.12.12. Discard construction waste at a registered waste management facility/landfill site, particularly those wastes or products that could impact on surface or groundwater quality by leaching into or coming into contact with water.

2.12.13. Construction vehicles are to be maintained in an acceptable state of repair and cleanliness when leaving site. Sand, dust and spillages from these vehicles that inevitably fall on the main roads should be cleared on a regular basis.

2.12.14. All soil contaminated, for example by leaking machines, refuelling spills, etc., is to be excavated to the depth of contaminant penetration, placed in 200 litre drums and removed to an appropriate landfill site.

2.12.15. The Contractors shall contain wash water from cement mixing operations, by directing the water into a sump for collection. The material contained in the sump shall be removed to an appropriate landfill site.

2.12.16. Water and slurry from concrete mixing operations shall be contained to prevent pollution of the ground surrounding the mixing points.

2.12.17. All visible remains of excess concrete shall be physically removed immediately and disposed as waste. Washing the visible signs into the ground is not acceptable. All excess aggregate shall also be removed.

2.12.18. Where, due to construction requirements, pollution of a water body may potentially occur, the Contractors are to ensure adequate measures (e.g. attenuation/settlement dams/oil absorbent products) are in place to prevent pollution. A method statement is to be provided to this effect.

2.12.19. Exercise extreme care with the handling of diesel and other toxic solvents so that spillage is minimised.

2.12.20. The Contractors shall take reasonable precautions to prevent the pollution of the ground and /or water resources on and adjacent to the site as a result of his activities.

2.12.21. Such pollution could result from the release, accidental or otherwise, of chemicals, oils, fuels, sewage and waste products, etc.

2.12.22. The Contractor shall obtain Drizit pads or similarly designed products or materials to soak up oil, petrol and diesel.

2.12.23. These materials shall be readily available for use wherever construction equipment is working, fuel and lubricants are being offloaded and stored and equipment is filled and serviced.

2.12.24. The Contractors shall ensure that he is familiar with the correct use and disposal of any materials designed to soak op petroleum products.

2.12.25. The Contractors shall ensure that no oil, petrol, diesel, etc. is discharged onto the ground.

2.13. **Hazardous materials**

Management Action:

2.13.1. The Contractors shall comply with all national, regional and local legislation with regard to storage, transport, use and disposal of petroleum, chemical, harmful and hazardous substances and materials.

2.13.2. The Contractors shall obtain the advice of the manufacturer with regard to the safe handling of such substances and materials.

2.13.3. The Contractors shall provide a list of all petroleum, chemical, harmful and hazardous substances and materials on site, together with storage, handling and disposal procedures for these materials.

2.13.4. The Contractors shall furthermore be responsible for the training and education of all personnel on site who will be handling the material about its proper use, handling and disposal.

2.13.5. Storage of all hazardous material is to be safe, tamper proof and under strict control.

2.13.6. Petroleum, chemical, harmful and hazardous waste throughout the site shall be stored in enclosed bunded areas. The bunded areas shall be clearly marked. Such waste shall be disposed of off site at a hazardous waste disposal site.

2.13.7. The bunded area is to be sufficiently large to contain a spillage equivalent to the volume of one container of the substances stored.

2.13.8. Temporary fuel storage tanks and transfer areas also need to be located on an impervious surface adequately bunded to contain accidental spills. Appropriate run-off containment measures must be in place.

2.13.9. All products to be dispensed from 200 litre drums shall be done with appropriate equipment, and not dispensed by tipping of the drum.

2.13.10. Any accidental chemical/fuel spills to be corrected immediately.

2.13.11. Fuels, solvents and other wastes will be stored in vessels equipped with secondary containment structures and will be removed from the concession area and the park being disposed of in compliance with national and local requirements

2.13.12. The containers in which the products are kept should, in compliance with hazardous material management procedures, be removed from the site once empty. Hazardous products should otherwise be stored on adequately bunded surfaces in the designated hazardous material storage areas.

2.14. **Erosion protection work**

Management Action:

2.14.1. Correct any cause of erosion at the onset thereof trough the most appropriate mechanism.

2.14.2. Soils should not be stripped when they are wet. This can lead to compaction and loss of soil structure.

2.14.3. During construction the Contractors shall protect all areas susceptible to erosion by installing all the necessary temporary and permanent drainage works as soon as possible and by taking such other measures as may be necessary to prevent surface water being concentrated in water sources and from scouring the slopes, banks or other areas.

2.14.4. In essence soil erosion protection is about reducing the velocity of water run-off in the disturbed areas. There are many appropriate methods, depending largely upon the size and topography of the area to be protected against erosion.

2.14.5. The stabilisation of disturbed areas, access roads and/or steep cuttings is very site specific and could include:

2.14.5.1. Mitre drains;

2.14.5.2. Drainage pipes;

2.14.5.3. Reno mattresses (biodegradable material, upon which soil and rocks are packed which then keeps it in place to bind the soil);

2.14.5.4. Benches (consisting of sand bags);

2.14.5.5. Gabions;

2.14.5.6. Gabion mattresses;

2.14.5.7. Scarifying (ripping) areas along the natural contours; or

2.14.5.8. Packing branches and rocks in small gullies and disturbed areas.

2.14.6. Drainage of access routes and mitre drains to be maintained and kept open and functional.

2.14.7. Block off access to gravel pits and temporary routes so as to prevent them being used as ‘roads’ at a later stage.

2.14.8. Surface erosion protection measures shall be required to prevent erosion where slopes are steeper than 1:8 on all soil types.

2.14.9. Erosion protection measures required should include all or some of the below, as specified by the Engineer:

2.14.9.1. Use of groundcover or grass, retention of as much of the indigenous vegetation as possible;

2.14.9.2. Construction of cut off berms (earth and/or rock pack) – these are to be angled across the contour and normally would approximate an angle of 30° from the bisector of the contour;

2.14.9.3. Placing of brush wood on bare surface;

2.14.9.4 Hard landscaping, e.g. gabions etc.

2.14.10. Scour chambers are to be fitted with energy dissipaters, or the jet of water directed onto a protected (i.e. grouted stone pitching/rock pack/Reno mattress) area to dissipate water velocity and to control and prevent erosion.

2.14.11. Storm water drainage measures shall be required on site to control runoff and prevent erosion.

2.15. **Use and rehabilitation of gravel pits**

Management Action:

2.15.1. The extent of the borrow area (envelope area) is to be clearly explained to the contractors prior to the commencement of gravel extraction activities. This gravel area is not to be increased.

2.15.2. Topsoil is to be stockpiled separately and used to recover and rehabilitate the pits after use.

2.15.3. Plan to reuse the soil, as soon as possible; the biological components will deteriorate over long periods of storage.

