

EMALAHLENI LOCAL MUNICIPALITY

**40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION OF
A 11,5 KM, 132 KV OVERHEAD LINE.**

CONTRACT NUMBER: ELM 07/2021 (READVERT)



THE CONTRACT

PART C3. SCOPE OF THE WORKS

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THE CONTRACT PART 3: SCOPE OF THE WORKS

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C3 SCOPE OF WORKS

This scope of work institutes information that specifies and describes the goods, services, or engineering and construction works which are to be provided and any other requirements and constraints relating to the manner in which the contract work is to be performed;

The Scope of Works includes three distinct sub-sections namely:

- C3.1 – Project Specifications
- C3.2 – Technical Schedules
- C3.3 – General Specifications

The Contractor must allow in his tender price, for the supply, delivery of material on site, installation and commissioning of the works as specified in this document. The onus is on the Contractor to ensure that he received a complete document as indicated in the Index.

GENERAL

This specification deals with the technical installation aspects relating to this project. Any discrepancy between the Particular Specification, Bill of Quantities and Drawings must be reported to the Engineer who will clarify such contradiction before closing of tender.

If any discrepancies exist between parts of this document, the following order of preference will take place:

- Drawings
- Bill of Quantities
- Project Specifications
- General specifications

Regarding the conditions of the contract, the order of priority is as follows:

- Special Conditions of Contract and Appendix to Tender
- General Conditions of Contract
- Tender requirements
- Common Law

DESCRIPTION OF THE WORKS

The scope of the contract is for the fabrication, erection and commissioning of a 11,5 km, 132 kV Chickadee overhead line from Eskom's Vulcan Main Transmission Substation (MTS) to the Siyanqoba Substation in order to provide a bulk electrical supply to the Siyanqoba Township. The Chickadee conductor will be strung on 20 to 24 m, steel monopoles in a single circuit configuration and will after completion be handed over to Emalahleni Local Municipality to commercially operate and maintain. A portion of this project will entail the installation of a new 20 MVA, 132/11 kV power transformer in the existing Siyanqoba Substation.

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The project will be funded by the Department of Mineral Resources and Energy (DoE) and it is envisaged that the project will be completed over a period of two (2) municipal financial years as funds become available. The tenderer must therefore allow to construct the HV overhead line over a two (2) year period as funds become available.

The tenderer must take note that the funds from DMRE is not guaranteed and the construction of the overhead line will be subject to availability of funds.

All the material shall be supplied by the tenderer which includes the manufacturing, according to Eskom Specification, transporting to site, offload, installation and commissioning will all be undertaken by the successful tenderer.

Prior to energizing, commissioning certificates must be submitted by the OEM for the power transformer. Prior to the energising of the 20 MVA transformers an oil sample must be taken and the oil sample shall not be older than 30 days at the time of energising.

HIGH LEVEL SCOPE OF WORKS

The scope of works is outlined below.

Table 1: High level primary plant scope of work

1.	Pegging and setting out of the line route, pole and stay positions.
2.	Excavation of pole and stay holes as well as soil nominations.
3.	Dressing of poles.
4.	Planting of poles.
5.	Planting of stays and temporary construction stays.
6.	Stringing and Regulation of CHICKADEE.
7.	Stringing and Regulation of OPGW.
8.	Installation of 20 MVA, 132/11 kV Power Transformer.
9.	Commission and energise the overhead line
10.	Submit 5 sets of as-built drawings and manuals of the new substation.

Table 2: High level control plant scope of work

1.	Install all fibre optic cable work.
2.	Commissioning of 1 x Transformer Protection Schemes
3.	Commissioning of 1 x Feeder Protection Schemes
4.	Testing, commissioning and handing over

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CONSTRAINTS WITH EXECUTION OF THE WORKS

- a) Any variation or modification with a cost implication must be approved by the Project Manager before work can commence. No late claim will be entertained.
- b) All relevant procedures pertaining to the project will be detailed on the first site handover meeting. The Contractor should however take note of the standard 42 page Construction Regulations & Checklist document which must be adhered to and signed off pertaining to all tasks successfully completed. The handing over document must be signed and handover must take place 7 days prior to the official energising of the project. The handing over document must be accompanied by commissioning certificates of the OEM as follows (Hard & soft copy):
 - 132/11 kV Transformers
 - Protection Schemes
- c) The Contractor must adhere to Safety Requirements.
A document must be compiled stating the following:
 - A method statement
 - Safe working procedure
 - Risk analysis

Further safety requirements are as follows:

- Only harnesses and no safety belts must be used in alleviated positions.
 - No labourers will be allowed to stay on site. A night watch shall be appointed to guard the site at night.
 - No short pants will be allowed on site.
 - Safety clothes suitable for the specific task must be worn at all times.
 - Toilet facilities are available on site; no temporary toilets will be allowed.
 - Day visitors will be able to enter with a visitor's card.
 - Hard hats and safety boots are compulsory on the construction site.
 - All operators must be trained and competent.
 - All equipment must be in a good working order.
 - The Contractor must have a first-aid kit on site and all injuries must be reported.
 - The Contractor must keep complete record of all man hours.
- d) The tenderer shall provide three complete sets of all special tools for the equipment supplied. The tenderer shall further provide a list of spare parts which it is recommended and should be kept by the Employer. Spares, which the employer decides to order, shall be delivered simultaneously with the rest of the equipment and shall be separately packed and appropriately marked.

The spares specified herein must be handed over to the Client before the issuing of the Taking Over Certificate and may not be used by the Contractor for maintenance or for

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replacement of components which have to be replaced due to defects during the Defects Liability Period or for the replacement of any item which is still under guarantee.

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THE CONTRACT PART 3: SCOPE OF THE WORKS

C3.1: PROJECT SPECIFICATIONS

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C3.1. PROJECT SPECIFICATIONS

This specification deals with the technical installation aspects relating to this project.

Any discrepancy between the Particular Specification, Bill of Quantities and Drawings must be reported to the Engineer who will clarify such contradiction before closing of tender.

If any discrepancies exist between parts of this document, the following order of preference will take place:

- a) The Contract Agreement (if any)
- b) The Letter of Acceptance
- c) The Letter of Tender
- d) The Particular Conditions
- e) These General Conditions
- f) The Specifications
- g) The Drawings, and
- h) The Schedules and any other documents forming part of the Contract

C3.1.1. DEFINITIONS

For the purposes of this document, terms used herein or in accompanying documents shall have the following meaning:

“Agreement” shall mean the agreement entered into between the Employer and the Contractor for the execution of the accepted Tender Price or accepted quotation. Under this contract this means the FIDIC Condition of Contract and other contract documents;

“Bills of Quantities” or **“Schedule of Quantities”** or **“Pricing Schedules”** shall mean the document attached to a Tender Document or Quotation in which the quantities of work, labour, materials and articles required for the execution of the contract will be entered, together with the rates or prices for such items;

“Calendar Days” means twenty-four (24) hour days commencing at midnight (00:00) which include working and non-working days.

“Certificate of Final Completion” means a certificate issued by the Engineer to the Contractor stating the date on which final completion of the works was achieved.

“Certificate of Practical Completion” means a certificate issued by the Engineer to the Contractor stating the date on which practical completion of the works was achieved.

“Certificate of Works Completion” means a certificate issued by the Engineer to the Contractor stating the date on which works completion of the works was achieved

“Contractor” shall mean the Employer has accepted the person or persons, partnership, firm or company, whose tender for the work referred to in the Contract or who has or have signed the contract and shall include his or their heirs, executors, administrators, judicial managers, trustees, successors in title and duly appointed representatives.

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“Contract” or **“Contract Documents”** shall mean and include the Conditions of Tender, General Conditions of Contract, Special Conditions of Contract, Project Specifications, Schedules of Quantities or Pricing Schedules or Bills of Quantities, Schedule of Prices for Variations, Drawings, Form of Tender, Letter of Acceptance and the Agreement to follow thereon and shall include such printed matter or explanatory memorandum submitted by a Tenderer with his tender as may be acceptable to the Employer;

“Contract Price” or **“Contract Sum”** shall mean the amount entered in the Form of Tender for the whole of the Works done or materials supplied for the Works, subject to additions or deductions as may be made in terms of the Contract;

“Construction Equipment” shall mean all the materials, machinery, implements, tackle, vehicles, barrows, tools, etc. provided by the Contractor, for the due performance of the Contract, but not essentially forming part of the Contract.

“Drawings” shall mean the drawings, sketches, diagrams, maps, plans, sections and other delineations which accompany or are referred to in the Contract Documents, and which have been signed by the Engineer and such further drawings as may be issued or approved by the Engineer relating to the works, whether such further drawings indicate variations of the Works, whether by way of addition, alteration or omission, or merely elaborate the signed Drawings in greater detail.

“Employer” or the **“Client”** shall mean the Owner of the completed Works or the official body who acts as the representative of the Owner and shall include their duly appointed representatives.

“Engineer” shall mean the Engineer duly appointed by the Employer to act on his behalf for the purpose of a Contract. Under this contract the Engineer might act as the Principle Agent

“In writing” shall mean type written script or printed communication matter transmitted via land mail or via e-mail, or delivered by hand, to the Engineer.

“OEM” shall mean the Original Equipment Manufacturer for any product or equipment required as part of this project.

“Order in Writing” shall mean any printed, typewritten or written document or letter signed by the Engineer and addressed to the Contractor for the purpose of his guidance and directions.

“Plant”, “Work” or “Works” shall mean all equipment, plant, materials, articles, matters and items comprised by, described in, or referred to in the Contract Documents and which are to be manufactured and/or delivered, constructed, erected and completed. These shall include all those details which are not particularly mentioned in the aforesaid Documents, nor shown upon the Drawings, but which are requisite for the perfect completion of each and every one of the several parts, and all additional Works that may be ordered to be executed according to the true intent and meaning of the Contract plus the maintenance for the prescribed period;

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“Schedule of Prices for Variations” shall mean the schedules attached to a Contract Document or Quotation in which the amounts to be added to, or deducted from the Contract Amounts are entered according to whether the items mentioned in the said schedule are extra to or omitted from the Contract as may be provided for in the General Conditions of Contract;

“Site” shall mean the land and/or place to which Works is to be delivered or where work is to be executed or carried out under a Contract and any other land and/or place acquired or used by the Contractor in connection therewith, and includes any place wherever anything is manufactured, excavated or stored for the purpose of carrying out a Contract, together with so much of the area surroundings the said place or places as the Contractor shall with the consent of the Engineer actually use in connection with the Works otherwise than merely for the purpose of access to the said place or places.

“Specification” shall mean the section in the Contract document in which the detail method and standard of executing the Work and the nature of the materials to be used or supplied are described;

“Standard Practice” shall mean the methods and means of working normally as employed by the Employer;

“Sub-Contractor” shall mean the person or persons, partnership, firm or company named in the Contract for any part of the Work or to whom any part of the Contract has been sublet with the consent in writing of the Engineer and the legal representatives, successors and assigns of such person or persons, partnership, firm or company and all specialists, merchants, tradesmen or others executing any Work or supplying any goods for which prime cost prices or provisional sums are included in the Specification or Bill of Quantities and Prices who may at any time be nominated, selected or approved by the Engineer;

“Tests on Completion” shall mean such tests as are prescribed by the Specification to be made by the Contractor before the Works is taken over by the Employer;

Words imparting the singular only shall also include the plural and vice versa where the context so requires. The headings or notes in these General Requirements shall not be deemed to be part thereof, or be taken into consideration in the interpretation or construction thereof or of the Contract.

C3.1.2. SITE ESTABLISHMENT

The specific Contractor shall supply, transport and off-load his own facilities such as sheds, water, electricity, lighting, etc. on the site. The Contractor shall also be responsible for removing all facilities established on site after his work is completed.

It shall be expected from the Electrical Contractor to erect a site office with surrounding fence. The surrounding fence to be 1,8 m high, with Y shape frame on top and equipped with barbed wired. Lockable gates must form part of the surrounding fence. This site yard must therefore provide adequate security to all material stored, even if it means that the Contractor must provide for a trench alongside the fence. The site office must be equipped with furniture for meeting purposes and the Contractor must make arrangements to have a full time security

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guard, keeping close watch over all material stored in this yard. Pin boards shall be provided in site facilities to accommodate all project and construction drawings.

The Contractor must also provide for all the necessary sanitary toilets, water, rain gauge etc.

The Contractor shall cater for his own water, electricity and sanitation requirements.

The Contractor must also erect a name board, with a size of 2 800 mm x 3 222 mm, at a suitable place to be pointed out by the Engineer. For further details, refer to the drawing of the name board which forms part of this project specification.

The Engineer will indicate the preferred site; the onus is on the contractor to verify if the proposed site is suitable. The Contractor shall submit a Site Establishment application to the Building and Land Use Department on the prescribed application form of the Municipality which can be obtained from the Building and Land Use Department.

C3.1.3. SITE INSTRUCTION BOOK

The Contractor shall make provision for a site instruction book (triplicate pages) which shall be kept in the site office at all times. All instructions and variations shall be written in this site instruction book by the Engineer while attending the site. The onus will be on the Contractor to confirm such instructions and variations in writing, if the Engineer neglects to do so within 14 days after the issuing of this instruction, especially if it has a cost implication.

C3.1.4. SECURITY

The Contractor shall make provision for a site instruction book (triplicate pages) which shall be kept in the site office at all times. All instructions and variations shall be written in this site instruction book by the Engineer while attending the site. The onus will be on the Contractor to confirm such instructions and variations in writing, if the Engineer neglects to do so within 14 days after the issuing of this instruction, especially if it has a cost implication.

C3.1.5. DRAWINGS

The tenderer shall ensure that accurate as-built records are kept of all infrastructure installed or relocated during the contract. A marked-up set of drawings shall also be kept and updated by the tenderer. This information shall be supplied to the Engineer's Representative on a regular basis. All information in possession of the tenderer required by the Engineer and/or the Engineer's Representative to complete the as-built/record drawings, shall be submitted to the Engineer's Representative before a Certificate of Completion will be issued.

C3.1.6. REQUIREMENTS FOR THE PROGRAMME

This tender must be accompanied by a detailed programme based on prior experience and accounting for site conditions. The programme must also make provision for delivery dates of material as quoted by their suppliers. The Contractor must take cognisance of the fact that

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he/she will be responsible for late delivery of material, except if the supplier can prove that late delivery was beyond their control. The Engineer and the Employer reserves the right to alter the programme to meet the priorities of the Client. These amendments will be such, that the Contractor will still be able to complete the works within the tendered construction time.

Based on the above, the tender must be accompanied by a cash flow report. This information is required for adjudication of the tender and to determine the escalation on the project when applicable. This will also assist the Contractor in putting his/her tender together and finalizing his/her tender price.

When compiling the project programme attention shall be given to the Health and Safety file which may require a permit application before the construction can initiate. Adequate allowance for this process shall be included in the programme if needed.

The Engineer, Project Manager and his Clerk of Works (if applicable) will have full access to the site and the Clerk of Works (if applicable) is expected to visit the site once a week. A formal site meeting or site inspection will be conducted every second week on a rotational basis.

It shall be expected from the Contractor to forward a weekly progress report to the Project Manager which must be emailed to his office every Friday.

The Contractor must submit a progress report at each monthly, scheduled site meeting based on this original program. The actual and scheduled progress must be clearly indicated in the report. The Contractor must also indicate his/her labour force and equipment on site in this report.

The programme must be, based on the following anticipated dates:

Tender award	- 20 October 2021
Commencement date	- 29 October 2021
Completion date, Phase 1	- 30 June 2022 (132 kV Overhead Line)
Completion date, Phase 2	- 30 June 2023 (132/11 kV Power Transformer)

The programme must also indicate the following:

- a) Time for site establishment.
- b) Material Procurement.
- c) Manufacture of equipment.
- d) Survey and pegging of line.
- e) Excavation of pole holes and stay holes.
- f) Planting and dressing poles and stays.
- g) Stringing.
- h) Tension and Regulation.
- i) Finishing.
- j) Closing span.
- k) Factory Acceptance Testing of 20 MVA, 132/11 kV Power Transformer.
- l) Delivery to site and Installation of 20 MVA, 132/11 kV Power Transformer.
- m) Site Acceptance Testing of 20 MVA, 132/11 kV Power Transformer.
- n) Testing and Commissioning.

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- o) Handover.
- p) "Float" for unforeseen delays

The Contractor must take cognisance that time is of the essence must also allow for normal rainfall during this period in his programme.

Expected delivery date of long lead material must be recorded in the section of this document containing forms to be completed.

C3.1.7. TIME FOR COMPLETION

The Contractor must allow sufficient time in his/her contract working period for delays due to climate and weather according to the average rainfall for this area, as indicated in the special conditions of contract.

Extensions of time will only be granted if evidence can be provided that the delays were caused by abnormal weather conditions. Claims for rework will not be considered, and is an issue for insurance. The Contractor shall however allow slack in the construction programme to cater for any unforeseen circumstances.

The penalty for late completion of the works is indicated in the contract conditions and it is emphasized that time is of the essence. Commencement of the contract will be as indicated in the acceptance letter.

The Taking Over Certificate will not be signed prior to receipt of all as-built information as detailed in this specification. This may result in penalties.

C3.1.8. SURVEY

The Contractor will be required to appoint a qualified Land Surveyor to peg the line according to the issued Construction Staking Table. Frans Brugman was responsible for the design survey and can be contacted at cell number 082 852 4309 for pegging of pole and stay positions.

Prior to commencement of any phase of the project as indicated on the drawings, the Contractor must do a thorough survey to ensure that all pegs applicable to this project are installed. Missing pegs must be report in writing to the Engineer. The Contractor will be responsible for re-installing of all missing pegs, not reported, at own expense on the day of handover of a particular phase.

Any stand pegs, where applicable, which are removed accidentally or intentionally by the Contractor in the course of his/her activities, shall immediately be reported to the Engineer. The Employer's land surveyor shall re-install such pegs at the expense of the Contractor. The Contractor must issue a certificate obtained from a professional land surveyor to verify that all pegs are installed along the line route.

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The Contractor shall after completion of the contract employ a land surveyor acceptable to the Engineer and Employer to certify the correctness of the constructed overhead line. This certificate must be submitted to the Engineer.

C3.1.9. MEASUREMENTS

Before ordering of equipment and conductor, the measurements must be finalised on site and must be confirmed with the Engineer. The accuracy or inaccuracy of the Bill of Quantities will not influence the validity of the tender. The quantities in the Bill are measured from a drawing and serve only as an indication to obtain a unit rate. At the end of the Contract period a final re-measurement, based on actual quantities, will be done.

C3.1.10. FINAL INSPECTION

After completion of each section of the project, the Tenderer must perform an internal, thorough inspection on all the work done, to satisfy himself that the work complies with the specifications, and then apply in writing to the Engineer for a final inspection. The Tenderer will be liable to pay the Engineer according to the newest gazetted ECSA rates for re-inspections. The application for the final inspection must be accompanied by the as-built drawings. The installation will not be approved before submission of the as-built drawings.

C3.1.11. QUALIFIED PERSONNEL

The Tenderer must submit a list of the staff allocated to this project with proof of their qualifications and experience in the construction and erection of HV overhead lines.

The Tenderer shall also submit a certificate issued by the Inspector of Occupational Health and Safety, indicating that he is fully competent performing electrical construction work and will therefore be fully responsible for the construction of the works. No work will be allowed before submission of these documents.

The Tenderer shall provide the Employer and Engineer with the names of the supervisory personnel on site before commencement of the contract works.