2.15.4. Do not stockpile in large piles. Store in low heaps no more than one or two metres high to best retain the organic components in good condition.

2.15.5. The stockpiles should be located where they will not be disturbed by activities within the gravel pit. Disturbing the topsoil can further damage the soil structure prior to final reuse.

2.15.6. Soils should not be stripped when wet. This can lead to compaction and loss of structure of the soil.

2.15.7. The stripping of the gravel pit to solid bedrock with no chance for rehabilitation should be avoided. Such areas within the gravel pit should be rehabilitated immediately.

2.15.8. The natural slopes in the area, which have evolved as a result of natural erosion processes, should be studied and used as a guideline to determine the inclination of the reconstructed slopes. Obviously, the size of the area to be rehabilitated is a major consideration.

2.15.9. Slopes should be designed to reduce the velocity of the run-off as the catchment area of the increases. Where the area of the site limits formation of the stable slope profile, contoured benches or similar erosion control methods may be required. Slopes with an overall convex profile should always be avoided.

2.15.10. Where the size of the slope area to be rehabilitated is small, benches consisting of sandbags can be considered. These temporary structures should under no circumstances be left in a place beyond their projected life, as they will deteriorate in a very short period of time.

2.15.11. Benches are best located in the middle of the slope. Where long spaces cannot be avoided several benches may be required. In such cases the slope and run-off characteristics must be considered.

2.15.12. The site must be surveyed to maintain the contours. Where banks are graded to direct run-off to specific draw points ensure that run-off is dissipated or properly controlled.

2.15.13. Topsoil will commonly not adhere to slopes that are steeper than 27 degrees. The maximum slope for mechanically spreading topsoil is approximately 19 degrees.

2.15.14. Depending on the characteristics of the site, such as geology, the nature of the soils and other site specific topographical features, more gentle slopes may be necessary.

2.15.15. When contouring, always rip and scarify precisely along the contour. This prevents inadvertently creating down slopes channels.

2.15.16. The contour line should be surveyed and marked by posts, if necessary.

2.15.17. The ripping should normally be as deep as is possible depending on the material, the equipment that is available and the sub-surface conditions. However, some subsoil conditions (e.g. where boulders are present) may not permit ripping to these depths.

2.15.18. The spacing of the lines when ripping or scarifying should be such that they overlap each other.

2.15.19. When soil conditions are wet, soil will not break up so avoid ripping and scarifying under wet conditions.

2.15.20. Water discharge from small retention structures (e.g. earth embankments and artificially created pits that hold water) should be implemented. Where practical, it can be controlled via corrugated metal or plastic pipe/s that drain the water through the retention structures into a safe discharge area (i.e. one, which does not promote erosion or the creation of another artificial water pit).

2.15.21. These temporary structures should under no circumstances be left in place beyond their projected life, as they will deteriorate in a very short period of time.

2.15.22. The siting of any disposal sites for waste rock, within a specific borrow pit should be considered in the earliest plans. In many cases the filling and rehabilitation of any artificial water pits within the gravel pit could be considered. The site is covered by at least 0,5m of local gravel and then the available topsoil.

2.15.23. Access point to the borrow pit site is closed when not in use.

2.16. Run-off from construction camps

Management Action:

2.16.1. Pumps and other machinery requiring oil, diesel, etc., which are to remain in one position for longer than two days shall be placed on drip trays. The drip trays shall be watertight and shall be emptied regularly and the contaminated water disposed off-site at a facility capable of handling such waste liquid. Drip trays shall be cleaned before any possible rain events that may result in the drip trays overflowing.

2.16.2. A drainage diversion system is to be installed to divert runoff from areas of potential pollution, e.g. batching area, vehicle maintenance area, workshops, chemical and fuel stores, etc.

2.16.3. Contaminated runoff and wastewater is to be directed into a collection system (e.g. sump, attenuation dam, PVC porta-ponds, etc.) for treatment or collection and disposal. The final collection point (e.g. sump) is to be PVC lined.

2.16.4. Collected contaminated runoff/wastewater is to be pumped out of the final collection point and disposed of at an appropriate waste disposal site. Sump liners are to be treated in the same manner.

2.17. Fire

Management Action:

2.17.1. The Contractors shall take all the necessary precautions to ensure that fires are not started as a result of activities on site.

2.17.2. No open fires for heating or cooking shall be permitted on site.

2.17.3. Closed fires or stoves shall only be permitted at agreed designated safe sites in the construction camp.

2.17.4. Adequate suitable fire fighting equipment shall be provided at each fireplace or stove.

2.17.5. The Contractors shall be responsible for providing the necessary basic fire-fighting equipment.

2.17.6. All equipment shall be maintained in good operating order.

2.17.7. The Contractors shall supply all site offices, kitchen areas, workshop areas, material stores and other areas identified with suitable, tested and approved fire fighting equipment.

2.17.8. Workers are to be provided with gas for cooking and shall be prevented from burning fires.

2.17.9. No open fires shall be allowed anywhere on site.

2.17.10. The Contractors shall ensure he has the necessary fire fighting equipment on site in terms of SANS 1200. This shall include at least rubber beaters when working in 'veld' areas. A minimum requirement for construction in a high fire risk area shall be a water bowser/cart (minimum 5 000 litres) equipped with pump and hose (min 30m) which shall be permanently on site.

2.17.11. The construction site must also be protected against fire, and a sufficient fire break must be constructed, around the construction site.

2.17.12. A road to be constructed along the entire boundary of the site.

2.17.13. A firebreak to be made along the site boundary road.

2.18. **Accidents**

Management Action:

2.18.1. The Contractors shall comply with the Occupational Health and Safety Act.

2.18.2. The Contractors shall be responsible for establishing an emergency procedure for dealing with spills or releases of petroleum.

2.19. **Storm and wind conditions**

Management Action:

2.19.1. Special care will be taken during rainy periods to prevent the contents of sumps from overflowing.

2.19.2. The Contractors shall set up a procedure for rapidly emptying any collection points to prevent their filling with rainwater.

2.19.3. The Contractors shall ensure that rainwater does not run off areas containing pollutants and thus result in a pollution threat.

2.19.4. Stockpiles of the fine material such as sand, topsoil material, cement, etc. must also be protected from runoff and wind.

2.20. **Dust**

Management Action:

2.20.1. At all times the Contractors shall control dust on site.

2.20.2. Dust control shall be sufficient so as not to have significant impacts in terms of the biophysical and social environments. These impacts include visual pollution on gravel and earth roads.

2.20.3. A dust abatement program shall be used. Standard dust abatement measures include watering or otherwise stabilizing soils, covering haul trucks, employing speed limits on unpaved roads, minimizing vegetation clearing, and promptly revegetating after construction is completed.

2.20.4. Revegetation plans should be developed for areas impacted by construction activities. Salvaged vegetation, rather than new planting or seeding, should be used to the extent possible.

2.20.5. Efforts to reduce dust and soil loss are to be undertaken, as appropriate, for all excavation, grading, construction, and other dust-generating and soil-disturbing activities.

2.21. **Noise**

Management Action:

2.21.1. Machinery and vehicle silencer units are to be maintained in good working order. Offending machinery and/or vehicles shall be banned from use on site until they have been repaired.

2.21.2. Noise levels shall e kept within acceptable limits for a protected area, and shall not be of such nature as to detract from the natural experience of other visitors to the protected area.

2.21.3. Music and other social noise to be controlled on site so as to not impose on others.

2.21.4. The Contractors shall at all times use equipment that is appropriate to the task in order to minimise the extent of damage to the environment and minimise noise levels.

2.21.5. Construction work will take place during the day as far as possible.

2.21.6. Work will only be undertaken at night in the case of emergencies.

2.21.7. Work hours will be from approximately 07:00 to 17:00

2.22. **Visual**

Management Action:

2.22.1. The type and colour of roofing and cladding materials are to be selected to reduce reflection.

2.22.2. Security lighting (both temporary and permanent) and lighting required for specific work activities must be placed such that it is not a nuisance to residents, visitors and the general public. Shields may be required to prevent lights from being visible from other parts of the area.

2.22.3. Construction will only take place at night during emergency situations and not as common practice.

2.22.4. Care will be taken when positioning the lights to ensure the least visual impact, while still providing a safe work environment for construction staff.

2.23. **Loitering**

2.23.1. The contractors shall ensure that loitering around the construction sites is not permitted. This includes job seekers, socialisers, food vendors, squatters, etc.

2.24. **Site clean up**

Management Action:

2.24.1. The Contractors shall ensure that all temporary structures, materials, waste and facilities used for construction activities are removed upon completion of the project.

SCHEDULE

MINISTERIAL DETERMINATION NO: 3: EXPANDED PUBLIC WORKS PROGRAMMES

Index

1. Definitions

1.1 In this determination -

"expanded public works programme" means a programme to provide public or community assets or services through a labour intensive programme initiated by government and funded from public resources.

1.2 Without limiting subsection (1), the following programmes constitute Expanded Public Works Programmes:

(a) Environment and Culture Sector Programmes including: Working for Water, Working on Fire, Working for Wetland, People and Parks, Working for Energy, Working for Woodlands, Working for the Coast, Landcare, Working on Waste, Working for Tourism, Investing in Culture Programmes

(b) Infrastructure Sector Programmes and Projects declared par of EPWP which may include the construction, rehabilitation and maintenance of: rural and low-volume roads, storm-water drains, water reticulation, basic sanitation, footpaths, sidewalks, bicycle paths, schools and clinics.

(c) Social Sector Programmes including Early Childhood Development, Home, Community Base Care, Community Safety and other community based programmes

(d) All projects and programmes accessing the EPWP wage incentive including those implemented by Non Governmental organisations (NGO) and Community Based Organisation (CBO) and the Community Works Programme

(e) Any other programme deemed to be part of the EPWP as determined by the Department of Public Works

2. Application

This Determination applies to all employers and employees engaged in expanded public works programmes.

3. The following provisions of the Basic Conditions of Employment Act do not apply to public works programmes –

3.1 Section 10(2) [Overtime rate]

3.2	Section 14(3)	[Remuneration required for meal intervals of longer than 75 minutes]
3.3	Section 29(h) to (p)	[Written particulars of employment]
3.4	Section 30	[Display of employee’s rights]
3.5	Section 41	[Severance pay]
3.6	Section 37	[Notice of termination]
3.7	Section 51 - 58	[Sectoral Determinations]

4. Conditions

As set out in the ANNEXURE:

ANNEXURE

CONDITIONS OF EMPLOYMENT FOR EXPANDED PUBLIC WORKS PROGRAMMES

1. Introduction

1.1 This document contains the standard terms and condition for workers employed in elementary occupations on an Expanded Public Works Programme (EPWP). These terms and conditions o NOT apply to persons employed in the supervision and management of a SPWP.

1.2 In this document –

(a) "department' means any department of the State, implementing agent or contractor;

(b) "employer" means any department, implementing agency or contractor that hires workers to work in elementary occupations on a EPWP;

(c) "worker" means any person working in an elementary occupation on a EPWP;

(d) "elementary occupation" means any occupation involving unskilled or semi-skilled word\k;

(e) "management" means any person employed by a department or implanting agency to administer or execute an EPWP;

(f) "task" means a fixed quantity of work;

(g) "task-based work" means work in which a worker is paid to fixed rate for performing a task;

(h) "task-rate worker" means a worker paid on the basis of the number of tasks completed;

(i) "time-rate worker" means a worker paid on ths basis of the length of time worked.

2. Terms of Work

2.1 Workers on an EPWP are employed on a temporary basis or contract basis.

3. Normal Hours of Work

3.1 An employer may not set tasks or hours of work that require a worker to work –

(a) more than forty hours any week;

(b) on more than five days in a week; and

(c) for more than eight hours on any day.

3.2 Any employer and worker may agree that a worker will work four days per week. The worker may then work up to ten hours per day.

3.3 A task-rated worker may not work more than a total of 55 hours in a week to complete the tasks allocated (based on a 40-hour week) to that worker.

4. Meal Breaks

4.1 A worker may not work for more than five hours without taking a meal brake of at least thirty minutes duration.

4.2 An employer and worker may agree on longer meal brakes.

4.3 A worker may not work during a meal break. However, an employer may require a worker to perform duties during a meal brake if those duties cannot be left unattended and cannot be performed by another worker. An employer must take reasonable steps to ensure that a worker is relieved of his or her duties during the meal break.

4.4 A worker is not entitled to payment for the period of a meal break. However, a worker who is paid on the basis of time worked must be paid if the worker is required to work or to be available for work during the meal break.

5. Special Conditions for Security Guards

5.1 A security guard may work up to 55 hours per week and up to eleven hours per day.

5.2 A security guard who works more than ten hours per day must have a meal break at least one hour or two breaks of at least 30 minutes each.

6. Daily Rest Period

Every worker is entitled to a daily rest period of at least twelve consecutive hours. The daily rest period is measured from the time the worker ends work on one day until the time the worker starts work on the next day.

7. Weekly Rest Period

Every worker must have two days off every week. A worker may only work on their day off to perform work which must be done without delay and cannot be performed by workers during their ordinary hours of work ("emergency work").

8. Sick Leave

8.1 Only workers who work more than 24 hours per month have the right to claim sick-pay in terms of this clause.

8.2 A worker who is unable to work on account of illness or injury is entitled to claim one day's paid sick leave for every full month that the worker has worked in terms of a contract.