If the Contractor, during any stage of the contract and for whatever reason, desires to change the supervisory personnel on site, he will do so in writing to the Employer and Engineer. Failure to do this will result in the Engineer halting the contract works until such time the necessary documentation is provided. Any such delays will not be considered by the Engineer for late completion of the contract.

C3.1.12. CONTRACTOR'S RESPONSIBILITY

C3.1.12.1. GENERAL

Until the Contract Works have been completed or deemed to have been completed, the Contractor shall be responsible (subject to the Memorandum of Agreement and the Conditions of Contract) for the Contract Works, whether under construction, during tests, or in use for service.

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The handling and storage of materials and equipment near the erection site prior to installation shall be done in a tidy and safe manner. The Contractor shall at his own expense, keep the site area allocated to him, and the erection area of the Contract Works, reasonably clean and shall remove all waste material as it accumulates, and as directed by the Engineer from time to time. There shall be no Safety, Health, Environmental or Quality impact due to the installations carried out and the Contractor shall take full responsibility for all construction methodologies.

Storage of materials shall not be permitted without prior approval, and the Contractor shall take all necessary steps to protect any materials stored on the site.

When the work is completed, the Contractor shall remove all rubbish and debris, unused materials, temporary erections and plant and shall leave the site of the work clear. The Contractor shall also make good at his own expense, any damage caused to buildings, plant or property belonging to the owner of the works.

C3.1.12.2. ORDERING OF MATERIAL AND EQUIPMENT

All the material shall be supplied by the tenderer, which includes fabrication, according to the relevant standards and specification, transporting to site, off-loading on site, installation and commissioning which will all be undertaken by the successful tenderer unless otherwise specified.

The offloading and safekeeping of material off-site is the responsibility of the Contractor.

The successful Tenderer shall attend meetings at venues and at times, as may be arranged by the Engineer, after having been advised that his/her Tender has been accepted, for the purpose of coordinating the technical requirements and the time frame of the project, so that orders can be placed for the correct materials.

Contractors must note that materials and equipment on long delivery shall be ordered well in advance as late deliveries will be the Contractors sole responsibility. Any applicable escalation on equipment or materials ordered late will be calculated using indices as specified by the Employer. If, for some reason, late deliveries are found to be to the advantage of the Employer, the Contractor will be instructed in writing regarding the delay in ordering of such materials.

Unless otherwise indicated or stated, all units of measurement indicated in the Pricing Schedules, Schedule of Quantities or Bills of Quantities are metric units.

The linear quantities of wire, conduit, trunking, cables, switchgear, fittings etc. as given in the Pricing Schedules, Schedule of Quantities or Bills of Quantities are measured from drawings for Contract document compiling purposes. Contractors can thus not accept that such quantities are accurate when materials are ordered. Before ordering any equipment, materials and cables, the measurements must be finalised on site and must be confirmed with the Engineer. The accuracy or inaccuracy of the Bill of Quantities will not influence the validity of the tender.

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At the end of the Contract period a final re-measurement, based on actual quantities, will be done. Any excess cable or material will be for the account of the contractor and payment for excess cable or material will not be considered.

If such measurements cannot be taken at the onset of the Contract, the Contractor shall obtain approval from the Engineer to order the required materials that may cause delays or additional cost due to escalation before ordering such materials as allowed for in the Pricing Schedules, Schedule of Quantities or Bills of Quantities.

C3.1.12.3. WORKSHOP ASSEMBLY

To avoid problems with the erection and installation activities on site, components, equipment and sub-assemblies must be pre-assembled in the place of manufacture to ensure proper fitting and operation on site.

Such pre-assemblies which are to be tested in the place of manufacture, shall be set up in a simulated mode, using the specified peripheral equipment as far as possible in a temporary connected condition to simulate site conditions as accurately as possible. This requirement is, in particular, applicable to field equipment for electrical and electronic installations.

The purpose of such preliminary testing, shall further be done to check whether the equipment complies with predetermined set values and shall produce certain predetermined set results, as set out in the various parts of the document.

Measurements of equipment shall be taken into consideration to ensure that such equipment and materials can be handled on site and can be placed into the specified positions.

Additional costs or delays resulting from failure on the part of the Contractor to check access conditions, positions, openings, etc., will be for the Contractors account.

Individual units of equipment shall be clearly marked by employing an identification code in such a manner that actual re-assembly, erection and installation on site can be done in the minimum of time with a minimum of fitting and adjusting on site.

Equipment should be delivered to site in the largest sub-assemblies that are practical.

Equipment of the same type shall all be obtained from one manufacturer and sub-components shall be changeable. Prior to manufacture, the Contractor shall ascertain the critical dimensions of points of entry to the building.

The Engineer may, upon request by the Contractor, inspect existing installations of prototype assemblies in the factory to determine whether the extent and workmanship of such units are of the required standard for the particular Contract. This may be done to obviate the possibility of having to replace unacceptable equipment already installed.

C3.1.12.4. DELIVERY OF EQUIPMENT

The Contractor shall make the necessary arrangements to get all equipment delivered to site in accordance with the Programme of the Works and in an undamaged condition.

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The Contractor shall pack equipment and material for transport and delivery in soundly constructed crates or other packages fitted with removable lids or openings for inspection.

All parts of the equipment prior to packaging, shall have been thoroughly protected to preclude damage during transport and storage.

Any damage that may occur in transit or storage must be repaired, corrected or replaced by the Contractor before such materials or equipment is installed. Any parts of items found to be defective after installation on site, shall be replaced or repaired at the Contractor's expense, to the Engineer's approval

The Contractor shall be responsible for the acquisition of any insurance cover that may be required for equipment in transit and temporary storage on and off site.

All the lifting and erection equipment required by the Contractor to off-load, install or erect equipment on site is deemed to have been allowed for by the Contractor in the Contract price, as no assistance in this regard will be provided by the Employer or other Contractors.

If no item has been measured in the Pricing Schedules, Schedule of Quantities or Bills of Quantities for such handling equipment, the rate of the item to be handled shall include such handling costs.

Materials stored off-site must be repacked or protected, after inspection, to provide the necessary protection thereof for transport to site.

C3.1.12.5. MATERIAL MANAGEMENT

The Contractor will be responsible for the transporting of all materials and equipment to the off-site storage facility or on-site and will provide the off-loading, rigging, lifting, handling and placement thereof into the permanent position as planned for the equipment. The Employer will not provide any assistance or equipment for the placing of equipment into position or materials

The Contractor shall administer this material according to store bookkeeping system by means of computer aid. A stock taking report shall be submitted to the Project Manager on a two-weekly basis.

It will at all times be assumed that the Contractor has ensured upon issue of material that no visible damage has occurred to it. In the case of damaged material, acceptance will be refused. If a dispute arises, the Executive Director: Public Work of Emfuleni Local Municipality shall be called in for a decision. Damage material found on site will be replaced at the cost of the Contractor and no extension of the contract time will be granted for the extra delivery time.

All material must comply with the requirements of the latest revised SANS Standards.

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In the event that offered material do not comply or fails the specified tests, the contractor shall at his cost replace the material or equipment that do not comply or has failed the specified tests. All replacement equipment or material shall comply with the relevant specifications.

C3.1.12.6. OFF-SITE HANDLING OF MATERIALS AND SAFETY

Equipment and materials stored off-site shall be stored in a safe, dry and clean environment and shall be protected against damage, from the elements and theft. Electrical and electronic equipment shall not be assembled, stored or tested in areas where grinding, welding or painting work takes place. Damaged equipment and materials, stored in factories or stores of the Contractor, will be rejected upon inspection.

Areas in stores or places of manufacture for testing or inspections of equipment and materials by the Engineer shall be clean and safe for the purpose of testing or inspections. Floors must be free of loose materials, dirt and debris.

Equipment and materials will not be inspected in noisy or dirty environments and also not in areas where welding, grinding, and painting or any other manufacturing processes are underway. Testing or inspections will not be undertaken in hazardous or explosive atmospheres.

Materials stored in the stores of the Contractor or in alternate storage space, and which is acceptable to the Engineer for off-site certification for payment, shall only be certified for payment under the conditions as laid down in this document.

C3.1.12.7. ON-SITE HANDLING OF MATERIALS AND SAFETY

Equipment and materials stored on site shall be stored in a safe, dry and clean environment and shall be protected against damage, from the elements and theft.

Heavy materials shall be stored in a manner as not to create a danger to other Contractors or to the Employer or the Engineer.

Small materials shall not be left lying around on site. Expensive, small items such as instrumentation or electronic components shall be kept under lock and key until the installation thereof.

Store rooms used by the Contractor shall be kept locked to prevent unnecessary loss of materials.

Redundant material, which is the property of the Employer, shall be removed from site and either be reused elsewhere or returned to the Employer through the relevant processes. If clear directions are not available in this regard, the Contractor shall obtain instructions for the removal of the equipment from the Engineer. No redundant material shall become the property of the Contractor or any other party and shall remain the property of the Employer unless decided otherwise by the Employer.

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C3.1.12.8. RE-LABELLING

The Contractor shall be responsible to attend to all labelling requirements that arise with any system installation. All labelling requirements shall be allowed for in the unit rates of the Contractors priced bill of quantities. A schedule of labels shall be compiled by the Contractor and submitted to the Engineer for approval.

C3.1.12.9. CONSTRUCTION METHODS

Before initiating any construction, the Contractor shall compile a list of all defects per sectional area and verify such defects alongside a duly authorized representative. The repair of any damage not listed shall be the full responsibility of the Contractor, the Employer shall under no circumstances be held responsible for payment of damages done by the Contractor or damages not listed prior to initiating construction.

Where the Contractor will perform trench work, it shall be the Contractor's responsibility to request that the employer scans the trench for any existing services, especially cables at substations. The Contractor shall mark the trench positions clearly by means of chalking.

The Contractor shall ensure that all wayleaves are approved prior to commencement of any work and shall be responsible for maintaining any pre-approved wayleaves.

C3.1.12.10. SITE SAFETY

NOTE: Tenderer's and Contractors must ensure that they have read and understood the requirements of this document.

The requirements of the Occupational Health and Safety Act, Act 85 of 1993 and the requirements of SANS 10142-1 (or the latest edition thereof) shall be complied with as far as site safety is concerned.

Excavations shall be barricaded, backfilled and compacted as soon as possible after excavating to allow safe passage for persons and traffic on site.

Contractors shall not allow any workers to work in excavations deeper than 1m, unless the sides of the excavations are properly shored and supported, especially in sandy or wet soil conditions.

Open manholes shall be barricaded.

Deep waterlogged excavations shall be pumped empty as soon as possible after flooding or shall be solidly barricaded until pumped dry.

Open, live or unsafe power connections shall not be left unguarded or unprotected.

The construction site shall be kept clean and tidy on a daily basis.

Off-cuts and rubbish shall be removed from the site and deposited in the designated dumping place on a daily basis.

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The Contractor shall adhere to all safety rules and regulations as may be in existence on a site or as may be required by the Employer or the Engineer. The Contractor shall also ensure that their workforce on site adhere to safety rules.

Contractor shall not drive or allow a vehicle or machine to be driven close to excavations.

Contractor shall keep all power connections and/or live equipment with voltages above 50V, temporary or permanent, in a good and safe condition and shall keep all doors, shutters and covers closed on such equipment, during construction, testing and commissioning and shall take all steps to prevent accidental contact of live equipment by any person.

The Contractor shall take control over any power cable or power circuit connected from equipment installed by him, or under his control and which operates at a voltage higher than 50V. The Contractor shall not energise such a cable or circuit and shall not grant permission to any other person on the site to energise such a cable or circuit without first having made sure that such action does not create a dangerous situation.

The Contractor shall not connect any portion of an installation to the point of supply of a Supply Authority without first having complied with the requirements and regulations of such an Authority as far as tests, certification or clearance from the Authority is concerned and also not until permission is obtained from the Engineer in this regard.

Any damage to equipment of other contractors or the Employer due to equipment being supplied by such an unauthorized power connection shall be for the account of the Contractor for this Contract.

The Contractor shall not energise any portion of an installation until the earth points of power equipment in such installation have been properly bonded and earthed to a known good earth point with a value of 5 ohm or less, referred to zero, as tested with a null balance megger.

C3.1.12.11. EXISTING SERVICES

The tenderer should take note of the existing cables and other services. The services may be buried and cannot be accurately pinpointed. Therefore, all excavations must be done with care.

The tenderer shall acquaint himself with the position of all the existing services such as storm water pipes, water mains, sewer mains, gas pipes, telephone cables, etc. before any excavations are commenced. For this purpose, he shall approach the Engineer's representative, the local municipal authority and any other authority, which may be involved, in writing.

The Electrical Contractor shall accept full responsibility for any damage caused by excavation work, whether caused directly or indirectly and whether written permission has been granted for machine excavation or blasting, or not.

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Repair of damaged services undertaken by the Electrical Contractor shall be to the satisfaction of the owner of the service. The cost of repair work undertaken by the owners of the service as well as consequential losses due to the damaging of the service will be recovered from payments due to the Electrical Contractor without notice, unless proof of direct payment to the owners can be produced.

The Contractor shall report any damaging of existing services immediately to the Engineer as well as the owner of the service, irrespective of whether the damage is considered a minor damage or not. Apart from reporting damage, an entry shall be made in the site diary, indicating the time of occurrence, extent of the damage, time reported and names of the persons reported to at the Consulting Engineers as well as Owners of the service.

Penalties shall be levied for damage caused to existing services caused under the following circumstances:

- Damage due to machine excavation or blasting without the written permission of the Engineer.
- Damage which the Contractor failed to report to the Engineer as well as the owners of the service, or which the Contractor failed to enter comprehensively in the site diary.
- The penalties referred to above, shall be 100 % of the cost of repair work carried out by the owner of the service as well as 100 % of the value of consequential losses as calculated by the owners of the service. Any such penalties shall be recovered from any payments due to the Contractor

C3.1.12.12. DESIGN RESPONSIBILITY

Preparation of all details designs, manufacturing drawings and documentations for approval specified throughout the enquiry document shall initiate once the successful tenderer has received a Letter of Acceptance.

The tenderer shall be responsible for furnishing all equipment detailed designs as well as the protection schemes based on the specification. The tenderer shall submit the initial design drawings to the Engineer for a design review and the allowed duration for the design review by the Engineer shall be 10 working days. The design freeze will be only granted after approval by the Engineer. The tenderer shall submit all outline drawings and design details including requested supporting documents within a reasonable time frame and prior to the commencement of the equipment manufacturing.

It is envisaged that detail design and certification of the following but not limited to will be required:

- a) All 132 kV overhead line steel structures and foundations.
- b) 20 MVA 132 / 11 kV power transformer.

The following documentation and drawings shall be submitted for approval:

- a) All primary plant equipment drawings.

Note: all drawings shall be submitted in hard and soft copy – soft copies shall be in editable dxf / dgn format.

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Five sets of the following information are required on completion of the works:

- a) Operation and Maintenance manuals.
- b) Commissioning Reports.
- c) Design Drawings.
- d) Factory Acceptance Testing Reports.
- e) Commissioning Reports.
- f) As-built drawings.
- g) Soft copy of all documentation

All detail designs shall be submitted to the Engineer for approval prior to the manufacturing of the equipment.

C3.1.12.13. FACTORY TESTS AND INSPECTIONS

The tenderer will also be responsible for arranging Factory Acceptance Tests (FAT) at the OEM, which will be attended by the Maintenance Personnel of the Employer and the Engineers Representative.

The Contractor shall inform the Engineer of equipment tests or any part of an installation in the place of manufacture or on site is ready for inspections or tests. The Engineer shall be given sufficient notice in advance of inspections or tests and final dates and times of such inspection will then be confirmed with the Contractor by the Engineer. The inspection or testing of manufactured equipment in a factory by the Contractor or by any other test facility in the presence of the Engineer must not be regarded as acceptance of responsibility by the Engineer for the correct performance of such equipment on site.

The OEM shall issue a list of all proposed tests to be conducted during the FAT to the Engineer for approval. The manufacturer shall issue a list of all proposed tests to be conducted during the FAT to the Engineer for approval 12 weeks prior to the scheduled FAT.

The Contractor shall provide a clean and safe testing area in the place of manufacture of any equipment to be tested and inspected by the Engineer. The area shall be open and accessible and tests or inspection will not be carried out in cramped or dangerous areas. No tests or inspections will be carried out in areas where overhead cranes or hoists are in operation.

All live equipment shall either be screened off or enclosed so that inspecting persons are not endangered during such tests or inspections. Inspections or tests will not be carried out near paint areas, paint booths, ovens, grinding or polishing areas or on equipment which are still under construction.

Tests will not be done by the Engineer in areas where a normal conversation cannot take place due to background noise. Test equipment, test leads, clean writing top space and all other facilities shall be provided for the Engineer during such tests. The Engineer reserves the right to instruct the Contractor to carry out the re-testing of any equipment which does not pass the first inspection or test.

The time and travelling cost of the Engineer for the purpose of any re-testing of equipment which failed to pass the first or a previous test will be for the account of the Contractor. Any

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delays in Contract time caused by failures of inspections or tests will also be for the account of the Contractor

The factory tests shall be done as far as possible with full control conditions as may be experienced on site. All remote controls of equipment must be simulated during these tests by using temporary connected toggle switches to replace remote field devices such as sensors, switches, contacts, etc. Temporary simulated signals for the future field instrumentation or signals for future controls and field instrumentation must be available during the factory tests and must be fully operative and all field signals must be simulated during these tests by using appropriate signal generators or signal sources.

The following equipment shall be subjected to Factory Acceptance Testing:

- a) 20 MVA, 88/11 kV Transformer

If any of the equipment specified is manufactured and/or assembled outside the Mpumalanga Province or South Africa, the tenderer shall make all the necessary arrangements for three (3) Engineer representatives and three (3) Employer representatives and one (1) Contractor representative to witness the FAT at the manufacturer. The cost thereof shall be for the account of the tenderer. The tenderer shall include into his unit rates of the FAT for flights to and from the manufacturer, accommodation in a four (4) star hotel or guest house, breakfast, lunch and dinner as well as local transport to and from the manufacturer to the accommodation. It will further be a requirement that separate rooms are booked for the representatives that will be attending the FAT.

C3.1.12.14. TRAINING OF PERSONNEL

The training of personnel of the Employer or User of the Works shall only be applicable to the Contract.

Training provided by the Contractor and OEM shall be directly applicable to the actual equipment to be used at the installation. Training shall be carried out on site and at the OEM's works. The priced unit rates in the bill of quantities shall allow for all travel, accommodation and living expenses.

All of the training shall be presented by the OEM and allowed for by the contractor in the bill of quantity's unit rates.

Operators of the installed equipment shall be trained by The Contractor to safely and successfully operate the equipment and controls.

This training course shall include the training of technical personnel of the Employer during the installation period and commissioning stages of equipment on site to make the technical staff and or skilled operators completely conversant with the installed equipment and the use thereof.

The Employer thus reserves the right to appoint certain staff to the Contractor's team during the installation and commissioning phase of the work for training as described in the previous paragraph. The Employer will bear the cost of salaries, accommodation and other allowances

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and traveling expenses of its personnel, but all other expenses to allow the personnel to attend the said training on site shall be borne by the Contractor.

The Employer may also decide to request the Contractor to make use of the ability of the staff of the Employer to assist with physical installation and commissioning work, and in such instance the Engineer will instruct the Contractor accordingly.

The Contractor shall provide all course material including manuals and training data in this case, and shall present well prepared lectures of the courses in locations which suite the Employer.

Advanced training courses shall proceed within one month after date of first hand-over of the particular section of the Works.

The Contractor shall price the items allowed for training in the Bill of Quantities of the tender document.