8.3 A worker may accumulate a maximum of twelve days' sick leave in a year.

8.4 Accumulated sic-leave may not be transferred from one contract to another contract.

8.5 An employer must pay a task-rated worker the worker's daily task rate for a day's sick leave.

8.6 An employer must pay a time-rated worker the worker's daily rate of pay for a day's sick leave.

8.7 An employer must pay a worker sick pay on the worker's usual payday.

8.8 Before paying sick-pay, an employer may require a worker to produce a certificate stating that the worker was unable to work on account of sickness or injury if the work is –

(a) absent from work for more than two consecutive days; or

(b) Absent from work on more than two occasions in any eight-week period.

8.9 A medical certificate must be issued and signed by a medical practitioner, a qualified nurse or a clinic staff member authorised to issue medical certificates indicating the duration and reason for incapacity.

8.10 A worker is not entitled to paid sick-leave for a work-related injury or occupational disease for which the worker can claim compensation under the Compensation for Occupational Injuries and Diseases Act.

9. Maternity Leave

9.1 A worker may take up to four consecutive months' unpaid maternity leave.

9.2 A worker is not entitled to any payment or employment-rated benefits during maternity leave.

9.3 A worker must give her employer reasonable notice of when she will start maternity leave and when she will return to work.

9.4 A worker is not required to take the full period of maternity leave. However, a worker may not work for four weeks before the expected date of birth of her child or for six weeks after the birth of her child, unless a medical practitioner, midwife or qualified nurse certifies that she is fit to do so.

9.5 A worker may begin maternity leave –

(a) four weeks before the expected date of birth; or

(b) on an earlier date –

(i) if a medical practitioner, midwife or certified nurse certifies that it is necessary for the health of the worker or that of her unborn child; or

(ii) if agreed to between employer and worker; or

(iii) on a later date, if a medical practitioner, midwife or certified nurse has certified that the worker is able to continue to work without endangering her health.

9.6 A worker who has a miscarriage during the third trimester of pregnancy or bears a stillborn child may take maternity leave for up to six weeks after the miscarriage or stillbirth.

10. Family responsibility leave

10.1 Workers, who work for at lease four days per week, are entitled to three days paid family responsibility leave each year in the following circumstances –

(a) when the employee's child is born;

(b) when the employee's child is sick;

(c) in the event of a death of –

(i) the employee's spouse or life partner;

(ii) the employee's parent, adoptive parent, grandparent, child, adopted child, grandchild or sibling.

11. Statement of Conditions

11.1 An employer must give a worker a statement containing the following details at the start of employment –

(a) the employer's name and address and the name of the EPWP;

(b) the tasks or job that the worker is to perform; and

(c) the period for which the worker is hired or, of this is not certain, the expected duration of the contract;

(d) the worker's rate of pay and how this is to be calculated;

(e) the training that the worker will receive during the EPWP.

11.2 An employer must ensure that these terms are explained in a suitable language to any employee who is unable to read the statement.

11.3 An employer must supply each worker with a copy of these conditions of employment.

12. Keeping Records

12.1 Every employer must keep a written record of at least the following –

(a) the worker's name and position;
(b) copy of an acceptable worker identification

(c) in the case of a task-rated worker, the number of tasks completed by the worker;

(d) in the case of a time-rated worker, the time worked by the worker;

(e) payments made to each worker.

12.2 The employer must keep this record for a period of at least three years after the completion of the EPWP.

13. Payment

13.1 An employer must pay all wages at least monthly in cash or by cheque or into a bank account.

13.2 A worker may not be paid less than the minimum EPWP wage rate of R63.18 per day or per task. This will be adjusted annually on the 1st of November in-line with inflation (available CPI as provided by StatsSA six (6) weeks before implementation).

13.3 A task-rated worker will only be paid for tasks that have ben completed.

13.4 An employer must pay a task-rated worker within five weeks of the work being completed and the work having been approved by the manager or the contractor having submitted an invoice to the employer.

13.5 A time-rated worker will be paid at the end of each month.

13.6 Payment must be made in cash, by cheque or by direct deposit into a bank account designated by the worker.

13.7 Payment in cash or by cheque must take place –

(a) at the workplace or at a place agreed to by the worker;

(b) during the worker's working hours or within fifteen minutes of the start or finish of work;

(c) in a sealed envelope which becomes the property of the worker.

13.8 An employer must give a worker the following information in writing –

(a) the period for which payment is made;

(b) the numbers of tasks completed or hours worked;

(c) the worker's earnings;

(d) any money deducted from the payment;

(e) the actual amount paid to the worker.

13.9 If the worker is paid n cash or by cheque, this information must be recorded on the envelope and the worker must acknowledge receipt of payment by signing for it.

13.10 If a worker's employment is terminated, the employer must pay all monies owing to the worker within one month of the termination of employment.

14 Deductions

14.1 An employer may not deduct money from a worker's payment unless the deduction is required in terms of a law.

14.2 An employer must deduct and pay to the SA Revenue Services any income tax that the worker is required to pay.

14.3 An employer who deducts money from a worker's pay for payment to another person must pay the money to that person within the time period and other requirements specified in the agreement law, court order or arbitration award concerned.

14.4 An employer may not require or allow a worker to –

(a) repay any payment expect an overpayment previously made by the employer by mistake;

(b) state that the worker receive a grater amount of money than the employer actually paid to the worker; or

(c) pay the employer or any other person for having been employed.

15. Health and Safety

15.1 Employers must take all reasonable steps to ensure that the working environment is healthy and safe.

15.2 A worker must –

(a) work in a way that does not endanger his/her health and safety or that of any other person;

(b) obey any health and safety instruction;

(c) obey all health and safety rules to the EPWP;

(d) use any personal protective equipment or clothing issued by the employer;

(e) report any accident, near-miss incident or dangerous behaviour by another person to their employer or manger.

16. Compensation for Injuries and Diseases

16.1 It is the responsibility of the employers (other than a contractor) to arrange for all personal employed on a EPWP to be covered in terms of the Compensation for Occupational Injuries and Diseases Act, 130 of 1993.

16.2 A worker must report any work-related injury or occupational disease to their employer or manager.

16.3 The employer must report the accident or disease to the Compensation Commissioner.

16.4 An employer must pay a worker who is unable to work because of an injury caused by an accident at work 75% of their earnings for up to three months. The employer will be refunded this amount by the Compensation Commissioner. This does NOT apply to injuries caused by accidents outside the workplace such as road accidents or accidents at home.

17. Termination

17.1 The employer may terminate the employment of a worker for good cause after following a fair procedure.

17.2 A worker will not receive severance pay on termination.

17.3 A worker is not required to give notice to terminate employment. However, a worker who wishes to resign should advise the employer in advance to allow the employer to find a replacement.