At conclusion of any training period, either for the operation and maintenance of equipment, or for advanced software and programming, the Contractor shall issue the necessary certificates at the end of the course and/or a signed statement to the effect that these training sessions were adequate.

The tenderer shall also be responsible for arranging formal training by the agency, distributor or accredited supplier for all specified equipment offsite as well as on site, which will be attended by the Maintenance Personnel of the Employer and the Engineers Representatives. The offsite training shall be held at a premise of the supplier. The number of delegates will be as specified in the BoQ.

Training shall be provided in a class room environment, the OEM shall provide relays or equipment for each delegate attending the training session which will allow for practical interaction with various control, monitoring and measuring equipment. Training material shall include the necessary equipment manuals and software.

Training content shall be approved by the original equipment supplier if the supplier is not the original equipment manufacturer.

Training shall as a minimum have the following objectives.

- a) Enable the trainee to operate the equipment with confidence.
- b) Ensure that equipment shall be correctly maintained.

C3.1.13. PAYMENTS

Payment application will be assessed once a month and the claim must be agreed to and approved by the Engineer. The claim must reach the Engineer's office 7 calendar days prior to the agreed invoice submission date.

The Engineer will not issue any certificate for interim payment of any equipment and material that is stored on or off site in such a way as to hinder inspection thereof.

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The Employer reserves the right to be under no obligation to pay for material delivered to or off site, and shall take preference for payment to the Contractor after commissioning of the works. The Contractor shall price the preliminary and general section of the bill of quantities adequately allowing for all overhead costs during the construction period.

Materials or equipment stored on or off site and packed in crates or boxes must be opened for inspection and the serial numbers, types or quantities must be easily identifiable by the Engineer before payment for such materials will be processed.

Payment will further not be certified for small materials such as short pieces of cable, conduit, wire, conduit boxes, saddles, screws, etc., that are stored on or off site. Payment for such materials will only be certified once the materials have been built in, installed or commissioned. In special cases, 80% payment for material on site may be considered subject to approval.

Interim payment will only be considered subject to the following conditions:

- a) The equipment must be complete and in a ready state for installation or commissioning. Loose components which are not yet built into or which will form part of the large materials mentioned in the previous paragraph, will not be considered for payment. (An example hereof is, for instance, instruments that must be fitted in a cabinet and are still in separate storage.)
- b) The materials which are to be type tested, performance tested or safety tested should have already passed inspections and/ or tests by the Contractor and/or the supplier of the equipment.
- c) The Contractor shall, prior to submitting interim payment claims, procure financial assurance by means of the guarantee from a registered bank, on the form provided by the Engineer, and equal to the total amount of payments to be made to the Contractor.
- d) The total value of such guarantee, provided by the Contractor to the Employer, may be varied by the Contractor, with the consent of the Employer, from time to time provided that the Employer will be covered at all times to the total amount paid by the Employer to the Contractor for items not yet built into the Works.

The guarantee will lapse 24 months after signed acceptance without reservation by the Engineer and Employer and all the said equipment and/or materials have been built into the permanent Works.

The material must be stored in a cordoned off area in the stores of the Contractor and a notice must be affixed to this area stating that the materials stored in that area are the property of the Employer. The area must be safe and not near flammable liquids or explosive equipment and must be kept clean and dry.

C3.1.14. PROJECT SPECIFICATION

The following project specifications are integral parts to this project specification, some of which may be included under separate cover:

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PSE 11 – Subtransmission Overhead Line

PSE 18 – Power Transformers

PSE 20 – NECRT's

PSE 56 – Surge Arrestors

PSE 100 – Using of Manpower

Please note that all references to Eskom will be regarded as Emalahleni Local Municipality. As part of achieving a standard specification countrywide and with Eskom playing a leading role in the compilation thereof, Eskom's specification has been used throughout this document.

It is therefore required that all tenderers must have access to the Eskom specification, via the Eskom Web at <https://scot.eskom.co.za/>. Please note that a fee is payable to Eskom for this service.

Application can be made to:

- a) Mrs Brenda Morrison
- b) Assistant Officer
- c) Tel: (011) 629 5266
- d) Fax: (086) 662 6387
- e) E-mail: Brenda.morrison@eskom.co.za

We, the undersigned hereby acknowledge that copies of the above documents are included in the tender document and confirm that I / We fully understand them and the consequences of non-compliance.

SIGNED AT ON BEHALF OF THE FIRM

ON THIS DAY OF 20.....

NAME:

SIGNATURE:

CAPACITY:

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C3.1.15. EQUIPMENT SPECIFICATION

The following equipment forms part of the 132 kV overhead line

Table 3: Standard Equipment Schedule

Title	Drawing No
THIMBLE	D-DT-3026
SURGE ARRESTOR DISTRIBUTION CLASS	D-DT-3100
CONDUCTOR ACSR	D-DT-3136
COPPER WIRE	D-DT-3137
LUG	D-DT-3166
SPIRAL VIBRATION DAMPER	D-DT-3175
CLEVIS BALL	D-DT-6059
SOCKET TONGUE	D-DT-6061
CLAMP DEAD END ASSEMBLY	D-DT-7000
CLAMP SHIELD	D-DT-7004
MULTI-FREQUENCY VIBRATION DAMPER	D-DT-7005
TURNBUCKLE EYE TONGUE	D-DT-7007
BALL EYE OVAL	D-DT-7008
TRUNNION SUSPENSION CLAMP	D-DT-7010
INSULATED SHIELD WIRE	D-DT-7012
LINE POST INSULATOR	D-DT-7013
INSULATOR LONG ROD	D-DT-7014
SHACKLE STRAIGHT BOLT	D-DT-7017
PISTOL CLAMP	D-DT-7022
STAY ROD ADJUSTABLE	D-DT-7023
CROSBY CLAMP WIRE ROPE	D-DT-7032
HELICALLY FORMED ARMOUR ROD	D-DT-7034
GUY GRIP	D-DT-7035
STL STRANDED WIRE	D-DT-7036
132kV STEEL POLE SUSPENSION	D-DT-7101
132kV STEEL POLE STRAIN	D-DT-7104
ADJUSTABLE & NON ADJUSTABLE INSULATOR STRAIN STRING ASSEMBLY DRAWING	D-DT-7311
INTERMEDIATE SUSPENSION ASSEMBLY	D-DT-7321
POSITIONS OF VIBRATION DAMPERS	D-DT-7322
NON INSULATED EARTH WIRE ASSEMBLY	D-DT-7323
STRAIN SHIELD WIRE INSULATED ASSEMBLY	D-DT-7324
ADJUSTABLE STAY ASSEMBLY	D-DT-7325
INSULATOR ATTACHMENT – KEYHOLE BRACKET	D-DT-7330
STAY LOCATION CHART	D-DT-7346
PERCHING BRACKET	D-DT-7347
132kV PLANTED POLE INTERMEDIATE	D-DT-7611
132kV PLANTED POLE INTERMEDIATE	D-DT-7612
132kV PLANTED POLE STRAIN	D-DT-7615

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Title	Drawing No
FOUNDATION DETAILS INTERMEDIATE	D-DT-7850
FOUNDATION DETAILS STRAIN	D-DT-7851
FOUNDATION CAP AND EARTHING DETAILS	D-DT-7857
EARTHING PIN	D-DT-8028
PHASE CONFIGURATION	D-DT-0311
FOOTING EARTH ELECTRODE	D-DT-0640
MV LV EARTHING ELECTRODE DETAILS	D-DT-0642
LINE DESIGNATION & STRUCTURE IDENTIFICATION LABELS FOR SUB-TRANSMISSION LINE TOWERS	D-DT-5050
CLAMP SHIELD WIRE	D-DT-7003
BRACKET,P/TOP INTER SNG & DBL S/WIRE ASSY	D-DT-7048
INTERMEDIATE POLE TOP AND SHIELDWIRE BRACKET FOR SINGLE OR DOUBLE SHIELDWIRE UNINSULATED ASSEMBLY	D-DT-7331
2WT763 - 88 132kV STANDARD POLE STRUCTURES FOOTING EARTH ELECTRODE DETAILS	2WT-763
STAY ROD INSTALLATION	2WT-1062
STAY ROD INSTALLATION SOIL TYPE 3 & 4	2WT-1143
SINGLE TO DOUBLE EARTH WIRE ARRANGEMENT	2-D-WT-816
INSTALLATION OF LINE LABELS ON CONCRETE AND STEEL POLES	2-WT-1148
132 / 88kV INSULATED EARTH WIRE ARRANGEMENT	2-WT-1420
132 / 88kV NON - INSULATED EARTH WIRE ARRANGEMENT	2-WT-1421
132kV STEEL POLE ANGLE STRAIN DOUBLE EARTH WIRE BRACKET	2-NT-796

C3.1.16. SUBTRANSMISSION OVERHEAD LINE (PSE 11)

The Contractor shall be responsible for the detail design and certification of all steel supporting structures and foundations. Designs shall be submitted to the Engineer for approval prior to the placing of orders.

- As per the construction regulations all pole holes shall be nominated by a Professional Structural / Geotechnical Engineer to determine the soil type.
- All flange mounted foundations shall be certified by a Professional Structural Engineer.
- All tension and crimping equipment shall have a valid calibration certificate.
- In order to regulate the stringing, a bull wheel shall be used and no part of the conductor shall be dragged over the ground.

The Contractor shall provide:

- General arrangement for every type of support structure indicating equipment mechanical and electrical data as well as the OEM for each component.
- Assembly drawings
- Support structure designs
- Foundation designs
- Soil nominations & foundation selection
- Implementations plan

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- Quality Plan
- SHE Plan
- Project Programme
- Cash flows
- List of plant & material
- Labour force and hours worked

Activity stages and requirements for implementation of the overhead line construction follows:

Activity Stage 1: Preliminary & General, Environmental, Health & Safety and Site establishment

The preliminaries / P&G section shall be included as per the Bill of Quantities:

- Preliminary and General cost;
- Environmental requirements;
- Health & Safety requirements;
- Site establishment;
- Security etc.

Activity Stage 2: Establish construction access

- Supply and transport of new power line servitude gates;
- Complete replacement of existing power line servitude gates;
- Complete installation of new power line servitude gates;
- Complete establishment of property construction access;
- Closure of construction access
- Bush clearing and cutting of trees.

Activity Stage 3: Survey activities

- Pegging of line route, structure setting-out & stays positions;
- Marking of servitude and access gates;
- Measuring of all over and under crossing clearances.

Activity Stage 4: Construction of temporary By-pass Lines – Not Applicable

Activity Stage 5: Drilling/Excavating of holes for structure foundations and stays

- Geotechnical investigation and soil/foundation type nominations;
- Foundation Design Verification
- Foundation installation
- Stay Rod & Foundations Design or Verification;
- Stay Rod and Foundation Installation;
- Barricading/Protecting of all open excavations.

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Activity Stage 6: Assembly and Erection of power line structures

- Assembly and erection of all structures;
- Assembly and installation of stay assemblies

Activity Stage 7: Power line Earthing

- Transport and installation of power line structure earthing material;
- Measure Structure Footing Resistance and Record;

Activity Stage 8: Dressing of all structures

- Dressing of all structures

Activity Stage 9: Stringing, Regulation & Making off

- Test Joints;
- Stringing;
- Making off and Regulation.
- Mid span joints
- Repair sleeves
- Clamping in
- Vibration dampers
- Bird flappers
- Aircraft warning spheres
- temporary structures
- closing spans to substations

Activity Stage 10: Labelling

- Structure/Pole Identification Labels
- Line Designation labels;
- Line Crossing labels;
- Phase Disks.

Activity Stage 11: Dismantling – Not Applicable

Activity Stage 12: Taking Over Of the Works and Clearance of Site

- Re-instate entire construction site;
- Final inspection of the line;
- Handing over, test & commissioning;
- Submission of "As Built" Information;
- Site clearance.

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C3.1.16.1. GENERAL DETAILS

PLS CAD has been used as a design package to profile the Chickadee line at 70 °C and to calculate the pole strengths of the single circuit mono poles.

Line voltage phase to phase: Built and insulated at 132 kV

Type: Three-phase, single circuit

Phase configuration: Vertically at strainers and intermediates; Horizontal configured at terminal positions.

Number of conductors per phase: Single

Number of earth conductors: Single OPGW.

C3.1.16.2. PHASE CONDUCTOR DETAIL

The transfer capacity of this single circuit Chickadee line is 559 A at 70 °C which will be adequate for many years to come.

The phase conductor between Vulcan MTS and Siyanqoba Substation is based on the following:

- Conductor type: "Chickadee" ACSR 18/1/3.77
- Conductor overall diameter: 18.87 mm
- Total cross sectional area: 212.1 mm²
- Aluminium stranding: 18/3.77 mm
- Steel wires stranding: 1/3.77 mm
- Conductor mass: 640.5 kg/km
- Ultimate tensile strength: 44.9 kN
- AC Resistance @ 20°C: 0.1427 ohm/km
- Final modulus elasticity: 75 787 MPa
- Coefficient of linear expansion: 21.6/°C x10⁻⁶
- Standard drum length: 1 500 m
- Catenary constant: 1 800 m

The burn-off rating of Chickadee is calculated to be 1,014 s for a fault current of 21 kA.

C3.1.16.3. SHIELD-WIRE DETAIL

Not Applicable

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C3.1.16.4. OPTICAL FIBRE INSTALLATION DETAIL

OPGW (48 Fibre 10/125 single mode) with a short circuit rating of 18,68 kA for 1 second shall be used as earth wire and spliced to ADSS when entering into the two substations.

The OPGW installation between Vulcan MTS and Siyanqoba Substation is based on the following:

- Conductor type: 48C OPGW 18.68 kA Ungreased
- Conductor overall diameter: 17.7 mm
- Wires stranding: Centre – 1/3.9 mm
Layer 1 – 5/3.6 mm AA wire + 1/3.4 mm Al Tube
Layer 2 – 13/3.3 mm AA wire
- Conductor mass: 841 kg/km
- Ultimate tensile strength: 118.3 kN
- DC Resistance @ 20°C: 0.252 ohm/km
- Final modules elasticity: 109 000 MPa
- Coefficient of linear expansion: 15.5/°C x10-6
- Catenary constant: 2 100 m
- Standard drum length: min. 4000 m

The burn-off rating of the 48 Fibre, 17,7 mm OPGW is calculated to be 1,0 s for a fault current of 18.68 kA.

NOTE – PLS CADD seed file of the offered OPGW to be provided to Engineer by OEM for verification and approval.

Planning allows for fibres to be spliced at Eskom's Vulcan MTS and Siyanqoba Substation for differential protection and communication purposes in the relevant BME equipment.

The fibre optic cable will be routed from the first Gantry / terminal structure (from the line side) into the substation HV Yards and into the cable trenches. In the cable trenches the fibre cable will run inside HDPE piping for protection. Should the routing of the cable be impossible to achieve using HDPE piping, the cable should then be routed using PVC piping. The duct fibre cable (run inside the pipe in the trenches) shall be armoured cable. Upon entry into the control rooms the fibre cable shall be fed below the main cable tray and supported with the brackets. This also applies to the fibre cabling running inside the control room as a means to protect the fibre from damage by the other cables. A BME cabinet will be installed as part of the substation contracts.

The substation contractor for this project be responsible for supply, delivery, installation, testing and handing over of all fibre related work at Vulcan MTS and Siyanqoba Substation.

Wires offered shall comply with Eskom standards and shall be obtained from Eskom approved suppliers / manufacturers (proof to be submitted with tender).

The following shall form an integral part of the optical fibre installation and shall be catered for in the tenderers priced unit rates unless marked as "excluded" -

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VULCAN MTS:

- Supply and install 40 or 50mm dia. duct
- Installation of HDD fibre cable into duct
- Outdoor splicing installed in dome enclosures
- Concrete draw pits
- 19" Cabinet 600x600mm
- Pigtails
- Mid-couplers
- Termination of fibre to patch panel incl. splicing
- Sarel box and splicing in HV switchgear panels
- OTDR testing including traces in hard and soft copy
- Terminal Equipment (Multiplexer) – future (excluded)
- Interface cards – future (excluded)

SIYANQOBA SUBSTATION:

- Supply and install 40 or 50mm dia. duct
- Installation of HDD fibre cable into duct
- Outdoor splicing installed in dome enclosures
- Concrete draw pits
- 19" Cabinet 600x600mm
- Pigtails
- Mid-couplers
- Termination of fibre to patch panel incl. splicing
- Sarel box and splicing in HV switchgear panels
- OTDR testing including traces in hard and soft copy
- Terminal Equipment (Multiplexer) – future

Note: Ensure that all cabinets are powered and Patch panels must be labelled correctly.

C3.1.16.5. FIBRE OPTIC CABLE TERMINATING IN A 19" CABINET

The Fibre optic cable shall be glanded on the outer sheath using a plastic compression gland where it enters the 19" cabinet. The armouring of the cable shall be cut back 10 cm after the gland and shall be insulated using heat shrink or self-vulcanising tape. The armouring shall by no means be connected to the earth. At least 6 m of slack should be left inside the cabinet.

The power line contractor shall be responsible for the fibre end-to-end installation and testing thereof. The end-to-end installation shall include the OPGW installation with all auxiliary equipment such as dome splices boxes on substation termination gantries, OPGW clamps (including down-lead clamps), fibre extensions through the substation trenches etc. Patch panels, ODF and BME shall be provided by the power line contractor at both ends.

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C3.1.16.5.1. SPLICING OF CABLES IN THE OPTICAL DISTRIBUTION FRAME

The Optical Distribution Frame must be mounted as indicated in the Cabinet Layout drawing. The slack Fibre optic cable must be routed as shown. This must be done neatly and the minimum bending radius of the cable (typically 250 mm) must be maintained at the bends. The cable should be run in such a way that the Optic Distribution Frame and slack cable can be easily removed from the cabinet.

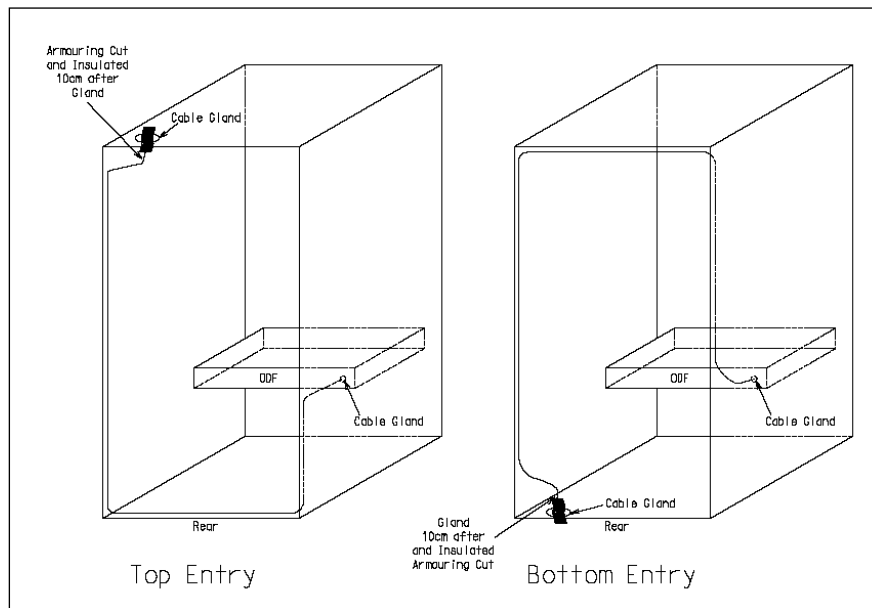


Figure 1: Optical Fibre Cable Routing in 19" Fixed frame Cabinet

The inner sheath of the Fibre optic cable shall be glanded at its entry to the Fibre Distribution unit by means of a plastic compression gland and the central strength member shall be securely fastened.

The fibres shall be neatly organised in the Fibre Distribution Unit with no twists or sharp bends. Plastic clips may be used to organise the bare fibres.

The fibres are to be spliced according to the Fibre Optic Cable Layout Drawing for the station.

For this 48 Fibre system all fibres will be spliced on non-ruggedised tails to be available on the patch panel. The required number of fibres shall be spliced through to equipment on ruggedised cable or on ruggedised pigtails.

C3.1.16.5.2. LABELLING OF OPTICAL DISTRIBUTION FRAMES

The Optical Distribution Frames shall be labelled as indicated. The destination name shall appear on the left side of the face plate. The ports shall be labelled below with the corresponding port number and above with the Bearer Code and an indication of which port is RX and which is TX.

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The port at which the light comes out is marked RX and the port into which the light goes in is called TX as indicated.

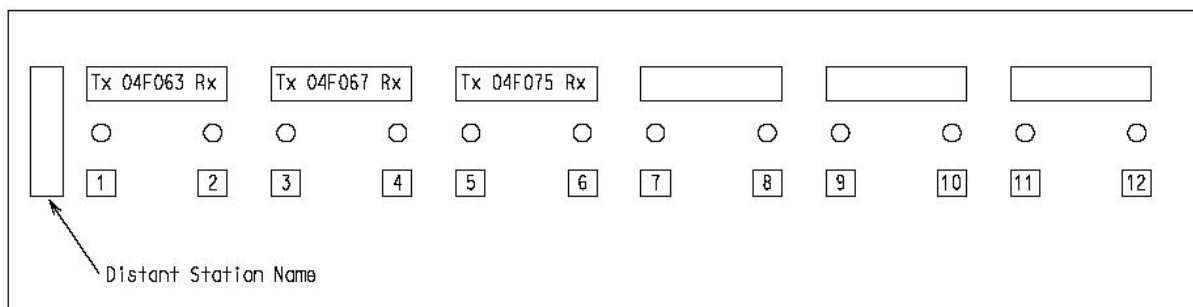


Figure 2: Faceplate labelling

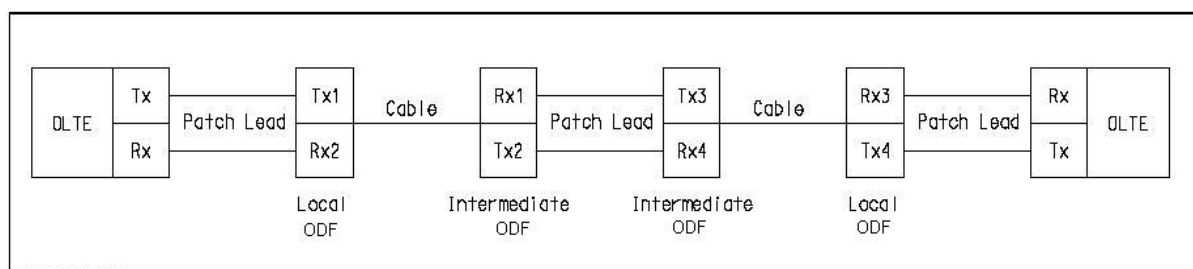


Figure 3: Rx vs Tx port labelling

This method of labelling ensures that patching at intermediate sites is from odd port to odd port and even port to even port. Thus there is no cross patching at the intermediate sites. This simplifies matters in the case of multiple intermediate sites.

The following shall form an integral part of the optical fibre installation and shall be catered for in the tenderers priced unit rates unless marked as “excluded”

C3.1.16.6. LINE HARDWARE

All line hardware shall be rated for 120 kN minimum.

C3.1.16.7. PROFILING DETAILS

The C-value for “Chickadee” phase conductor must be less or equal to 1 800 m for the Ruling Condition @ 15 °C, every day tension in still air.

The C-value for the OPGW wire must be less or equal to 2 100m (vibration limit) for the Ruling Condition @ 15 °C, every day tension in still air.

Minimum phase conductor clearances to be designed @ 15 °C with 1050 Pa (41.387m/s) wind loading.

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Maximum phase conductor clearances to be designed @ 70 °C with 0 Pa wind loading.

The Project Engineer to supply the PLS Cadd Stringing Sag and Tension Charts for the phase conductor and shield-wire.

The Contractor shall request the final sag-tension charts from the Engineer with at least 7 days' notice prior to the intent of starting with stringing.

C3.1.16.8. STRUCTURES

Table 4: Structure Coordinates

NO	SPAN AHEAD (M)	CAH			COMMENT
		T	M	B	
1	39	10.6	10.6	10.6	Gantry-12m beam.106
2	51	12.5	12.5	12.5	Str_4pole_in-line_15m_17m.pol
3	122	12.5	12.5	12.5	Str_4pole_in-line_15m_16m.pol
4	70	8	8	8	Str_4pole_in-line_10m_11m.pol
5	172	8	8	8	Str_4pole_90deg_10m_12m.pol
6	184	16.6	14.8	13	Str_mono_in-line_20m.pol
7	165	17	15.9	14.8	Int_mono_SC_22m.pol
8	163	17	15.9	14.8	Int_mono_SC_22m.pol
9	187	16.6	14.8	13	Str_mono_SC_7615d_r2_20m.pol
10	234	17	15.9	14.8	Int_mono_SC_22m.pol
11	148	17	15.9	14.8	Int_mono_SC_22m.pol
12	97	8	8	8	Str_4pole_in-line_10m.pol
13	208	8.9	8.9	8.9	Str_4pole_in-line_11m.pol
14	259	21.8	20.7	19.6	Int_mono_SC_24m_FM.pol
15	239	21.8	20.7	19.6	Int_mono_SC_24m_FM.pol
16	89	21.8	20	18.2	Str_mono_SC_23-2m_FMSS.pol
17	92	8	8	8	Str_4pole_in-line_10m_12m.pol
18	42	8	8	8	Str_4pole_90deg_10m_12m.pol
19	410	21.8	20	18.2	Str_mono_SC_23-2m_FMSS.pol
20	273	21.8	20	18.2	Str_mono_SC_23-2m_FMSS.pol
21	317	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol
22	305	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol
23	297	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol
24	423	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol
25	297	30.5	30.5	30.5	Str_3pole_in-line_32m.pol
26	289	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol
27	326	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol
28	273	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol
29	231	16.6	14.8	13	Str_mono_in-line_20m.pol
30	275	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol
31	281	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol
32	276	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol
33	260	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol
34	281	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol

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NO	SPAN AHEAD (M)	CAH			COMMENT
		T	M	B	
35	240	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol
36	303	20.6	18.8	17	Str_mono_SC_7615d_r2_24.pol
37	333	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol
38	290	23.1	22	20.9	Int_mono_SC_25.3m_FM.pol
39	251	20.6	18.8	17	Str_mono_SC_7615d_r2_24.pol
40	260	21.8	20.7	19.6	Int_mono_DCHVdcmv_24m_FM.pol
41	251	21.8	20.7	19.6	Int_mono_DCHVdcmv_24m_FM.pol
42	236	21.8	20.7	19.6	Int_mono_DCHVdcmv_24m_FM.pol
43	224	21.8	20.7	19.6	Int_mono_DCHVdcmv_24m_FM.pol
44	235	21.8	20.7	19.6	Int_mono_DCHVdcmv_24m_FM.pol
45	68	20.6	18.8	17	Str_mono_SC_7615d_r2_24.pol
46	71	21.8	20	18.2	Str_2pole_2xSC_23.2mtcah+MV_FM.pol
47	150	21.8	20.7	19.6	Int_mono_DCHVdcmv_24m_FM.pol
48	150	21.8	20.7	19.6	Int_mono_DCHVdcmv_24m_FM.pol
49	150	21.8	20.7	19.6	Int_mono_DCHVdcmv_24m_FM.pol
50	150	21.8	20.7	19.6	Int_mono_DCHVdcmv_24m_FM.pol
51	149	21.8	20	18.2	Str_2pole_2xSC_23.2mtcah+MV_FM.pol
52	152	21.8	20.7	19.6	Int_mono_DCHVdcmv_24m_FM.pol
53	149	21.8	20.7	19.6	Int_mono_DCHVdcmv_24m_FM.pol
54	150	21.8	20.7	19.6	Int_mono_DCHVdcmv_24m_FM.pol
55	135	21.8	20.7	19.6	Int_mono_DCHVdcmv_24m_FM.pol
56	37	17.6	15.8	14	Str_2pole_2xSC_19mtcah+MV_FM.pol
57		10.6	10.6	10.6	132kv-12m beam-double.106

C3.1.16.9. STRINGING

All tension and crimping equipment shall have a valid calibration certificate as issued by a SANAS accredited institution. In order to regulate the stringing a bull wheel shall be used and no part of the conductor shall be dragged over the ground.

C3.1.16.10. CUSTOM POLES

Tenderers are required to price all custom poles and custom pole foundations according to the requirements as included in the project specification. The priced labour rate shall include the detail designs and certification of both the poles and foundations by a Professional Engineer, preferably Rinus v.d. Ende +27 82 570 0149. The detail designs shall be submitted to the Project Engineer for approval prior to commencement of manufacturing.

The design of these structures shall be in accordance with ASCE/SEI 48-11, SANS 10280-1 2013 and DSP_34-1683.

The maximum wind loading is determined using 1050 Pa wind pressure following the simplified method for poles shorter than 25 m and using 29 m/s reference wind velocity following detailed method as per SANS10280-1.

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Pole deflection under maximum wind load shall not exceed 6% of the pole height above ground.

Poles should have the lowest number of slip joints determined by the manufacturer based on the bending press and galvanizing bath limitations. Step welds shall not be accepted. The base and/or flanges shall be distortion free.

The poles shall be manufactured from hot dipped galvanized 300 WA steel and the minimum thickness of the steel used for manufacture of poles or for circular hollow sections shall be 4,5 mm. The overlap section of a slip joint shall be at least 1.5 times the maximum inside diameter of the female and the poles shall have a continuous taper.

The principle of top and middle shafts being of a constant length with bottom shaft varying in length to accommodate range of pole lengths for the same type of structure should apply.

Pole shall be hot dip galvanised to SANS 121. The finished product shall have a smooth external surface free from steel splinters and welding splatter.

Table 5: Tube Details

	Overall Length (m)	Embedded (m)	Shape	Tip dia (mm)	Bott dia (mm)	Length (m)	Thickness (cm)	Lap Length (m)	Yield Stress (MPa)
SIYA 15m	15	2.3	12 sided	240	512	9	0.5	0.7	355
						6.7	0.6	0	355
SIYA 17m_b	17	2.3	12 sided	240	512	11	0.5	0.7	355
						6.7	0.6	0	355
SIYA 16m	16	2.4	12 sided	240	528	10.4	0.5	0.8	355
						6.4	0.6	-	355
SIYA 10m	10	1.8	12 sided	277	490	7	0.5	0.7	355
						3.7	0.6	-	355
SIYA 11m_b	11	1.7	12 sided	240	469	11	0.5	-	355
						-	-	-	355
SIYA 12m_b	12	1.8	12 sided	276	492	9	0.5	0.7	355
						3.7	0.6	-	355
SIYA 20m	20	2	12 sided	240	602	11	0.5	0.7	355
						9.7	0.6	-	355
22m-23kN CIS	22	2.8	12 sided	180	654	11.5	0.6	0.8	355
						11.3	0.6	-	355
SIYA 11m	11	1.9	12 sided	280	510	8	0.5	0.7	355
						3.7	0.6	0	355

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**40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION
OF A 11,5 KM, 132 KV OVERHEAD LINE.**

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	Overall Length (m)	Embedded (m)	Shape	Tip dia (mm)	Bott dia (mm)	Length (m)	Thickness (cm)	Lap Length (m)	Yield Stress (MPa)
SIYA 24m_SM	24	0	12 sided	290	697	11.5	0.6	0.8	355
						13.3	0.6	-	355
CIS 23.2 SM 451	23.2	0	12 sided	451	1202	11.5	0.8	1.25	355
						9	0.8	1.65	355
						5.6	1	-	355
CIS 25.3 SM 260	25.3	0	12 sided	260	786	11.5	0.5	0.8	355
						9	0.6	1.05	355
						6.65	0.8	-	355
3pl12F 32 str	32	0	12 sided	260	1060	11	0.6	0.74	355
						11	0.6	1.05	355
						11.79	0.6	-	355
SIYA 24m	24	0	12 sided	290	697	11.5	0.6	0.8	355
						13.3	0.6	-	355
CIS 19 SM 520	19	0	12 sided	520	941	11.4	0.8	1.2	355
						8.8	1.2	-	355

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Table 6: Tube Details

Dwg. No	Structure Qty.	Tube Qty.	SIYA 15m	SIYA 17m_b	SIYA 16m	SIYA 10m	SIYA 11m_b	SIYA 12m_b	SIYA 20m	22m-23kN CIS	SIYA 11m	SIYA 24m_SM	CIS 23.2 SM 451	CIS 25.3 SM 260	3pl12F 32 str	SIYA 24m	CIS 19 SM 520
132kv-12m beam-double.106	1	0															
Gantry-12m beam.106	1	0															
Int_mono_DCHVdcmv_24m_FM.pol	13	13										13					
Int_mono_SC_22m.pol	4	4								4							
Int_mono_SC_24m_FM.pol	2	2										2					
Int_mono_SC_25.3m_FM.pol	15	15												15			
Str_2pole_2xSC_19mtcah+MV_FM.pol	1	2															2
Str_2pole_2xSC_23.2mtcah+MV_FM.pol	2	4											4				
Str_3pole_in-line_32m.pol	1	3													3		
Str_4pole_90deg_10m_12m.pol	2	8				6		2									
Str_4pole_in-line_10m.pol	1	4				4											
Str_4pole_in-line_10m_11m.pol	1	4				3	1										
Str_4pole_in-line_10m_12m.pol	1	4				3		1									
Str_4pole_in-line_11m.pol	1	4									4						
Str_4pole_in-line_15m_16m.pol	1	4	3		1												
Str_4pole_in-line_15m_17m.pol	1	4	3	1													
Str_mono_in-line_20m.pol	2	2							2								

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Dwg. No	Structure Qty.	Tube Qty.	SIYA 15m	SIYA 17m_b	SIYA 16m	SIYA 10m	SIYA 11m_b	SIYA 12m_b	SIYA 20m	22m-23kN CIS	SIYA 11m	SIYA 24m_SM	CIS 23.2 SM 451	CIS 25.3 SM 260	3p12F 32 str	SIYA 24m	CIS 19 SM 520
Str_mono_SC_23-2m_FMSS.pol	3	3											3				
Str_mono_SC_7615d_r2_20m.pol	1	1							1								
Str_mono_SC_7615d_r2_24.pol	3	3														3	
	57	84	6	1	1	16	1	3	3	4	4	15	7	15	3	3	2

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C3.1.16.11. D-DT VARIATIONS

All standard Eskom poles and variations to Eskom poles shall have 12 sided tubes.

C3.1.16.12. FOUNDATIONS

All pole holes shall be nominated by a Professional Civil Engineer to determine the soil type.

All foundations shall as a standard be raised with 200 mm to create a "clearance buffer". After completion of the overhead power line work, all surfaces of the foundation protruding above natural ground level shall be bitumen painted.

The foundation finishing shall be shaped in a way that no water can accumulate on flat foundation surfaces. The natural ground and soil around the foundation shall be shaped in such a manner to minimize amassing of water in close proximity to the foundation.

The tenderer shall be responsible for the design of custom (non-Eskom-standard) poles. The foundation shall be designed by a professional qualified civil engineer.

C3.1.16.13. COMPRESSION JOINT SAMPLING AND TESTING

The purpose of the test is to ensure that the assembly meets the required strength of 95% of the rated tensile strength of the conductor. By testing an assembly compressed on site with the compression machine to be used on the project and by the personnel appointed to perform the crimps, the entire system is proven.

Before any stringing activities commence, the Engineer, Engineers Representative or Clerk of Works shall randomly select two dead-end fittings and one joint from those on site supplied for the project. They shall check that the equipment conforms with buyer's guide drawings D-DT-7000 and D-DT-7001, indelibly mark them with his/her signature and give them to the Tenderer to compress.

The Tenderer shall compress, in the presence of the Engineer, Engineers Representative or Clerk of Works and the Employers Representatives, a sample phase conductor assembly. The assembly shall consist of two dead-end fittings and a mid-span joint. The crimping equipment used shall be that allocated for the project and the personnel performing the crimps shall be those appointed to do so. The tenderer shall ensure that the calibration certificate, issued by a SANAS accredited institution, of the crimper used is available onsite during the preparation of the testing sample.

The length of conductor between the fittings shall not be less than 100 times the diameter of the conductor. This test assembly shall be labelled and sent to an approved and accredited test laboratory for tensile testing.

The Tenderer shall, at his/her expense, arrange for the samples to be mechanically tested, in the presence of himself and the Engineer, Engineers Representative or Clerk of Works and

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the Employers Representatives, at an approved and accredited laboratory. Test certificates to be provided as part of the of the Handing Over Documentation.

If any of the mechanical testing of the assembly takes place outside the Gauteng Province or South Africa, the tenderer shall make all the necessary arrangements for three (3) Engineer representatives and three (3) Employer representatives and one (1) Contractor representative to witness the mechanical testing. The cost thereof shall be for the account of the tenderer.

Should the Test joint fail, the mechanical testing, the tenderer shall, at his/her own cost, re-test another sample at the approved and accredited mechanical testing laboratory.

C3.1.16.14. METHOD STATEMENT (SAFE WORK PROCEDURE TO PERFORM MAIN TASKS)

The contractor is expected as part of his tender submission documentation submits Method Statements on how to perform the Main Tasks listed below.

The method Statement must in detail describe:

- a) The preparation work.
- b) Equipment.
- c) Resources needed.
- d) Actual procedure to execute.
- e) The checks or critical actions to proof the Task.
- f) Paperwork and sign off. Please include any drawings, sketches or photos that will assist

Table 7: Method Statement

Item	Main Task	Safe Method of Execution	Risks Dealing with.
1	Assembly of a three piece slip joint steel mono pole		
2	Planting of intermediate mono pole		
3	Planting of a strain mono pole		
4	Installation of stay		
5	Installation of temporary or construction stay		
6	Installation of compression Full tension joint -ACSR conductor		
7	Installation of Compression dead end for ACSR conductor		

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C3.1.16.15. TECHNICAL SPECIFICATION

It is not possible to specify all works and material in its minutest detail. There is a vast list of national and international standards that applies to the construction of overhead power lines and will therefore not be listed as manufacturers should be cognisance of the applicable specifications and standards.

C3.1.16.15.1. PRELIMINARY AND GENERAL

WORK SPECIFICATION:

The Contractor shall allow for the following specific requirements of the Engineer:

- Office accommodation for meetings held on site.

In addition to the specific requirements of the Engineer, detailed above, the Contractor shall allow for his own preliminaries and/or overhead costs as required for the execution of the contract. It shall be divided into the following two sections:

FIXED-CHARGE ITEMS SUCH AS (SANS 1200A - 8.3):

- Contractual requirements.
- Establishment of facilities on site such as plant, sheds, water, electricity, lighting, etc.
- Removal of facilities from site after completion of work.
- Any other fixed-charge items.

TIME RELATED ITEMS SUCH AS (SANS 1200A - 8.4):

- Contractual requirements.
- Operation & maintenance of facilities on site.
- Supervision.
- Company and head office overhead costs.
- Comply with Health and Safety requirements.
- Other time related items.