17.4 A worker who is absent for more than three consecutive days without informing the employer of an intention to return to work will have terminated the contract. However, the worker may be re-engaged if a position becomes available.

17.5 A worker who does not attend required training events, without good reason, will have terminated the contract. However, the worker may be re-engaged if a position becomes available.

Certificate of Service

18.1 On termination of employment, a worker is entitled to a certificate stating -

(a) the worker's full name;

(b) the name and address of the employer;

(c) the EPWP on which the worker worked;

(d) the work performed by the worker;

(e) any training received by the worker as part of the EPWP;

(f) the period for which the worker worked on the EPWP;

(g) any other information agreed on by the employer and worker.

PART C4

SITE INFORMATION / DRAWINGS

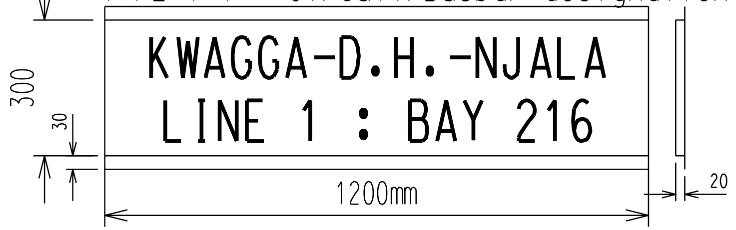
CONTENTS

(Drawings submitted by tenderer must be included here)

NOTE: Larger drawings are available on request.

NUMBER	DESCRIPTION
C4.1	WD-1 - Kwagga Substation Location
C4.2	TYPE- 01-1 - Labels
C4.3	TYPE - 01-2 - Labels
C4.4	TYPE - 01-3 - Safety signs
C4.5	TYPE 03DW-001 - Door and Window Schedule-Model-000
C4.6	TYPE 05D-001 - Fence - Palisade
C4.7	TYPE 05D-002 - Fence - Palisade - Gate detail
C4.8	Kwagga single line diagram.rev1
C4.9	CL – Site layout
C4.10	CL - Single line
C4.11	CL - Building Drawing – Guard house

TYPE 1.1 : Circuit/Busbar designation



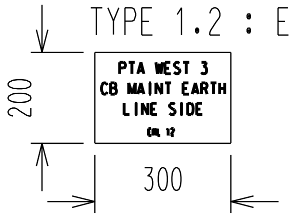
Letter Details:

Characters: 25max/line
Height : 150mm
Stroke : 20mm

Location :

Circuit : High on gantry beam
(Min. 2 per circuit)
Busbar : Above head on structure
Station name : Eye level

TYPE 1.2 : Equipment identification



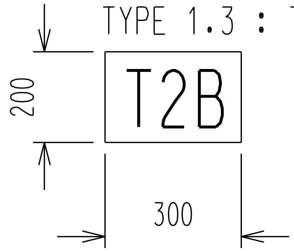
Letter Details:

Characters: 15max/line
Height : 25mm
Height : 15mm
Stroke : 20mm

Location :

Equipment : Eye level on structure

TYPE 1.3 : Trf Numbers designation



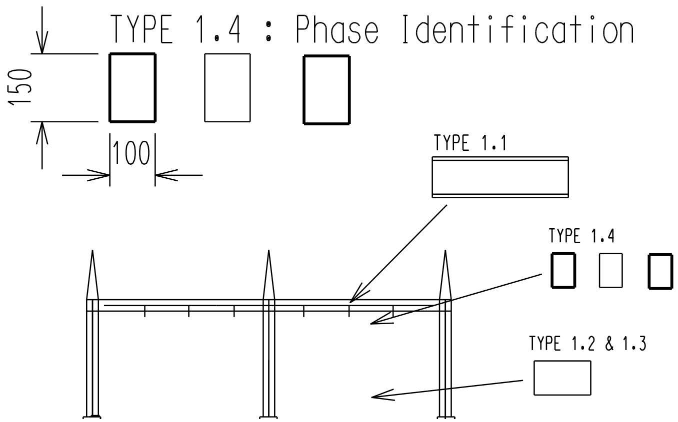
Letter Details:

Characters : 25 max
Height : 150mm
Stroke : 20mm

Location :

Bay No. : High on gantry beam
Trf. no. : Eye level on structure

TYPE 1.4 : Phase Identification



Location :

Structure : Above head on structure
Example : Busbars, Towers

GENERAL NOTES :

COLORS :
Type 1.1 - 1.3 :
Board : Yellow Background
Letters : Black
Type 1.4 :
Each Background : Red, Yellow, Blue

FONT :
Folio (Condenced)
Bold

MATERIAL :
For Types 1.1 - 1.4 :
Board : 0,6mm Chromadec
Letters : UV Resistant Vinyl

BRACKETS, BOLTS & NUTS :
Galvanised Steel

LABEL DIRECTION :
All labels to face the same side

CITY OF TSHWANE METROPOLITAN MUNICIPALITY
ENERGY & ELECTRICITY DIVISION

LABELS FOR SUB/INFEED/SWITCH-STATIONS

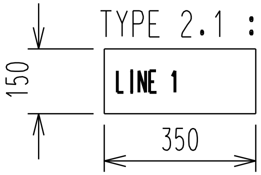
Amendment	1	Description
Requested	WJG J	Edit letter heights for boards type 1.1 and type 1.3
Drawn	WJG J	
Checked	JS v J	
Date	4-3-02	

City Electrical Engineer: J.A. EHRICH Prof. Eng.

Register File : E-8/2/2/2/3/16
Project File : E-11/2/47/5/10

Design: WJG Jooste Date: 4-3-2002	Checked: T v Rooyen Date: 8-3-2002		Register Dwg No. PPD-TYPE-1	Rev. 1
Drawn: JS v Jaarsveld Date: 4-3-2002	Approved: F Botha Date: 11-3-2001	Scale: FOR A3 1 : 20	Project Dwg No. KW-2030	Sheets 1 of 2

TYPE 2.1 : Line Identification



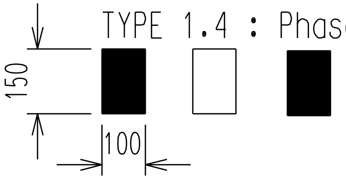
Letter Details :

Characters : 6 max
Height : 150mm
Stroke : 20mm

Location :

Tower : High up on tower
Example: See tower below

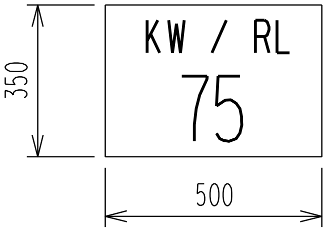
TYPE 1.4 : Phase Identification



location :