MATERIAL SPECIFICATION:

The specific Contractor shall supply, transport and off-load his own facilities such as sheds, water, electricity, lighting, etc. on the site. The Contractor shall also be responsible to remove all facilities established on site after his work is completed.

C3.1.16.15.2. LINE CONSTRUCTION

WORKS SPECIFICATION

NOTES:

- All work shall be in accordance to the relevant SABS 1200 documents and Eskom Specification TRMSCAAC1, TRMASAAJ7, SCSASABF9 and SCSASABG1.
- All labour costs shall be included in quoted rate.

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FOUNDATIONS SHALL INCLUDE:

- Supply and erecting complete foundations according to the relevant drawing from SCSASABG1 including excavations, formation, reinforcing, holding down bolts, concrete casting and backfilling with the appropriate mixture.
- Risk of collapse and keeping excavations free of water shall be included in the quoted rate.
- All excavations shall be kept covered or barricaded, if unattended, in a manner accepted by Eskom to prevent injury to people or livestock.
- The Contractor shall notify the Clerk of Works upon completion of the excavation for the foundation. No shuttering, reinforcing steel or concrete shall be placed until the Clerk of Works has inspected the excavations and acknowledge his approval.
- For construction purposes, the correct foundation shall be installed for the type of soil conditions and structure to be installed.
- The Contractor shall do foundation type nominations before construction of the line takes place.
- The nominations shall be done in the vicinity of each supporting structure position where the foundation is to be installed.
- Steel plates shall be used for setting all holding down bolts.
- The nominated foundation types shall be re-evaluated on site by the Contractor, in conjunction with the Clerk of Works, after the excavation of the initial foundation type has been done.
- The final foundation nomination shall be the responsibility of the Contractor and shall be logged in the Construction Handbook.
- The authorised person responsible for the foundations shall sign the 'Foundation' certificate in the Construction Handbook.

TOWER EARTHING SHALL INCLUDE:

Steel Poles:

- Install an earthing electrode should the desired tower footing resistance not be achieved.
- Excavation in all materials 200mm wide trenches for the earth electrode.
- Risk of collapse and keeping excavations free of water shall be included in the quoted rate.
- The earth electrode for the steel poles shall be a three point star as shown on drawing 2-D-WT/763.
- The earth electrode shall be bonded to the steel pole using 7/2.12 (25mm²) stranded copper conductor having a crimped lug on the end that will be bonded to the steel pole.
- The lug shall be fastened to the pole with a M12 galvanised bolt.
- All visible copper protruding above the ground shall be painted with the same type and colour paints of the equivalent or supports which it is bonded to.
- The footing resistance of each tower shall be measured before stringing takes place and shall be logged in the Construction Handbook.
- The authorised person responsible for the tower earthing shall sign the 'Earthing' certificate in the Construction Handbook.
- The nominal tower footing resistance shall be less than 20Ω.

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- The first five steel poles from the substation, shall have a footing resistance less than 10Ω , if not, the shield wire on these structures shall be insulated.
- Where the specified tower footing resistance have not been obtained using standard earthing methods, additional earthing shall be installed.
- The additional earthing shall be counter poise conductors in accordance to SCSASABF9.

Terminal Structures:

- Earthing of the terminal structure shall be according to the latest revision of SCSASABF9 and to Eskom earthing Standard D-DT 5085.
- The terminal structure shall be bonded to the main substation earth mat with a single 50x3mm copper strap.
- The copper strap will be installed by the substation Contractor and bonded by the line Contractor.
- The copper strap shall be bonded to the terminal tower legs with M16 bolts.
- All visible copper protruding above the ground shall be painted with the same type and colour paint of the equivalent or supports, which it is bonded to.
- The footing resistance of the terminal tower shall be measured before stringing or bonding to the main substation earth mat takes place and shall be logged in the Construction Handbook.
- The authorised person responsible for the tower earthing shall sign the 'Earthing' certificate in the Construction handbook.
- The nominal tower footing resistance shall be less than 10Ω .
- Where the specified tower footing resistance have not been obtained using standard earthing methods, additional earthing shall be installed.
- The additional earthing shall be in accordance to SCSASABF9.

PLANTING OF STEEL POLES SHALL INCLUDE:

- All steel poles shall be positioned vertically plumb in the centre of the excavations viewed from any direction according to the relevant steel pole drawings.
- Nylon or fabric slings shall be used when handling steel poles.
- Backfilling shall be done according to SCSASABK8 – Distribution Standard for soil compaction for stay and pole foundations.
- Imported soil shall be used for the soil/cement mixture and shall not consist of any excavated Black Turf.
- The layers shall be compacted to a minimum density of 95% MOD AASHTO before the next layer of soil/cement mixture is placed.
- For stayed poles with concrete anchors, the pole shall not be erected until the concrete has had 21 days in which to cure.
- The authorised person responsible for the installation of the towers shall sign the 'Tower Installation' certificate in the Construction Handbook.

ASSEMBLY AND ERECTION OF TERMINAL STRUCTURES SHALL INCLUDE:

- The terminal towers shall be assembled and erected on the complete tower foundation.

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- Towers shall not be erected until the concrete foundation has had 14 days in which to cure.
- Terminal tower material in storage shall be blocked off the ground with sufficient number of blocks to prevent bending or warping of individual members.
- Nylon or fabric slings shall be used when handling steel members.
- Tower material shall not be dumped or dropped from trucks, but shall be carefully off-loaded and stacked.
- Steel towers that become bent, twisted or deformed during transport, assembly or erection shall be replaced at the expense of the Contractor.
- The threaded portions of any bolt shall project through the corresponding nuts by an amount not exceeding 15mm and not less than 3mm.
- All bolts shall be tightened and thereafter fixed in position by punching four indentations symmetrically around the threads with a round pointed centre punch.
- All nuts and exposed bolt threads shall be painted with accepted calcium plum bate based galvanised iron primer.
- The authorised person responsible for the installation of the towers shall sign the 'Tower Installation' certificate in the Construction Handbook.

INSTALLING STAY ROD ASSEMBLY SHALL INCLUDE:

- Supply and install complete stay rod assembly according to specified drawings in Volume 6, including excavations, concrete casting, backfilling and compaction.
- Risk of collapse and keeping excavations free of water shall be included in the quoted rate.
- All excavations shall be kept covered or barricaded in a manner accepted by Eskom to prevent injury to people or livestock when no casting is done.
- The Contractor shall notify the Clerk of Works upon completion of the excavation for the stay rod. No concrete shall be placed until the Clerk of Works has inspected the excavations and acknowledge his approval.
- For construction purposes the correct hole type shall be installed for the type of soil conditions and stay rod assembly to be installed.
- The excavation shall be done at a distance away from the pole so that the angle of the stay wire after being installed is 45° as shown on drawings (See Volume 6, drawing list, e.g. 2-WT/1143 Sheet 1).
- The Contractor shall do excavation nominations before construction of the line takes place.
- The nominations shall be done in the vicinity of each supporting structure position where the stay rod is to be installed.
- The nominated excavations shall be re-evaluated on site by the Contractor, in conjunction with the Clerk of Works, after the excavation of the stay rod hole has been done.
- The final excavation nomination shall be the responsibility of the Contractor and shall be logged in the Construction Handbook.
- The soil will be compacted in strict accordance to SCSASABK8.

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PERCHING BRACKET

- Perching brackets must be installed on all structures.
- The attachment of the perching bracket must be done as indicated on drawing D-DT-7347.

INSTALLING STAY WIRE SHALL INCLUDE:

- The stay wires shall be handled with care to prevent damage to the individual strands.
- The stay wire shall be long enough to be tied to the stay rod at, at least two positions as indicated on drawing e.g. 2-WT/1143 Sheet 1.
- All structures shall be stayed according to applicable drawings. Please ensure compliance.

DRESSING STRUCTURES SHALL INCLUDE:

- Installing all hardware according to the relevant assembly drawings.
- All bolts shall be secured with stainless steel split pins.
- All bolts and split pins of the hardware shall be installed pointing in one direction so that the split pins are visible from one side of the line only.
- Earth wire insulators shall be installed on the steel structures where the line runs parallel to the railway lines and 800m or both sides of a pipe line crossing.
- Earth wire at Name
- Substation shall be terminated at the line terminal structures.
- The earth wire shall be bonded to the steel structure for all other structures.

DISPOSAL OF EXCAVATED MATERIAL SHALL INCLUDE:

- Removal of excavated Black Turf or any other soil unsuitable for backfilling and transporting it to borrow pits.
- The excavated material shall be disposed of in borrow pits or a suitable place, indicated by the Eskom site representative or the Eskom environmental representative.
- The Contractor shall make own arrangements for the provision to dispose of the excavated material on such a disposal place.
- Free haul shall be the distance within a radius of 5km from the pole/tower position.
- Limited haul shall be the first 1km beyond the end of the free haul distance by the shortest practicable route.
- Long haul shall be the remainder of the distance beyond the limited haul by the shortest practicable route.

IMPORTING SOIL SHALL INCLUDE:

- Transporting imported soil from borrow pits to pole/tower position.
- In areas where the excavated soil is Black Turf, imported soil shall be used for the soil/cement mixture.

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- The Contractor shall make own arrangements for the provision of a suitable borrow pit for importing soil.
- Free haul shall be the distance within a radius of 5km from the pole/tower position.
- Limited haul shall be the first 1km beyond the end of the free haul distance by the shortest practical route.
- Long haul shall be the remainder of the distance beyond the limited haul by the shortest practical route.

TRANSPORTATION SHALL INCLUDE:

- Transporting all material and equipment from the construction camp to the pole/tower position.
- Free haul shall be the distance within a radius of 5km from the construction camp.
- Limited haul shall be the first 1km beyond the end of the free haul distance by the shortest practicable route.
- Long haul shall be the remainder of the distance beyond the limited haul by the shortest practicable route.
- If the Contractor is planning to use a batching plant not located in the construction camp, the cost due to transporting the concrete from the batching plant to the construction camp shall be at the expense of the Contractor.

MATERIAL SPECIFICATION

NOTES:

- Unless otherwise specified, the Eskom project manager shall specify what material will be provided by Eskom and what material must be provided by the Contractor.
- The Contractor shall book the material from the Eskom store in Store Name, transport and off-load all material at the construction camp.
- The Contractor shall transport all equipment and material for the day's work from the construction camp and off-load it at the specific pole position.

FOUNDATIONS:

- Unless otherwise specified, the Contractor shall supply all material and equipment necessary for the supporting structure foundations along the line route. The Contractor shall transport all the material and equipment to the construction camp.
- At the end of the day, the Contractor shall transport all the unused equipment and material back to the construction camp.

TOWER EARTHING:

- The Contractor shall supply all the equipment necessary for installing the tower earthing.
- Conductive concrete where required, shall be supplied by the Contractor.
- The Contractor shall supply the tower earthing bolts with nuts and washers in accordance to the relevant tower drawings.
- All bolts and nuts shall be in accordance to SABS 135 with a strength grade of 4.8.

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- All bolts with nuts and washers used for bonding shall be hot dipped galvanised to SABS ISO 1461.

PLANTING POLES:

- The Contractor shall supply all the equipment necessary for planting the poles.
- All additional bolts with nuts and washers not supplied with the steel pole shall be supplied by the Contractor and be in accordance to the relevant tower drawings.
- All bolts and nuts shall be in accordance to SABS 135 with a strength grade of 4.8.
- All bolts with nuts and washers used for bonding shall be hot dipped galvanised to SABS ISO 1461.

TERMINAL TOWER ASSEMBLY AND ERECTION:

- The Contractor shall supply all the equipment necessary for assembling and erecting the terminal towers.
- All additional bolts with nuts and washers not supplied with the steel pole shall be supplied by the Contractor and be in accordance to the relevant tower drawings.
- All bolts and nuts shall be in accordance to SABS 135 with a strength grade of 4.8.
- All bolts with nuts and washers used for bonding shall be hot dipped galvanised to SABS ISO 1461.

STAY ROD INSTALLATION:

- The Contractor shall supply all the equipment necessary for installing the stay rods.
- The Contractor shall supply the concrete where applicable and imported soil for the stay rod assemblies.

PERCHING BRACKET

- The Contractor shall supply all the equipment necessary for installing the perching brackets.

INSTALLING STAYS WIRES:

- The Contractor shall supply all the equipment necessary for installing the stay wires.

DRESSING THE STRUCTURES:

- The Contractor shall supply all the equipment necessary for dressing all the structures.
- The Contractor shall supply additional bolts with nuts and washers.
- Bolts, nuts and washers shall be hot dipped galvanised to SABS ISO 1461.
- Bolts shall be to SABS 135 with a strength grade of 4.8.

DISPOSAL OF EXCAVATED MATERIAL:

- The Contractor shall be responsible for disposing of excavated soil not used for backfilling.

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- The Contractor shall transport all the excavated soil not used for backfilling to the suitable borrow pit.

IMPORTING SOIL:

- The Contractor shall be responsible for supplying imported soil. If not otherwise specified, the imported soil shall be in accordance to SABS 1200.
- The imported soil shall not contain notable quantities of organic matter or stones of average dimension exceeding 150mm.
- The Contractor shall transport all the imported soil from the borrow pit to the pole position.

TRANSPORTATION:

- The Contractor shall transport the concrete from the batching plant to the pole position.

DOCUMENTATION:

- The Engineers Clerk of Works or the Engineer's representative shall supply the Construction Handbook.
- The Contractor shall complete all the sections of the Construction Handbook that applies to the construction of the line.
- The sections shall include all the job description and check list tables, building of the line table and earthing table.
- The Contractor shall appoint a responsible person for each task listed on the 'Authorised Persons' sheet and fill their names in on this sheet.
- The Contractor shall ensure that the authorised person shall sign the task certificate after the completion of the work.
- After completing the Construction Handbook, the Contractor shall return the Construction Handbook back to Eskom for review.

C3.1.16.15.3. STRINGING AND REGULATION

WORKS SPECIFICATIONS

NOTES:

- All work shall be done according to Eskom Specification TRMSCAAC1.
- Stringing, jointing, conductor repairs and regulation shall be reported in the Construction Handbook.
- All labour cost shall be included in quoted rate.
- The successful tenderer shall prepare and test a test string according to TRMSCAAC1 before any stringing takes place. The tenderer shall submit four copies of the test report to Eskom for review.
- No stringing shall take place before written approval is received from Eskom.
- Copies of calibration certificates, test reports, etc. for all the instruments and equipment used in the stringing and regulation process shall be submitted to Eskom for review.

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STRINGING CONDUCTORS SHALL INCLUDE:

- The top phase on the steel poles shall be the WHITE phase.
- If the phases should be rotated, it should be done at the 90° strain tower.
- Tension Stringing shall be used to string the phase conductors and earth wires.
- All stringing shall be done according to the provided Sag and Tension Charts.
- Suitable structures under each phase conductors shall be erected to protect all fences from conductor damage during stringing.
- Adequate protection shall be provided where there may be danger of a conductor being crossed over by vehicles, or damaged by other equipment or objects.
- Conductors shall not be left in contact with the ground, vegetable matter or any conducting or semi-conducting material.
- Wood lagging shall be used to protect the conductor when working at ground level.
- Jumpers shall be formed in a manner as to provide the maximum amount of clearance from earthed hardware, and tower steelwork.
- Where temporary stays are required, the Contractor shall be responsible for making the suitable arrangements.
- Conductors shall not be anchored to any part of the steel poles/towers.

LINE AND RAILWAY CROSSINGS SHALL INCLUDE:

- All line crossing shall be in accordance to TRMSCAAC1 - Installation of phase and earth conductors.
- All Railway crossing shall be in accordance to TRMSCAAC1 - Installation of phase and earth conductors.
- The price quoted shall include authorised temporary work carried out by the Contractor, transport, erection and dismantling of temporary conductor supports at all crossings, excluding crossings requiring special scaffolding.

CONDUCTOR JOINTS SHALL INCLUDE:

- Only Eskom coded jointers shall be authorised to carry out joints on phase conductors and earth wires.
- Each coded jointer shall further be issued with his unique identification number or sign, which he shall use to punch, completed joints as a register of his acceptance.
- The number of joints over the total length of the line shall be kept to a minimum.
- Joints shall not be closer than 15m from suspension towers.
- Joints shall not be closer than 30m from strain towers.
- Joints shall not be installed in spans crossing railways, proclaimed roads, power or communication lines.
- In no case shall there be more than one joint in a given span.
- Joints shall not be installed in a span that is dead-ended at both ends.
- No joint shall pass through a stringing pulley.
- All conductor joints shall be reported on in the Construction Handbook.
- The authorised person responsible for the jointing shall sign the 'Joint and Damage' certificate in the Construction Handbook.

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CONDUCTOR DAMAGE REPAIRS:

- Damage to conductors caused by the Contractor shall be repaired in a manner determined by the Clerk of Works, at the expense of the Contractor.
- Where there is repeated damage in the same span, or in consecutive spans, the entire conductor in such spans shall be replaced.
- All conductor repairs shall be reported on in the Construction Handbook.
- The authorised person responsible for the conductor repairs shall sign the 'Joint and Damage' certificate in the Construction Handbook.

MAKING OFF SHALL INCLUDE:

- Making off, phase conductors and earth wires at each steel pole structure, including clamping-in all conductors and attaching armour rods and vibration dampers to the conductor.
Cutting the conductors where the new lines will be connected onto the existing lines
- Connecting the cut conductors onto the new towers.
- Connecting the jumpers from the old lines to the new lines.
- The earth wire at the terminal structure shall be made off according to drawing 2-D-WT/816.
- All regulation shall be done according to the provided Sag and Tension Charts.
- The conductor temperature shall be determined by means of a Celsius thermometer as shown in Annexure E of the Construction Handbook.
- All conductors in a regulated section shall be clamped-in, beginning at the second structure from the forward end of the pulling, and shall progress structure by structure, until the conductors at all structures are clamped-in.
- The conductors shall be clamped-in in such a manner that no additional tension is placed on the insulators
- Armour rods shall be installed according to the manufacturer's specifications.
- The suspension clamps and U-bolts shall be torque to manufacturer's specifications.
- Asymmetrical vibration dampers shall be installed on the phase conductors and Spiral vibration dampers shall be installed on the earth wires.
- The asymmetrical vibration dampers shall be installed on all tensioned spans as specified in the table and positioned according to the tables in Volume 2 of this document. The placement shall be measured from the middle of a suspension clamp and from the edge of a strain clamp.
- The Spiral dampers shall be installed on all tensioned spans, as specified in the table and positioned according to the tables in Volume 2 of this document.
- Helical preform connected vibration dampers shall be installed according to the manufacturer's specifications.
- The authorised person responsible for the regulation shall sign the 'Sag and Tension' certificate in the Construction Handbook.

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DOCUMENTATION:

- The Contractor shall complete all the sections of the Construction Handbook that applies to the stringing and regulation of the line.
- The sections shall include all the job description and check list tables and the regulation table.
- The Contractor shall appoint a responsible person for the stringing, jointing and regulation tasks listed on the 'Authorised Persons' sheet and fill their names in on this sheet.
- The Contractor shall ensure that the authorised person shall sign the task certificate after the completion of the work.
- After completing the Construction Handbook, the Contractor shall return the Construction Handbook back to Eskom for review.

C3.1.16.15.4. LABELLING

WORKS SPECIFICATIONS

NOTES:

- All labels shall be in according to Eskom Specification ESKASAAN0, SCSSCAAP5 and to drawings D-DT 5064 and 2-WT-1148.
- All labour cost shall be included in quoted rate.
- All labels shall be manufactured according to Eskom Specification TRMSCAAC5.
- All labels, except line crossing labels, shall be black lettering on yellow background.

POLE IDENTIFICATION LABELS:

- The bottom of the identification labels shall not be less than 5000mm from the base of the steel pole.
- The pole identification labels shall be strapped to the pole with not less than three 12mm stainless steel straps.
- The off structure shall be numbered as the first structure.
- The numbers shall be changed to correlate with the existing numbering.

LINE DESIGNATION LABELS:

- A line designation labels shall be installed on the third suspension structure from the substations
- The line designation labels shall be installed between the top phase conductor and the earth wire.
- The line designations shall be installed below the line-crossing label.
- The line designation labels shall be strapped to the pole with not less than three 12mm stainless steel straps.

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LINE CROSSING LABELS:

- All line crossing labels shall be installed so that it would be visible from the direction of approaching the line crossing, line deviation or T-off.
- All line crossing labels shall be installed above line designation labels.
- All line crossing labels shall be a black diagonal cross on an orange background.
- The line crossing labels on the steel poles shall be installed between the top phase conductor and the earth wire
- The line crossing labels shall be strapped to the pole with not less than three 12mm stainless steel straps.
- Line crossing labels will only be installed where the new line crosses underneath other lines

MATERIALS SPECIFICATIONS

- Unless otherwise specified, the Eskom project manager shall specify what material will be supplied by Eskom for installing the line labels.
- The Contractor shall book the material from the Eskom store in the nearest depot, transport and off-load all material at the construction camp. The Contractor shall also supply all the equipment necessary for installing the line labels.
- The Contractor shall transport all equipment and material from the construction camp to the pole positions.
- pole identification labels, Line designation labels and Line crossing labels:
- All fixing straps, bolts with nuts and the Contractor shall supply washers for the labels.
- The fixing straps shall be 12mm stainless steel straps.
- All bolts, nuts and washers shall be hot dipped galvanised to SABS ISO 1461.
- All bolts shall be in accordance to SABS 135 with a strength grade of 4.8.
- All labels shall be in accordance to ESKASAAN0 and DISASZAA2.
- All labels shall have a vitreous enamel finish.

C3.1.16.16. OHL PROCEDURES

The following are typical procedures for some of the risks listed in the table above. The Contractor as part of his health and safety plan must draw up a procedure like this for all the risks shown on the previous page and all other risks identified by Contractor/ Project Manager/

All Safe Work Procedures must be adhered to. Special attention must be given to the following procedures:

- PC-09-GC-21 : Stringing (Tension and Terminate)
- PC-09-GC-29 : Dismantling of MV and LV overhead power lines
- PC-09-GC-31 : Stringing of conductors across a road
- PC-09-GC-34 : How to do closing span on existing/new lines
- PC-09-GC-39 : Outages

The following sections are extracts from the above procedures.

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C3.1.16.16.1. STRINGING (TENSION AND TERMINATE) (PC-09GC-21)

DEFINITION

Stringing means the tensioning and termination of conductors in the prescribed manner and specifications.

DANGERS

- Falling objects
- Workmen can fall from towers
- Induction from other lines
- Traffic-Roads and/or railway

PROCEDURE

- The equipment and methods used for stringing the conductors (including earth conductors) shall be such that the conductors will not be damaged. Particular care shall be taken at all times to ensure that the conductors do not become kinked, twisted or abraded in any manner.
- Stringing shall be done in daylight hours only.
- Tensions, while pulling, must be sufficient to clear all obstacles safely without damage to the conductor. At no time shall the pulling tension exceed the tension shown on the sag charts.
- Adequate protection shall be provided where there may be danger of a conductor being crossed over by vehicles, or damaged by other equipment and objects.
- Radio communications shall be used to relay information and instructions between the conductor tensioning station, intermediate check points, mobile stations and the pulling station at all times during the stringing-tensioning operation.
- Whenever joints or dead-ends are made, auxiliary erection clamps and hauling devices shall not be placed closer than 8m to the point of joint or dead-end.
- The conductor shall be cut with a ratchet or guillotine cutter to produce a clean cut, retaining the normal strand lay and producing minimum burrs. The aluminium strands shall then be stripped from the steel core by using an acceptable stripper. Under no circumstances shall high tensile hacksaw blades be used to cut conductor.
- The Contractor shall string all conductors and earth conductor to the appropriate sags and tensions as determined from the conditions specified in the contract documents.
- Conductors and earth conductors shall be strung to the appropriate sag determined for the actual span length, and the equivalent span of the strain section involved.
- The Contractor shall provide, and maintain in good condition, suitable dynamometers, sag boards or other accepted apparatus for the proper checking of the work. Dynamometers shall read in Newton's and shall be tested and re- calibrated at regular intervals
- In pulling the conductor, caution shall be used to avoid pulling the conductor above sag.
- All conductors, except for conductors in sag sections over flat terrain, shall be plumb-marked at each structure for the complete section regulated, before clamping-in or dead-ending of the conductor is begun.

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C3.1.16.16.2. DISMANTLING OF MV AND LV OVERHEAD POWER LINES (PC-09-GC-29)

Not Applicable

C3.1.16.16.3. STRINGING OF CONDUCTOR ACROSS A ROAD (PC-09-GC-31)

DEFINITION

Stringing means the tensioning and termination of conductors in the prescribed manner and specifications.

DANGERS

- Traffic/Pedestrians
- Falling from heights
- Falling objects
- Hand injuries

PROCEDURES

- Assign workers with red flags and road signs to strategic points on either side of the road crossing position.
- The assistance of the Traffic Department can be requested where national roads are involved.
- Regulate traffic as required to execute the work safely.
- Run out conductor as per procedure number PC-09-RC-04.
- String conductors as per procedure number PC-09-GC-13.
- Tension and sag conductor as per procedure number PC-09-GC-11.
- Ensure correct clearances are obtained as indicated on profile.
- Recall workers with flags and road signs.

C3.1.16.16.4. HOW TO DO CLOSING SPAN ON EXISTING/NEW LINES (PC-09-GC-34)

DEFINITION

Closing span means the connection of newly built lines onto an existing live line.

DANGERS

- Energised overhead power lines
- Falling objects

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PROCEDURES

- Ensure existing live line is isolated and earthed in accordance with Reg. 5.04.5 (HV Regs).
- Dress the existing pole with the necessary hardware.
- String conductor according to Procedures PC-09-GC-11 and PC-09-GC-13.
- Install jumpers according to procedure PC-09-GC-22.
- Remove all personnel, equipment and tools.
- Cancel permit (if issued).

C3.1.16.16.5. OUTAGES (PC-09-GC-39)

DEFINITION

Outages mean the switching off of all sources of supply of power so that work can be done on a specific point or apparatus.

DANGERS

- Switching, linking and earthing errors
- Static
- Fall from heights
- Falling objects
- Weather (e.g. lightning)
- Back feed through network
- Work on wrong line

PROCEDURE

PRIOR TO OUTAGE DATE

- Ensure work planning is complete and reflected in the duration of outage required.
- Supervisor liaise with Project Management timeously to allow a 14 day notification period to national control so that liaison may occur on site with all stake holders present. A date, time and duration is set and minuted.

ON OUTAGE DATE

- OTSC represented by the Appointed Operator perform the required operating. Make the area required safe for work and issues a work permit to Construction's appointed Responsible Person.
- Responsible Person ensures asset to be worked on is safe according to regulations and accepts the permit by signing as Responsible Person.
- Responsible Person informs all Construction persons under his supervision of the status of the asset as well as to their specific duties.
- Responsible Person constantly supervises to ensure adherence to ORHVS and general safe working practices during the outage period.

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COMPLETION AND HANDING OVER

- Responsible Person ensures that all elements of the asset are as per contract requirement and that all materials, personnel, equipment and machinery are removed to enable safe operation of the asset.
- Responsible Person hands back the asset to the Appointed Operator by signing off the permit after which the Appointed Operator will carry out his function. This is also done in liaison with national control. In the case of a new asset being put into operation, a handing over certificate to TSC by Project Management.

C3.1.16.17. QUALITY PLAN

- The Contractor needs to submit a quality plan indicating the control points for quality to ensure that the works are done according to specification.
- The Contractor is required to employ a competent Supervisor or Foreman on site for the duration of the project to implement workmanship quality checks. .
- The Engineer or his representative will do inspections and quality checks on installations completed by the Contractor prior to hand-over of each project.

C3.1.16.18. ACCESS TO THE SITE

- The Employer will provide the Contractor with an Access Certificate to formally provide access to the site and works implementation.
- The Contractor shall ensure that he is familiar with conditions of access roads and sites as well as subsurface conditions prior to tendering and to include this in his pricing.

C3.1.16.19. INTERACTION WITH CUSTOMERS / PARTIES AFFECTED

- The Tenderer shall be responsible for negotiation with customers with regard to use of access routes on farms etc.
- The Tenderer will be responsible for negotiation with land or business owners and / or the Local Authority with regard to the construction activities of the works.
- The Tenderer will be responsible for external disputes which may occur with regard to the construction activities of the works.
- The Tenderer is required to make all the necessary arrangements with the Local Authorities for road crossing structures and removal thereof, e.g. Removal of pavements, thrust boring under roads, way leaves, etc.

C3.1.16.20. CARRYING OUT THE WORKS

- The Scope of "Works" is an extension of the drawings, specifications and bills of quantities listed. The Contractor shall notify the Employer of any discrepancies before commencement of the works
- The onus is on the Contractor to obtain the latest revision of standards applicable.

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- The Contractor is required to supply all material, labour, plant, equipment, loose tools, consumables and transport for the duration and completion of the project unless alternatively requested in the "Services Supplied - Section 5".
- Contractor to provide summary of all costs for the execution of the works of the complete project.
- The Contractor must immediately notify the Employer in writing of scope and site variations.
- The Contractor will report all obstacles on site that could impact negatively on time and cost in writing to the Employer.
- Contractor to clear and de-establish total site on completion of proposed works.
- Contractor is required to clear and cart away rubble and surplus works

C3.1.16.21. VEGETATION MANAGEMENT

The supplier must ensure:

- that all indigenous and protected trees (in terms of national and provincial legislation) are identified and permits obtained from the relevant authority prior to the cutting of such trees.
- that written permission is obtained from the owner of protected trees prior to the cutting of such trees.
- that permits be available on site where such trees are cut.
- That the owner be consulted, and his/her consent being obtained, prior to the cutting of trees.

C3.1.16.22. WASTE DISPOSAL

The supplier shall ensure:

- That waste is disposed of on a permitted waste site, for the applicable waste type, in terms of the Environment Conservation Act, 73 of 1989.
- A disposal certificate is issued to the Employer or his Agent prior to final payment, as proof of disposal.
- That where appropriate, waste is being recycled or re-used.

C3.1.16.23. SUPPLYING CLEANING MATERIAL

The supplier shall ensure:

- That products sold to the Employer or his Agent is not in contravention of any international or national environmental treaty, agreement or environmental legislation.
- That products sold to Employer or his Agent are biodegradable,
- That material data sheets are provided for all products as well as an assurance letter providing assurance in terms of above two bullets.
- That a service be provided for the re-use or safe disposal of hazardous substances.

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C3.1.16.24. EMERGENCY WORK

The supplier shall ensure:

- That all environmental risks associated with the activity be assessed and documented prior to the execution of the activity.
- Identified environmental risks must be avoided and where it cannot be avoided, be remediated to the satisfaction of the Employer or his Agent, the landowner, or any relevant Government authority.
- That all environmental incidents and complaints are reported to the project manager within 24 hours.

C3.1.17. POWER TRANSFORMERS (PSE 18)

This section of the specification provides for the manufacture, supply, testing before shipment, delivery, off-loading and positioning on a concrete base, installation, site testing, handing over in a working condition and maintenance of one (1), 20 MVA, 132 000/11 000 V step down transformers with on-load tap changing equipment at Siyanqoba Substation.

The Contract also includes the supply and delivery of all auxiliary materials and equipment necessary for a complete installation and all drawings, plans and instructions.

The power transformers to be supplied shall comply with the latest Eskom Specification (240-68973110) "SPECIFICATION FOR POWER TRANSFORMERS RATED FOR 1.25MVA AND ABOVE AND WITH HIGHEST VOLTAGE OF 2.2kV OR ABOVE".

Transformers offered shall comply with the following specific requirements:

- | | |
|--|-----------------------------------|
| a) Application: | Outdoor |
| b) Number required | One (1) |
| c) Dry type or oil immersed: | Oil immersed |
| d) Rated Frequency: | 50 Hz |
| e) Continuous maximum rating at rated voltage: | 20 MVA |
| f) Vector Group: | Ynd1 |
| g) On load voltages | |
| h) Primary | 132 kV |
| i) Secondary | 11 kV |
| j) Tertiary | |
| k) Earthing | |
| l) Primary | Solid or via 66 kV surge arrestor |
| m) Secondary | NECRT |
| n) Tertiary | Not Applicable. |
| o) Anti-vibration | 20 mm malthoid (Three ply) |

If there is any uncertainty to any of the transformer parameters, it shall be clarified in writing with the Engineer prior to closing of the tender. Transformers within the substation shall be capable of short time parallel operation for load transfer.

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The cooling system of the transformer shall be an Oil-Neutral and Air-Neutral (ONAN) system for the maximum transformer rating.

The transformers are required to be supplied with open air insulated tank top mounted bushings for both the 132 kV as well as the 11 kV side. The HV bushings on all transformers are to be of the Resin Impregnated Paper (RIP) condenser core type, with composite external insulation with silicone or porcelain weather sheds. The 11 kV side bushings of the transformers shall have a minimum insulation level for 33 kV with a creepage distance of 31mm/kV.

It is a requirement of this contract that the power transformers are equipped with radiator banks fitted to the transformer in the space allocated on the project drawings. The power transformer, radiator banks and auxiliary transformers shall be effectively earthed to the substation earth system.

C3.1.17.1. CLEARANCES

The electrical clearance shall be:

HV (132 kV – 145 kV RMS)

- a) Phase – Earth: 1000mm
- b) Working Clearance: 3400mm (Vertical)
2400mm (Horizontal)

MV (11 kV – 12 kV RMS)

- a) Phase – Earth: 200mm
- b) Working Clearance: 2600mm (Vertical)
1600mm (Horizontal)

C3.1.17.2. NEUTRAL BUSHING

The neutral bushing shall be solidly earthed by means of a 50 x 3 mm Cu strap painted silver. The neutral bushing must be equipped with two CT cores in turret arrangement as an integral or in built part of the transformer:

- a) Core 1 – Class X for LV REF Protection
- b) Core 2 – SEF Protection
- c) CT wiring to be brought out into a CT JB and wired to the transformer marshalling box or kiosk.

C3.1.17.3. TESTS

The transformer shall be tested in accordance with GSE18

The transformer test methodology and connection diagrams for testing shall be submitted together with the bid offer.

C3.1.18. NECRT (PSE 20)

This section of the specification provides for the manufacture, supply, testing before shipment, delivery, off-loading and positioning on a concrete base, installation, site testing, handing over

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in a working condition and maintenance of combined oil-immersed 11 kV three phased neutral electro-magnetic couplers with neutral earthing resistors and auxiliary transformers (NECRT's)

The Contract also includes the supply and delivery of all auxiliary materials and equipment necessary for a complete installation as well as drawings, plans and instructions as further specified herein.

The NECRT's to be supplied shall comply with the latest Eskom Specification (240-57648848) "SPECIFICATION FOR COMBINED THREE-PHASE NEUTRAL ELECTRO-MAGNETIC COUPLERS WITH NEUTRAL EARTHING RESISTORS AND AUXILIARY TRANSFORMERS (NECRT's)".

a) Application:	Outdoor
b) Number required:	One (1)
c) Continuous maximum rating at rated voltage of auxiliary transformer:	100 kVA
d) Indoor or outdoor:	Outdoor
e) Dry type or oil immersed:	Oil immersed
f) Rated Frequency:	50 Hz
g) Normal "on-load" voltages:	
Primary for NECRT	11 kV
LV for Aux. Trfr.	420 V
h) Method of system earthing	
MV System	via NEC / NEC
LV	Solid
i) Vector group of NEC	Zig-Zag
j) Vector group of auxiliary transformer	Dyn 11

The NECRT's will be installed on concrete plinths as indicated on the project drawings.

All low voltage circuit breakers to be supplied for this project shall be complete with flash barriers and inter phase barriers with rear insulating screens, Cable and Power connectors, chassis side plates as well as IP40 Escutcheons.

The supply and installation of a 11 kV cable, as well as the LV supply connections between the transformer and the auxiliary transformers form an integral part of this part of the contract.

The auxiliary transformers will be fitted with the following integrated mechanical protection devices, complete with the necessary wiring to the abovementioned control cable boxes:

- Oil/winding over temperature alarm and trip contacts.
- Gas (Buchholz) over pressure alarm and trip functions, complete with sufficient alarm and trip contacts to comply with the protection scheme, shall be provided.
- A common set of alarm/trip contacts for alarm and indication functions in the transformer protection panel.
- A common set of alarm and trip contacts to provide alarm and trip indication for the SCADA system.

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- e) The contractor shall make allowance for the witnessing of the FAT by the Employer / End-User and the Engineer, in the priced unit rate.

C3.1.19. SURGE ARRESTORS (PSE 56)

The surge arresters to be supplied and installed shall primarily consist of the following:

- a) Supply and install heavy duty station type surge arresters.
- b) Supply and install 3 x 132kV heavy duty station class surge arresters close to the 88kV bushings of the new power transformers with the respective 11 kV surge arresters close to the secondary transformer bushings.
- c) Supply and install 1 x 66 kV neutral surge arresters on the neutral star points of the primary winding on the power transformers.

All the transformer primary and secondary surge arresters shall be mounted on tailor made supports to be fixed and fitted directly on the transformer.

The following surge arrestors are required as part of this contract:

- a) 11 kV Surge arrestor: station class, gapless, metal oxide, polymer housed, minimum MCOV of 12 kV, maximum residual voltage of 45 kV, 10 kA discharge current, Class 2 - line discharge (IEC), 31 mm/kV creepage; [D-DT-6216]
- b) 66 kV Surge arrestor: station class, gapless, metal oxide, polymer housed, minimum MCOV of 48 kV, maximum residual voltage of 165 kV, 10 kA discharge current, Class 2 - line discharge (IEC), 31 mm/kV creepage (used for the protection of unearthed transformer primary neutrals); [D-DT-6212]
- c) 132 kV Surge arrestor: station class, gapless, metal oxide, polymer housed, minimum MCOV of 84 kV, maximum residual voltage of 210 kV, 10 kA discharge current, Class 2 - line discharge (IEC), 31 mm/kV creepage; [D-DT-6211]

Surge arresters shall all preferably be fitted with grading rings. Grading rings shall be rigid and shall be securely fitted to the surge arrester.

Surge counters are required to be provided and installed on all of surge arresters, an insulated base on all PCD attachments shall therefore be included on surge arrester footings. The earthed ends of all surge arresters shall each be independently connected to the substation earthing system, by means of a copper earth conductor with a minimum cross-sectional area of 250mm². In the installation of the surge arrester earth conductors, 90° bends in the earth conductors shall be avoided.

Type Test Certificates indicating full compliance with IEC 60099, IEC 60815 and the relevant Eskom Specification, shall be submitted with all Tenders.

C3.1.20. SUBSTATION TECHNICAL SPECIFICATION – CONTROL PLANT

The contractor will be responsible for all aspects of the control plant installation.

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C3.1.20.1. PROTECTION PHILOSOPHY

In order to achieve the necessary performance requirements at all voltage levels, protection of the network shall follow the philosophy whereby no single failure of protection and its associated systems shall permit a fault to remain connected to the primary system.