Structure: Above head on structure
Example: Busbars, Towers

TYPE 2.2 : Tower Designation



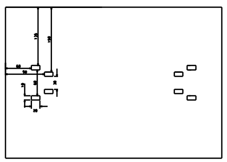
Letter Details :

Characters : 10 max
Height 1 : 90mm (Line Designation)
Height 2 : 190mm (Tower Number)
Stroke : 20mm

Location :

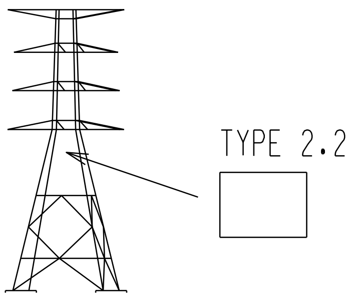
Tower : High up on tower
Example: See tower below

TYPE 2.2 : Tower Designation



Fixure Details :

See dimentions



GENERAL NOTES :

COLORS :
Type 1.4, 2.1 & 2.2 :
Board : Yellow Background
Letters : Black
Type 1.4 :
Each Background : Red, Yellow, Blue

FONT :
Folio (Condenced)
Bold

MATERIAL :
For Types 1.4 - 2.1 :
Board : 0,6mm Chromadec
Letters : UV Resistant Vinyl

For Type 2.2 :
Board : 1mm vitreous enamel (baked)

FRAMES, BRACKETS, BOLTS & NUTS :
Galvanised Steel

LABEL DIRECTION :
All labels to face source
All labels on same side of tower

CITY OF TSHWANE METROPOLITAN MUNICIPALITY
ENERGY & ELECTRICITY DIVISION
P.O. BOX 6338, PRETORIA, 0001
TELEPHONE: 308-0423

LABELS FOR TOWERS AND POWER LINES

Amendment	1	Description
Requested	WJG J	Edit letter heights for board type 2.1
Drawn	WJG J	
Checked	JS v J	
Date	4-3-02	

City Electrical Engineer: J.A. EHRICH Prof. Eng.			Register File : E-8/2/2/2/3/16 Project File : E-11/2/47/5/10	
Design: WJG Jooste Date: 4-3-2002	Checked: T v Rooyen Date: 8-3-2002		Register Dwg No. PPD-TYPE-1	Rev. 1
Drawn: JS v Jaarsveld Date: 4-3-2002	Approved: F Botha Date: 11-3-2003	Scale: FOR A3 1 : 20	Project Dwg No. KW-2030	Sheet: 2 of 2

SUBSTATION BUILDING

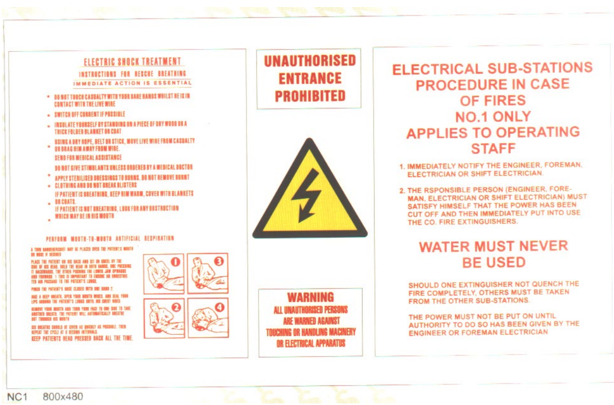
OUTSIDE THE BUILDING

NC 75 600x600

EACH DOOR

INSIDE/BACK

NC1



FIRE EXTINQUESER

NC 58
500x700mm

TOP 1.3METER FROM GROUND

N60
250x350mm

BOTOM 2.1METER FROM GROUND

BATTERY ROOM

INSIDE DOOR

NC 76

MV 5

MV 9

MV 10

CITY OF TSHWANE

PRIMARY 132/11KV SUBSTATIONS

SAFETY SIGNS

Revision: 1 | **Drawing No: TYPE 01-3**

SUBSTATION YARD

OUTSIDE THE SUBSTATION YARD GATE

WW 23

SUBSTATION NAME

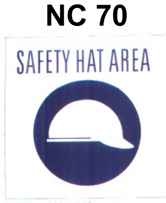
WW 23

NC 2 (500X300)