To implement this philosophy, it is necessary to ensure that all faults are detected by independent high speed protection systems, including Main and Back-Up protections, the outputs of which are selectively allocated to independent tripping systems with separate D.C. supplies.

Circuit-breaker fail protection shall be provided to cater for failure of circuit-breakers and associated tripping circuits. The function shall be duplicated and integrated within both main protection systems.

Redundancy of critical functions (e.g. tripping) shall be achieved via hardwired signals in parallel with the specified communication protocol.

The successful tenderer shall be responsible for the detail design, detail schematic drawings, installation, testing, commissioning and handing over of the secondary plant according to the information and equipment offered. All drawings must be submitted to the Engineer for approval prior to manufacturing. The design shall be based on underlying Eskom Distribution Standards.

The control technology design shall be done according to the following schemes:

- Eskom based Transformer protection schemes
- Eskom based On-load Tap Change Control protection schemes

The protection design philosophies for the above mentioned schemes are outlined in the paragraphs to follow. Philosophies given are high level requirements, all details shall be submitted by the Contractor for approval, including a Functional Design Specification for approval detailing all proposed schemes.

HV Protection panels shall be equipped with tiled Mimics and Semaphores or painted Mimics with Semaphores if approved by the Engineer.

C3.1.20.2. PROTECTION PANELS

The schemes are to be housed in a single free-standing panel.

Two versions of scheme constructions are required: one using a swing frame panel with only front access, the other using a fixed frame panel with front and rear access. This is to cater for the following applications:

- a) Where space is a premium and panels need to be mounted either back to back or against the wall;
- b) Where there is enough space to allow front and rear access and thus make working within the panel considerably easier.

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For this project all panels shall have front and rear access.

Protection panel shall comprise of the following:

- a) Ethernet switch where required
- b) Bay control device
- c) Main protection
- d) Breaker control switches (HV, MV and or LV)(Open /Close)
- e) SIS (Supervisory Isolating Switch)
- f) Lamp check push button
- g) Test normal pushbuttons
- h) MCB's
- i) Panel not healthy lamp, etc.

C3.1.20.3. BREAKER FAIL PHILOSOPHY

Circuit breaker fail tripping shall be implemented using the relevant circuit's (Intelligent Electronic Device) IED (Circuit Breaker Fail) CBF functionality.

C3.1.20.4. SCHEME SUPPLY SUPERVISION PHILOSOPHY

All 110 V_{D.C.} and 230 V_{ac} supply MCBs in the protection control panels shall have mechanically attached auxiliary signal contacts, which when switched off or tripped, will indicate on the protection panels as "Protection/Control Unhealthy" via a red LED and signal to the SCADA system.

Trip circuit supervision of the trip coils shall be via inputs in the IEDs, time delayed to 400 msec (pickup and drop-off) to prevent flicker (operation) during normal switching, and shall monitor the trip coil integrity in the both open and close positions.

C3.1.20.5. INTERLOCKING PHILOSOPHY

Two transformers may operate in parallel should the operator wish to do so.

For the transformer schemes, a take-along trip shall be implemented so that when the 132 kV (HV) CB is opened, the respective 11 kV incomer CB will also be tripped. An 11 kV CB close shall be inhibited, should the HV circuit be de-energised. For a transformer OC/EF trip the MV breaker shall trip first to unload the transformer following by a trip of the HV breaker – breakers shall be interlocked.

If the 11 kV incomer cable earth is applied, an interlock shall prevent the HV CB from closing if the MV isolator is closed or immediately tripped the HV CB, if last mentioned, is closed.

C3.1.20.6. PERFORMANCE REQUIREMENTS

The protection shall remain stable for all load conditions, charging and discharging arrangements, harmonic currents, oscillatory currents, resonant effects, or travelling wave effects caused by the transmission system or caused by primary transducers. The protection equipment shall be designed so that a minimum or no routine maintenance is required, in terms of total accumulated time and frequency.

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The design should allow fault location, rectification (possibly by replacement sub-units) and returning to service, to be performed as quickly as possible, preferably with the equipment in service and in situ. Provision of spare fibre cables shall be considered to allow rapid repairs if problems arise.

C3.1.20.7. RELIABILITY

The supplier shall specify the correct commissioning procedure so that the reliability of the protection is maintained.

C3.1.20.8. SPEED

To avoid damage to transformer, the protection IED used should operate as quickly as possible. The speed of operation should not compromise the selectivity capability of the IED. Preference will be given to relays with fast tripping times.

It is essential that, under internal fault conditions, the power transformer be isolated from the network in a minimum time. It is imperative therefore that any relay element placed in series with the unit protection be extremely fast acting.

C3.1.20.9. TRIPPING D.C CIRCUIT

Double-pole miniature circuit-breakers (DP MCBs) shall be provided for the protection and isolation of the D.C. supplies to each scheme.

C3.1.20.10. CLOSING D.C. CIRCUIT

Anti-pumping - In the event that a breaker is closed into a fault, while the operator is applying a closed signal via a closed control switch, the circuit breaker should trip and prevent closing again until the closing circuit has been de-energized by the operator's releasing the control switch.

C3.1.20.11. PROTECTION CT CIRCUITS

For each circuit the protection CT core shall feed onto standard terminals and then to the CT test block and IED measuring elements.

A MMLG test block shall be used in all the wired CT circuits. Each test block shall include integral shorting of the incoming terminals when the cover is removed.

For this application, the CT circuits shall be used for the Differential, REF, Breaker-fail, and Over-Current, Earth Fault, and Instantaneous Over-current protection functions and for the Measurements functions.

The neutral of each CT circuit shall be earthed at one place only: on the incoming neutral terminal inside the protection panel. A sliding link terminal shall be provided on the earth connection for isolation proposes in order to facilitate insulation resistance testing.

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C3.1.20.12. IED BINARY INPUTS

The main IED is required to be provided with the status of all external plant, trips and alarms so as to relay this information to SCADA system via the serial and Ethernet communication links. This includes indication of each individual element that operates the Master Trip (relay) functionality. It is thus a requirement that the main IED has sufficient binary inputs to accumulate this data.

Changes in states of the inputs shall be logged by the IED's built-in sequence of event recorder function. All trips shall be used to start the IED's disturbance recorder.

C3.1.20.13. LOCAL INDICATIONS, PANEL MIMIC AND ANNUNCIATOR

Local indication of the following alarms and trips shall be provided:

- i. Transformer Buchholz Alarm
- ii. Transformer Buchholz Trip
- iii. OLTC Buchholz Alarm
- iv. OLTC Buchholz Trip
- v. Transformer tank over pressure Trip
- vi. Transformer Winding and Oil Temperature Alarm
- vii. Transformer Winding Temperature Trip
- viii. Transformer Oil Temperature Trip
- ix. Transformer Oil Level (High/Low) or Cooler Fail Alarm
- x. Bus zone trip for each busbar.

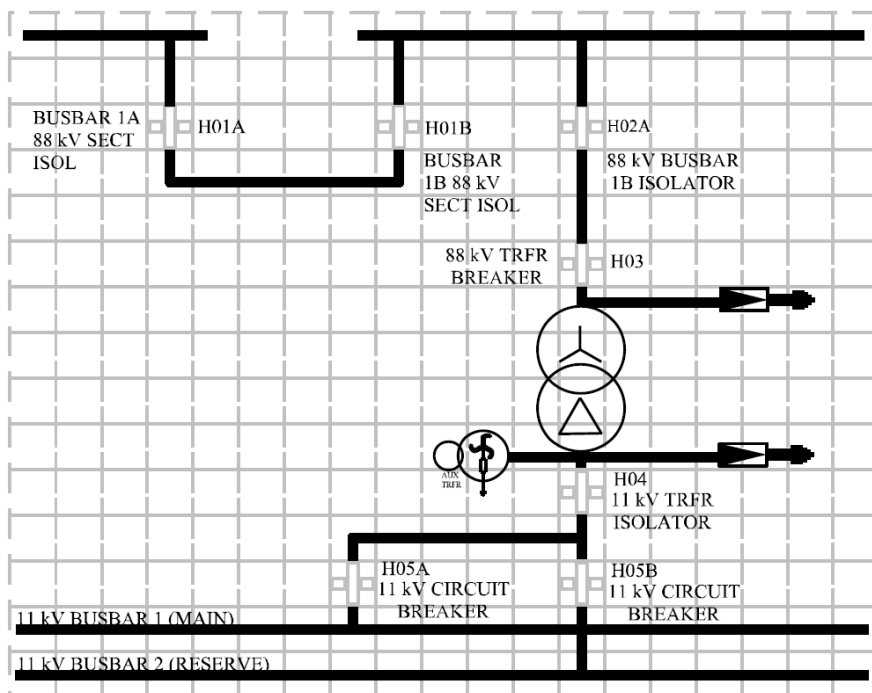


Figure 4: Typical Tiled Mimic Layout

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C3.1.20.14. 132 / 11 KV TRANSFORMER PROTECTION PHILOSOPHY

The 20 MVA, 132 / 11 kV, YNd1 transformers will be protected by the same Eskom based transformer protection scheme and both schemes shall be installed as part of this contract. The following protection functions (provided by the SEL 487 or similar) are to be employed:

Table 8: SEL487 Transformer Protection Functions

SEL 487 Relay or similar	HV Overcurrent
	HV Breaker Fail
	HV Ref (Direction Comparison)
	HV Earth Fault
	Differential Protection
	LV REF (High Impedance)
	LV Earth Fault
Back-up Protection SEL751 or similar	Backup directional OC/EF
	Standby E/F

Cabling requirements shall be as indicated on the project drawings. The contractor shall submit detail control cabling schedules indicating the cable types, sizes, glands, lengths, connector types etc. for approval.

C3.1.20.15. VOLTAGE TRANSFORMER REQUIREMENT

Voltage transformer (VT) input to the transducers will be obtained from the respective transformer's 11 kV, VT JB. The VT inputs to the Tap Change Schemes are to be looped from the transformer protection schemes.

C3.1.20.16. CURRENT TRANSFORMER RATIOS TO BE EMPLOYED

The new (2P2M2B) 132 kV, CT's will have two multi-ratio (MR) 1600/1 protection cores, two MR 1600/1 bus zone cores and two MR 1600/1 metering cores. The new (1P2M), 11 kV CT's include one protection and two metering (metering and indication) multi-ratio 1200/1 cores.

- For the 20 MVA, 132 / 11 kV transformers, the full-load-current is 87.5 A at 132 kV and 1049.7 A at 11 kV. These two values are guidelines in selecting the appropriate CT ratios for the HV and LV protection functions.
- The high voltage (HV) restricted-earth-fault (REF) function is to operate via direction comparison of the currents from the Differential CT inputs and the transformer's HV **neutral CT**. The transformer's HV neutral CT has a fixed ratio of 300/1.
- The HV differential protection (diff), HV REF and HV overcurrent functions are to receive CT inputs from the same sets of **post type CT** cores. A CT ratio of 200/1 will be used.
- CT inputs to the high impedance LV REF will be provided via the 11 kV CT's and a neutral CT on the NEC/R.
- CT inputs to the Transformer Differential protection will be provided via the 11 kV CT's and the post top HV CT's.

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Table 9: CT Ratio's

HV CT ratio's	Differential, O/C & E/F (HV Post-type CT's)	200/1
	HV REF (Transformer HV Neutral)	300/1
	Bus Zone (Main) Bus Zone (Check)	Not Applicable
MV CT ratio's	Differential (LV indoor CT) LV O/C & E/F	1200/1 1200/1
	LV REF (NEC)	1200/1
	LV SEF (NEC) (STANDBY E/F)	300/1

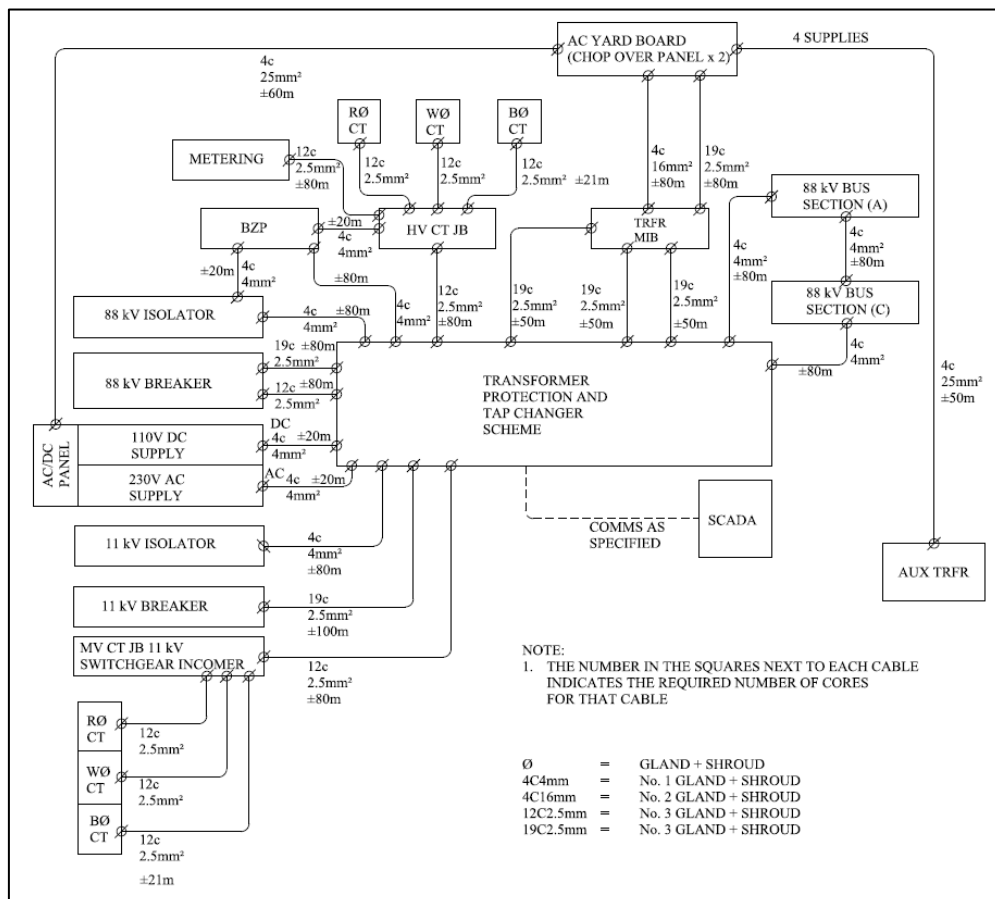


Figure 6: 20MVA 132/11KV Transformer and Tap Changer Cabling Diagram

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C3.1.20.16.1. 132/11 KV TRANSFORMER TAP CHANGER PROTECTION PHILOSOPHY

On-Load Tap Change Protection and Control will be achieved using the Eskom base scheme (A. Eberle REG-DA or similar). The schemes are to be mounted below the transformer protection schemes in each transformer's swing-frame panel.

The tap change scheme requires status inputs from all breakers and isolators on the HV and MV sides of the transformer. HV and MV bus section breaker and isolator status information must be supplied to the second transformer. Provision must also be made for circulating current scheme to ensure parallel operation of the transformers.

C3.1.20.16.2. INSTRUMENT TRANSFORMER REQUIREMENTS

The VT inputs to the Tap Change Schemes are to be looped from the transformer protection schemes (transformer protection panel).

Current transformer inputs to the tap change scheme are to be obtained from the transformer's MV bushing CT's as indicated.

Table 10: Tap Change Current Input

Tap Change current input (Bushing CT's)	1200/1
---	--------

C3.1.20.17. 132 KV FEEDER PROTECTION PANEL

It is a requirement that the 132 kV Eskom Feeder protection panel installed at Siyanqoba Substation match the Eskom 6FZD3600 Feeder protection Scheme. The scheme utilises the ABB RED670 IED as the main protection relay, with the backup protection IED's being a REF615 Directional protection relay.

C3.1.21. USING OF OWN MANPOWER (PSE 100)

It is a requirement of the Contract that the work be executed in such a manner as to maximize the use of labour in order to provide the local community with employment opportunities (where applicable) in accordance with the approved Council Policy and Guidelines.

It should be noted that the local labours can be from any area within the Emfuleni Municipal area, which is within a reasonable distance from the construction site.

The Contractor shall only use skeleton staff and skilled staff for implementation of the project. The contractor shall appoint local labourers for all unskilled tasks. Should it prove to be impossible to identify people from the community to perform the expected tasks identified by the Contractor, written approval shall be obtained from the Engineer, or the community, prior to utilising his own manpower to complete the project. The Contractor's own personnel will be responsible for all specialised work. The Contractor shall therefore use only skilled labour of his own workforce. All other unskilled labour required shall be local labour.

The identification of the approved CLO to be appointed by the Contractor under the Contract shall be resolved by the Contractor, the particular Ward Councillors in collaboration with the Local Community in the form of a Project Steering Committee. It will be required, therefore,

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that the successful Tenderer (i.e. the Contractor) enter into a contract for the employment of the above-mentioned CLO, the parties to which will be the Contractor, the Local Authority and the CLO.

In order to achieve the recruitment of local labour, the Local Communities would establish, together with the Local Authority, a database of unemployed persons, indicating their specialized training, previous experience and employment, etc. The successful Tenderer will be required to follow the approved Council Policy and Guidelines and to liaise with the Member of the Mayoral: Engineering Services (MMC) in recruiting his/her workforce and will be required to produce weekly records suitably detailed to enable the Engineer/Employer, or his/her authorized representative, and the Local Communities to ascertain that the abovementioned labour requirements are achieved. The Contractor is required to provide informal skills training so that the required standard of workmanship is maintained. Any difficulty experienced by the Tenderer/Contractor in the procurement of the requirement percentages of local labour is to be referred immediately to the Engineer.

The contractor will also be required to report monthly on the amount of local labour in accordance with the EPWP program reporting formats which will be provided to the successful contractor.

C3.1.21.1. EXPECTED TASKS AND RESPONSIBILITIES

The different tasks and responsibilities are as follows:

C3.1.21.1.1. SERVICES REQUIRED

- a) 1 x CLO - Community Liaison Officer
- b) Unskilled labourers

The contractor shall provide for the necessary facilities for the workforce i.e. water, toilets, guard houses, stationary, PPE, identification etc.

C3.1.21.1.2. DUTIES, TASKS AND RESPONSIBILITIES

CLO

- a) Represent the local community in matters concerning the use of local labour on the works and to assist with and facilitate communication between the Contractor, the Engineer and the local communities.
- b) Ensure labourers obey Contractors instructions.
- c) Terminate, retrench, expel and discipline workers
 - Not obeying Contractors instructions
 - Refuse to work
 - Not reporting for work without excuse
 - Misbehave, steal, drink, intimidating etc. during working hours etc.
- d) Settlement of disputes.
- e) Obtain way leaves.
- f) Any other reasonable instructions required by the Contractor, Project Manager or Employer.

LOCAL LABOUR

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40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION OF A 11,5 KM, 132 KV OVERHEAD LINE.

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- a) Perform and execute tasks such as:
 - Minor excavation work.
 - Excavation of cable trenches.
 - General unskilled labour.
- b) Any other reasonable instructions required by the Contractor, Project Manager or Employer.

CONTRACTOR

- a) Employ the CLO, security officers and local labour.
- b) The period of appointment of the CLO shall be as stated in the Contract for Temporary Employment as a Community Liaison officer referred to below. The date of commencement of temporary employment of the CLO shall be as agreed with the Engineer.
- c) Provide and supply all clothing, tools and materials to perform the tasks required.
- d) Manage the workforce with the assistance of the CLO to ensure that the programme to carry out the work is met.
- e) Manage all material. The Contractor will be responsible for the management, issuing and verification of all material.
- f) Conduct and convene meetings on a daily base, to dish out work and tasks and to record progress.
- g) To ensure all safety requirements are met.
- h) Pay and remunerate the workforce once a month by means of a cash cheque and record all payments with relevant signatures.
- i) The Contractor will register all local labourers for unemployment insurance.
- j) Enter into written agreement with CLO and workforce and appoint workforce in writing in accordance with the relevant Emfuleni procedure.