OUTSIDE ON THE YARD GATES AND FENCES

OUTSIDE EACH 275kV YARD GATE

NC 70



MV 7

PV 8

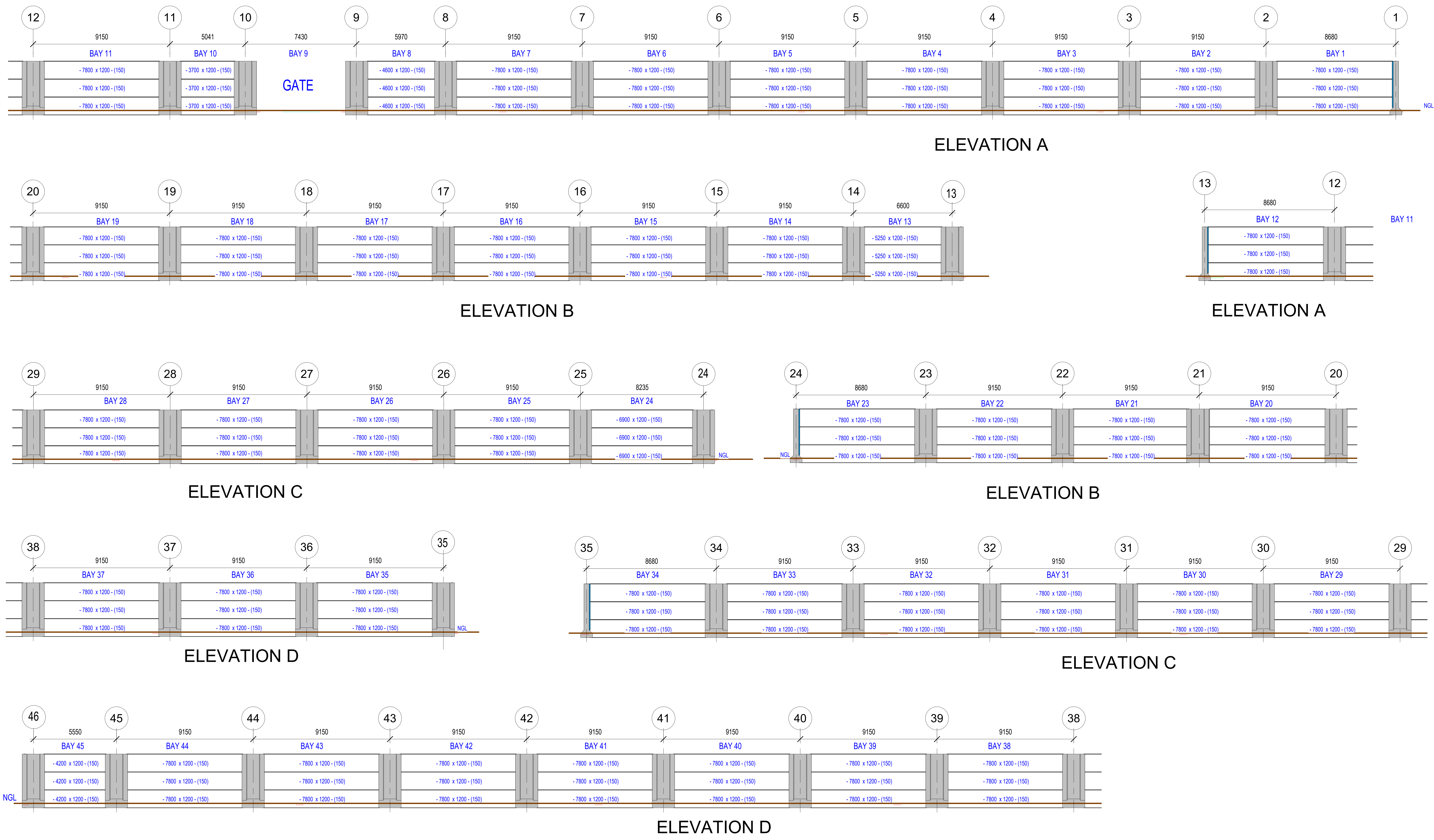
PV 4

OUTSIDE ON THE SUBSTATION FENCE

WW 23

20 METERS APPART

	CITY OF TSHWANE	PRIMARY 275/132KV SUBSTATIONS SAFETY SIGNS
	Revision: 1	Drawing No: TYPE 01-4



GENERAL NOTES

1. THIS DRAWING IS NOT TO BE SCALED FIGURED DIMENSIONS ONLY TO BE TAKEN
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH RELEVANT ARCHITECTURAL ENGINEERS AND LAND SUREYORS DRAWINGS WHERE AVAILABLE
3. WIND LOADING AS PER SANS 10160-3:2019
4. ALL STRUCTURAL DESIGN TO COMPLY WITH SANS 10400
5. MIN SOIL BEARING CAPACITY 50 kPa - SOIL CONDITIONS DEPENDANT. G5 UNDER COMPACTION BELOW OR AS OTHERWISE NOTED
6. FOUNDATION CONCRETE STRENGTH MN 25 mPa 19mm STONE
7. COLUMN CONCRETE STRENGTH MN 35 mPa 13mm STONE

PRESTRESS WALLING NOTES

1. STRENGTH ON DESTRESS - 30 mPa
2. STRENGTH AFTER 28 DAYS - 50 mPa
3. FINISH TO WALLS - SMOOTH OFF SHUTTER WITH V JOINT, STEEL FLOAT ON ON BACK END. WALLS HAVE AN INTERLOCKING TONGUE AND GROOVE JOINT
4. WALLS TO HAVE 75 mm BEARINGS OR AS OTHERWISE NOTED

APPROVAL

CLIENT

SIGNATURE .... SIGNATURE ....

ENGINEER

SIGNATURE .... SIGNATURE ....

REFERENCE

REF.DRAWING.NO.	TITLE

REVISIONS

REV	DATE	DESCRIPTION	BY	CHKD	APPR
0	19.05.2025	ISSUED FOR APPROVAL			
1	19.05.2025	BAY NUMBERS ADDED			
			Author		

NAME............

SIGNATURE ....

REV:............

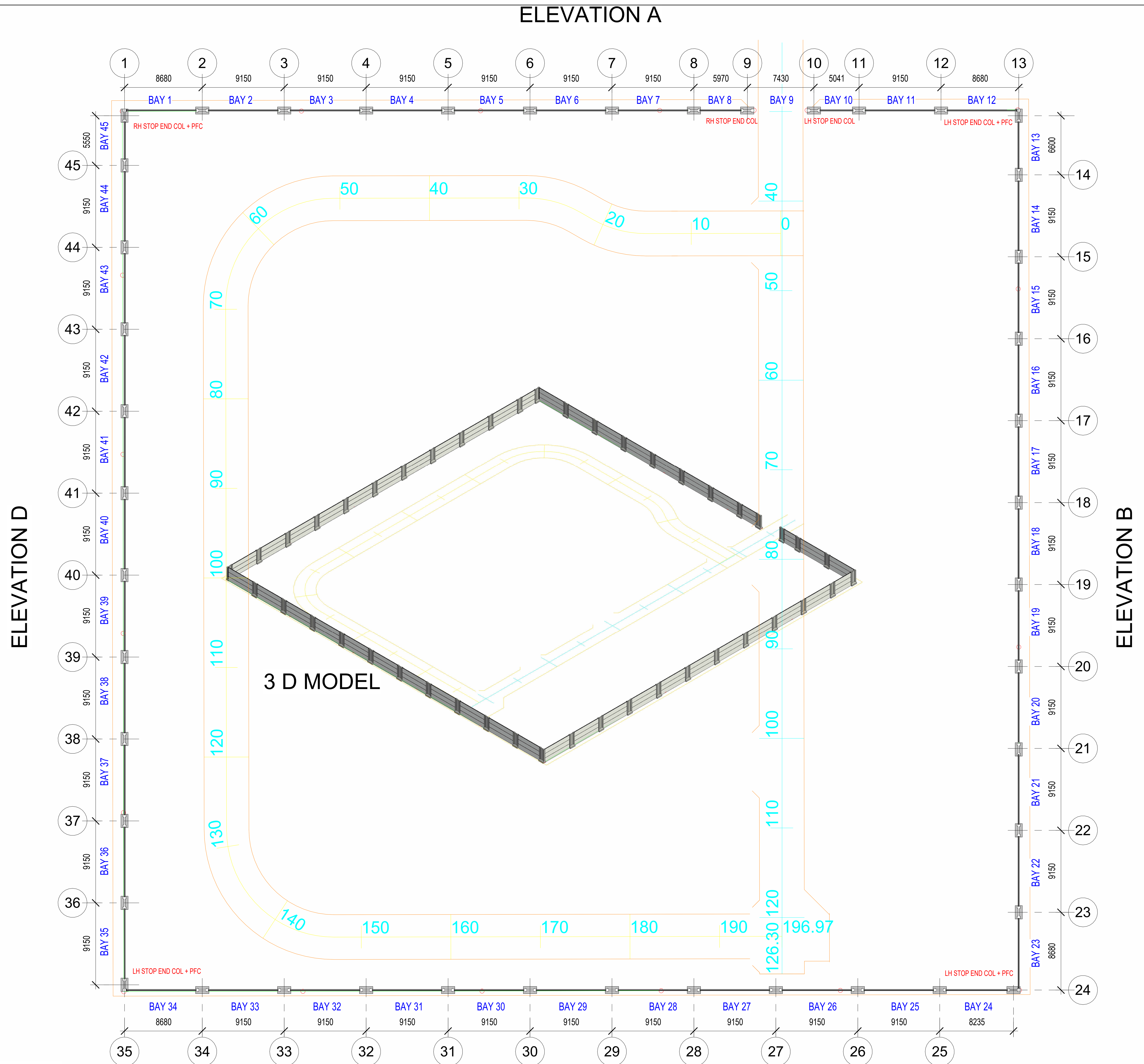
PROJECT

WALLING ELEVATIONS

DATE	SCALE	CLIENT
19.05.2025	1:120	

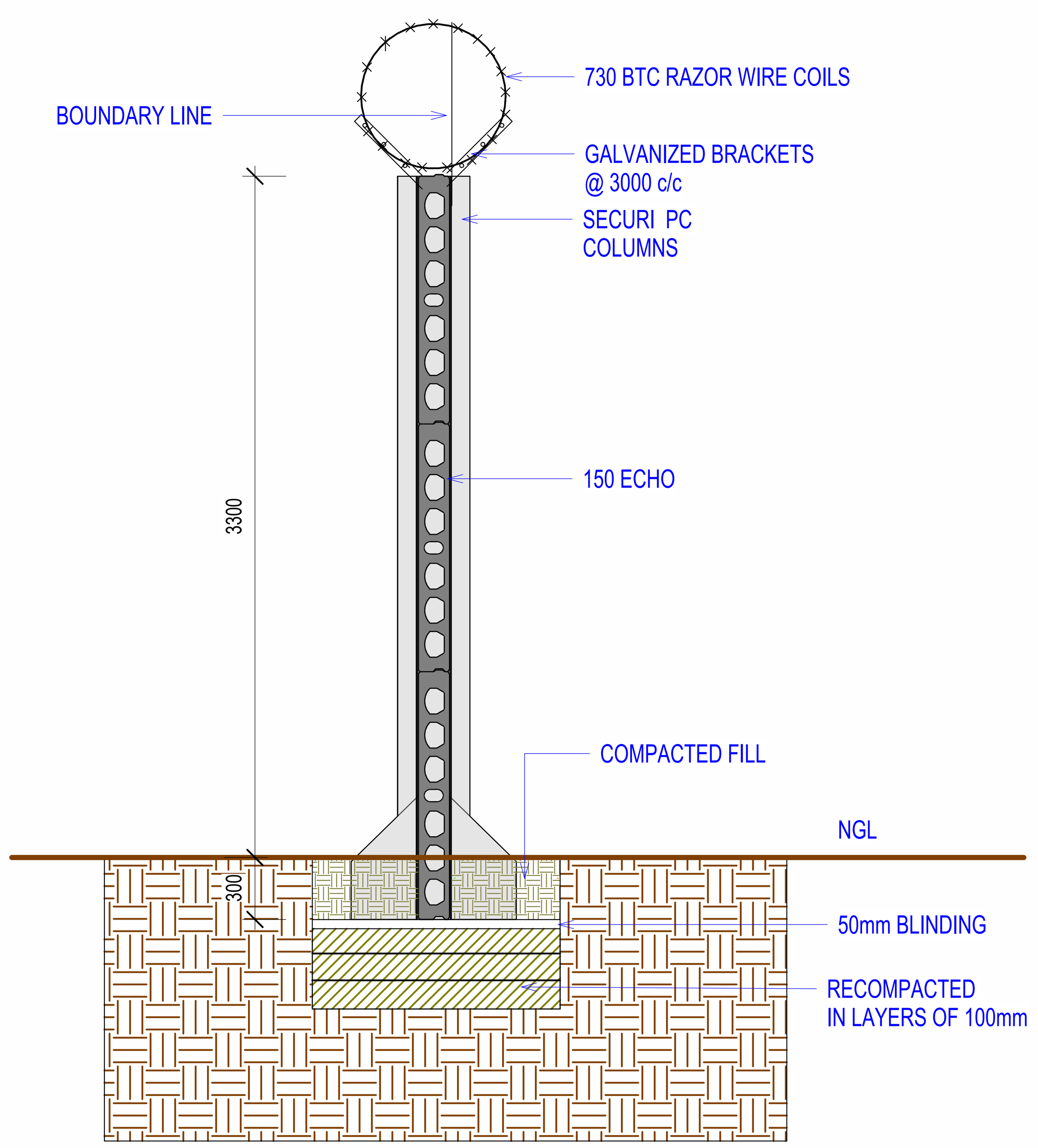
DRAWING No: 2 REV 1

AO



ELEVATION C

WALLING PLAN 1:250



TYPICAL SECTION

METHOD STATEMENT - COLUMN

EXCAVATE 1800 X 1200 X 650 DEEP

FILL TO BE COMPACTED BY WHACKER/RAMMER ONLY
LAYER THICKNESS MUST BE 100mm
3% CEMENT/ SOIL MIX. WEIGHT CEMENT PER 100mm LAYER=18kg.
90 kPa BEARING CAPACITY IS REQUIRED

200 X 75 PFC CHANNELS	
No Off	PFC Length
4	3100

LH STOP END -COLUMNS
No Off
1

LH STOP END -COLUMNS + PFC
No Off
3

RH STOP END -COLUMNS
No Off
1

RH STOP END -COLUMNS + PFC
No Off
1

STANDARD - COLUMNS
No Off
39

WALLING SCHEDULE		
Slab	No Off	Area m²
150	132	

APPROXIMATE WALLING LENGTH +- 392.2m

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REVISIONS

REV	DATE	DESCRIPTION	BY	CHKD	APPR
0	19.05.2025	ISSUED FOR APPROVAL			
1	19.05.2025	BAY NUMBERS ADDED, SHEDULES UPDATED AND BTC RAZOR WIRE ADDED			

NAME..................

SIGNATURE ....

REV:..................

PROJECT

PRECAST WALLING DETAILS

DATE	SCALE	CLIENT
19.05.2025	1:120	

DRAWING No: 1 REV 1

AO

Columns:

The columns must include an integrated concrete foundation to allow them to be installed at 8000mm to 10000mm centres.

COLUMNS	HEIGHT	WALL HEIGHT	ANTI-DIG	SPACING
	4200mm	3600mm	600mm	8000mm

Hollow Core Panels/Slabs:

Precast hollow core panels which are constructed with high tensile pre-stressed steel with minimum strengths of 50Mpa,

Panels thickness: 150mm

Panels Breath: 12000mm

Panels length: 8000mm