The contract shall be between the Contractor and the CLO and the local labour, all costs involved shall be borne by the Contractor and the tender shall be deemed to include for this.

C3.1.21.1.3. CONDITIONS OF EMPLOYMENT

- a) Obey Contractors instructions.
- b) Sign time sheets and report for work from Monday to Friday.
- c) Work overtime if required by Contractor.
- d) Working hours is 45 hours per week from 07:00 to 16:30 with 30 minutes lunch break from 12:00 to 12:30.
- e) Payment will be effected according to attendance register, with no work no pay policy.
- f) Payment will be done by means of a cash cheque once a month on the last Friday of the month at 14:00.
- g) Unemployment insurance funds will be deducted.
- h) Tax will be deducted if applicable and when deducted, IRP5 certificates will be issued.
- i) Payment categories:
 - CLO - Estimated R 6 000,00 per month or pro rata for days working
 - Labourers - Estimated R 150,00 per day

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The above are estimated minimum amounts and shall be negotiated between the Contractor, Municipality relevant manpower. To prevent disputes arising any manpower shall not be paid more or paid less than the rates being used within the Municipal area.

- j) Overtime will be paid according to time plus a third.
- k) If the required progress is not met after actions taken by the CLO, the Contractor will have the right to strengthen his own workforce with the approval of the Project Manager.

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EMALAHLENI LOCAL MUNICIPALITY

**40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION
OF A 11,5 KM, 132 KV OVERHEAD LINE.**

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THE CONTRACT PART 3: SCOPE OF THE WORKS

C3.2: TECHNICAL SCHEDULES

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C3.2. TECHNICAL SCHEDULES

The following list outlines the Technical Schedule for tendering which shall be populated by the contractor / OEM. Failure to complete any schedule may result in the bid submitted being disqualified.

At no stage during the delivery of the works may the contractor change supplier / manufacturer without the written consent from the Engineer.

C3.2.1. TSE11 – SUBTRANSMISSION OVERHEAD LINE

- a) Conductor and Line Hardware

C3.2.2. TSE18 - POWER TRANSFORMERS

- b) 20 MVA, 88/11 kV Power Transformer in accordance with Eskom 240-68973110

C3.2.3. TSE20 – NECRT'S

- a) 11 kV / 300-360 A: Neutral electromagnetic coupler with neutral earthing resistor and auxiliary transformer (NECRT) in accordance with Eskom specification 240-576488480.

C3.2.4. TSE48 - OPGW

- a) Optical Ground Wire (OPGW) in accordance with NRS specifications NRS 061 and NRS 081

C3.2.5. TSE56 - SURGE ARRESTORS

- b) Station class surge arresters for an 11 kV system in accordance with Eskom specification DSP_34-419.
- c) Station class surge arresters for a 66 kV system in accordance with Eskom specification DSP_34-419.
- d) Station class surge arresters for an 132 kV system in accordance with Eskom specification DSP_34-419.

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SIGNED AT ON BEHALF OF THE FIRM

ON THIS DAY OF 20.....

NAME:

SIGNATURE:

CAPACITY:

TSE11 – TECHNICAL SCHEDULE ELECTRICAL

SUBTRANSMISSION OVERHEAD LINES

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NO TABLE OF FIGURES ENTRIES FOUND.

1. GENERAL

The general requirements for subtransmission overhead lines are covered by GSE11. The detail project requirements shall be covered in the Project Specification, Drawings and Bill of Quantities.

2. TECHNICAL SCHEDULE

The following additional information is required for the overhead power line portion of the works:

2.1. CONDUCTORS

2.1.1. CHICKADEE CONDUCTOR

Supplier :

Material of conductor :

Number and diameter of wires :

In accordance with the specification :Yes / No

2.1.2. SHIELD WIRE

Supplier :

Material of conductor :

Number and diameter of wires :

In accordance with the specification :Yes / No

2.1.3. OPGW

The technical schedule for OPGW is covered in GSE48.

2.2. INTERMEDIATE / SUSPENSION ASSEMBLY (132 KV)

2.2.1. POST INSULATORS (132 KV)

Material :

Insulator type number :

Maximum working load :

Minimum failing load :

Outside diameter :

Distance between centres of unit : mm

Mass of unit : kg

Minimum dry flashover : kV

Minimum wet flashover : kV

Minimum puncture voltage : kV

In accordance with the specification :Yes / No

2.2.2. ARMOUR ROD

- Manufacturer :
- Type :
- In accordance with the specification :
Yes / No

2.2.3. LINE POST TRUNNION CLAMPS

- Manufacturer :
- Type :
- In accordance with the specification :
Yes / No

2.3. STRAIN ASSEMBLY (132 KV)

2.3.1. LONG ROD INSULATORS

- Material :
- Insulator type number :
- Maximum working load :
- Minimum failing load :
- Outside diameter :
- Distance between centre of unit : mm
- Mass of unit : kg

- Minimum dry flashover : kV
- Minimum wet flashover : kV
- Minimum puncture voltage : kV
- In accordance with the specification :Yes / No

2.3.2. COMPRESSION DEAD END CLAMPS

- Manufacturer :
- Type :
- Maximum working load :
- In accordance with the specification :
Yes / No

2.3.3. D SHACKLES

- Manufacturer :
- Type :
- Maximum working load :
- In accordance with the specification :
Yes / No

2.3.4. TONGUE SOCKET

- Manufacturer :
- Type :
- Maximum working load :
- In accordance with the specification:
Yes / No

2.3.5. BALL CLEVIS

- Manufacturer :
- Type :

- Maximum working load :
- In accordance with the specification :
Yes / No

2.3.6. TURNBUCKLE OVAL EYE TONGUE

- Manufacturer :
- Type :
- Maximum working load :
- In accordance with the specification :
Yes / No

2.4. PGW SUSPENSION HARDWARE

- Manufacturer :
- Type :
- In accordance with the specification :
Yes / No

2.5. OPGW STRAIN HARDWARE

- Manufacturer :
- Type :
- In accordance with the specification :Yes /
No

2.6. VIBRATION DAMPERS

- Manufacturer :
- Type :
- In accordance with the specification :
Yes / No

2.7. POLE STAYS

- Stay wire number and diameter of wires.....:

2.7.1. STAY ROD ASSEMBLY

- Type :
- Size :
- Stay plate - size :
- In accordance with the specification :
Yes / No

2.7.2. STEEL THIMBLE

- Supplier :
- Type :
- Complies with specification :Yes / No

2.7.3. PREFORMED STEEL DEAD-END GUY GRIP

- Supplier :
- Type :
- Complies with specification :Yes / No

2.8. LABELS

- Manufacturer :
- Type :
- In accordance with the specification :
Yes / No

2.9. AIR CRAFT WARNING DEVICE

- Manufacturer :

- Type :
- In accordance with the specification :.....
Yes / No

2.10. POLES

- Manufacturer :
- Shape :
- Steel type :.....
- Galvanizing by :
- Design specification :

2.11. FOUNDATIONS

- Soil Nomination by :
- Foundation Certification by :
- Qualification for above person :
- ECSA Pr.Eng Registration # :

SIGNED ON BEHALF OF TENDERER :.....

COMPANY NAME :

NAME IN BLOCK LETTERS :

DATE :

TSE18 – TECHNICAL SCHEDULE ELECTRICAL

POWER TRANSFORMERS:
1.25 MVA AND ABOVE
2.2 kV AND ABOVE

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1. GENERAL

The general requirements for power transformers rated for 1.25 MVA and above and with highest voltage of 2.2 kV or above are covered by Eskom specification 240-68973110. The detail project requirements shall be covered in the Project Specification, Drawings and Bill of Quantities.

2. TECHNICAL A & B SCHEDULE

Schedule A: Purchaser's specific requirements

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

Table 1: Technical Schedule

Item	Description	Schedule A	Schedule B
1.	Purchasing Details		
1.1	SAP No	N.A.	xxxxxxxxxx
1.2	Class	Class 1	
2	Delivery and off-loading		
2.1	Transformer delivered to:	Siyanqoba	
2.2	Off-loaded from transport vehicle and transferred to intended operating position by supplier.	Yes	
2.3	Distance from off-loading position m	± 10	
2.4	Rise or fall to off-loading position mm	± 500	
2.5	Acceleration limit in any direction g	10	
3	Erection		
3.1	Erected ready for service	Yes	
3.2	Place 3 ply Malthoid on plinth	Yes	
4	Tests (Type Tests are for first of design units only, although Customer has right to request this for any transformer)		
4.1	Temperature rise tests	Yes	
4.2	Lightning Impulse Withstand Test	Yes	
4.3	Chopped Impulse Test	Yes	
4.4	Acoustic noise level measurements	Yes	
4.5	Determination of capacitances, windings to earth & between windings as well as bushing dielectric loss (tan delta)	Yes	
4.6	Zero sequence impedance measurement for three winding transformers	Yes	
4.7	Short-circuit withstand tests	Provide design details	
4.8	Insulation resistance to earth	Yes	
4.9	Short duration AC tests (partial discharge)	Yes	
4.10	Frequency Response Analysis Test (Factory &	Yes	

Item	Description	Schedule A	Schedule B
	Site)		
4.11	Impact Recorders (Active part & Tank)	Yes	
4.12	Voltage Ratio and Phase Displacement	Yes	
4.13	Winding DC Resistance	Yes	
4.14	Separate Source Voltage Withstand	Yes	
4.15	Over Voltage Withstand	Yes	
4.16	Short Circuit Impedence and Load Loss	Yes	
4.17	No Load Loss and Magnetizing Current	Yes	
4.18	On Load Tap Changing	Yes	
4.19	Oil DGA	Yes	
4.20	Paint Thickness and Quality	Yes	
4.21	Auxiliary Wiring Functionality and Pressure Test	Yes	
5.	Continuous rated power for all tapping's		
5.1	ONAN MVA	20	
5.2	ONAF MVA	N/A	
6	Rated voltage (Un) on principal tapping		
6.1	Primary kV r.m.s	132	
6.2	Secondary kV r.m.s	11	
7.	Voltage tapping range of Primary/Secondary ratio (% of the ratio on the principal tapping):		
7.1	Max %	5	
7.2	Min %	-15	
7.3	Size of steps %	1.25	
7.4	Number of positions (including transition positions)	17	
8.	Resulting no-load voltage appearing having MV constant		
8.1	On principal tapping kV	132	
8.2	On extreme plus tapping kV	138.6	
8.3	On extreme minus tapping kV	112.2	
9.	Transformer Type		
9.1	Vector Group	YNd1	
9.2	Type of transformer	Core	
9.3	Number of limbs	3	
9.4	Winding Arrangement (Core/Secondary/Primary/Regulating)	As Specified	

Item	Description	Schedule A	Schedule B
9.5	Type of cooling	ONAN	
10	Operating environment		
10.1	Corrosion protection	Yes	
10.2	Pollution level	Very Heavy	
11	Maximum current density in windings		
11.1	Primary (outer winding) A/mm ²	≤ 3.0	
11.2	Secondary (inner winding) A/mm ²	≤ 3.2	
12	Transformer losses		
12.1	No load losses (Maximum rated power)		
12.1.1	@ 90% kW	≤ 10.65	
12.1.2	@ 100% (This value will be used in fin evaluation) kW	≤ 14.65	
12.1.3	@ 110% kW	≤ 19.5	
12.2	Load losses		
12.2.1	Extreme Plus tap position kW	≤ 130	
12.2.2	Nominal tap position kW	≤ 130	
12.2.3	Extreme Minus tap position kW	≤ 135	
	(Note: Loss evaluation will be performed using the average of the above three values)		
13.	Core Design		
13.1	Maximum flux density @ Un T	< 1.75	
14	Losses for cooling equipment (Fans)		
14.1	Power kW	N/A	
14.2	Current A	N/A	
15	Primary / Secondary impedance at 75 °C at rated MVA (Refer 7.1 of Design Parameter Schedule)		
15.1	On principal tapping %	11	
15.2	On extreme plus tapping (maximum impedance) %	11.2	
15.3	On extreme minus tapping (minimum impedance) %	>10	
16	Primary / Secondary tolerances applicable to guaranteed impedances		
16.1	On principal tapping	IEC	
16.2	On extreme plus tapping	IEC	
16.3	On extreme minus tapping (minimum impedance) %	+10 / -0	
17.	Temperature rises at altitude of 1 800 m		
17.1	Top oil °C	55	

Item	Description		Schedule A	Schedule B
17.2	Windings (by resistance)	°C	60	
17.3	Hotspot of winding	°C	< 73	
17.4	Hotspot of metal parts in contact with oil	°C	< 105	
18.	Maximum acoustic noise	dB(A)	73	
19.	Heavy Duty Type		Yes	
20.	Minimum insulation for windings (Note: Provide detailed test plan for evaluation)			
20.1	Impulse withstand test voltage for line terminal:			
20.1.1	Primary	kV peak	550	
20.1.2	Secondary	kV peak	95	
20.2	Sixty-second, separate source			
20.2.1	Primary	kV r.m.s	230	
20.2.2	Secondary	kV r.m.s	28	
20.3	Sixty-second, induced-overvoltage withstand test voltages			
20.3.1	Primary to earth	kV r.m.s	230	
20.3.2	Secondary	kV r.m.s	22	
21	Main terminals & Bushing			
21.1	Type		Outdoor	
21.2	Details of Primary bushing / terminal (composite)			
21.2.1	Make & Model		xxxxxxxxxx	
21.2.2	Stem size (dia x length)	mm	26 x 125	
21.2.3	Current Rating (incl 20% overcurrent)	A	> 160	
21.2.4	Impulse withstand voltage at sea level	kV peak	650	
21.2.5	Power frequency withstand voltage	kV r.m.s	275	
21.2.6	Total Creepage	mm	> 4500	
21.2.7	Protected Creepage (<50% of Total Creepage)	mm	xxxxxxxxxx	
21.3	Details of Secondary bushing / terminal (composite)			
21.3.1	Make & Model		xxxxxxxxxx	
21.3.2	Stem size (dia x length)	mm	38 x 125	
21.3.3	Current Rating (incl 20% overcurrent)	A	> 1300	
21.3.4	Impulse withstand voltage at sea level	kV peak	200	
21.3.5	Power frequency withstand voltage	kV r.m.s	70	

Item	Description		Schedule A	Schedule B
21.3.6	Total Creepage	mm	> 375	
21.3.7	Protected Creepage (<50% of Total Creepage)	mm	xxxxxxxxxx	
21.4	Details of Neutral bushing / terminal (composite)			
21.4.1	Make & Model		xxxxxxxxxx	
21.4.2	Stem size (dia x length)	mm	26 x 125	
21.4.3	Current Rating (incl. 20% overcurrent)	A	> 160	
21.4.4	Impulse withstand voltage at sea level	kV peak	350	
21.4.5	Power frequency withstand voltage	kV r.m.s	140	
21.4.6	Total Creepage	mm	> 1500	
21.4.7	Protected Creepage (<50% of Total Creepage)	mm	xxxxxxxxxx	
22	Physical arrangement			
22.1	Compliance with Figure 2 & 3		Yes	
22.2	Overall dimensions of complete unit			
22.2.1	Height	mm	< 5500	
22.2.2	Length	mm	< 6400	
22.2.3	Width	mm	< 5000	
22.3	Overall dimensions of tank only		xxxxxxxxxx	
22.3.1	Base plate type (flat / prefabricated)	mm	Flat	
22.3.2	Length	mm	± 3200 (< 4400)	
22.3.3	Width	mm	≤ 1500	
22.3.4	Base plate thickness	mm	± 20	
23	Cooling equipment			
23.1	Radiators			
23.1.1	Material Type (Cooler tubes / press sheet radiators)		xxxxxxxxxx	
23.1.2	Material Thickness	mm	xxxxxxxxxx	
23.2	Motors (Forced cooling)			
23.2.1	Make		N/A	
23.2.2	Type		N/A	
24	Safe withstand vacuum at sea level	kPA	1.5	
25	Transformer oil type		240-75661431 ESKOM 32-406	
26	Tap-changers			
26.1	Type		OLTC	

Item	Description	Schedule A	Schedule B
26.2	Tap-changer	xxxxxxxxxx	
26.2.1	Manufacturer	xxxxxxxxxx	
26.2.2	Model Number	xxxxxxxxxx	
26.2.3	Precise electrical location of tapplings.	Y-neutral end	
26.2.4	Diagrammatic arrangement shown on Drawing No.	xxxxxxxxxx	
26.2.5	Number of maintenance free operations	300,000	
26.3	Nominal 50 Hz ratings of tap-changer:		
26.3.1	Voltage kV	> 45	
26.3.2	Current (non-vacuum type) A	> 300	
26.3.3	Current (vacuum type) A	> 160	
26.4	Insulation levels of tap-changer		
26.4.1	phase-to-phase peak kV peak	380	
26.5	Tap-changer 50 Hz withstand		
26.5.1	phase-to-phase kV r.m.s	125	
26.6	Tap-changer contacts		
26.6.1	Selector kV/A	xxxxxxxxxx	
26.6.2	Selector switch kV/A	xxxxxxxxxx	
26.6.3	Diverter switch kV/A	xxxxxxxxxx	
26.6.4	Tie-in Resistor used?	Yes /No	
26.6.5	Value of tie-in resistor Ω	xxxxxxxxxx	
26.7	Tap-changer transition resistor kV/A	xxxxxxxxxx	
26.8	Tap-changer driving motor		
26.8.1	Type of driving motor	3 phase	
26.8.2	Supply voltage to motor V_{ac}	420V	
26.8.3	Power kW	xxxxxxxxxx	
26.8.4	Current A	xxxxxxxxxx	
27	Drawings & Manuals		
27.1	Quantity of drawings as per 3.2.2	1	
27.2	Quantity of Manuals (hard copy + electronic)	5 + 1	
28	Indicating and protective devices		
28.1	Tap-changer protective device (detail)	Specify Type	
28.2	Pressure relief device	Specify Type	
28.3	Oil- and gas-actuated relay	Specify Type	

POWER TRANSFORMERS

Item	Description	Schedule A	Schedule B
28.4	Conservator bag required	No	
28.5	Conservator bag type	N/A	
28.6	Dehydrating breathers	Specify Type	
28.7	Oil level indicators	Specify Type	
28.8	Oil temperature thermometer	Specify Type	
28.9	Winding temperature thermometer(s)	Specify Type	
29	Schedule of type test & routine test certificates submitted	Yes - compulsory	
30	Spares recommended by manufacturer (Provide detailed list)		
31.	OTHER (OPTIONAL ITEMS)		
31.1	Online Gas Monitoring System	Not Required	
31.2	Moisture Management System	Not Required	

3. TECHNICAL A & B DEVIATION SCHEDULE

Table 2: Deviations schedule

Any deviations offered to this specification shall be listed below with reasons for deviation. In addition, evidence shall be provided that the proposed deviation will at least be more cost effective than the specification.		
Item	Sub-clause	Proposed deviation

SIGNED ON BEHALF OF TENDERER: _____ :

COMPANY NAME :

SIGNATURE _____ :

NAME IN BLOCK LETTERS :

DATE _____ :

4. DESIGN PARAMETER SCHEDULES A AND B FOR A YNd1 POWER TRANSFORMER

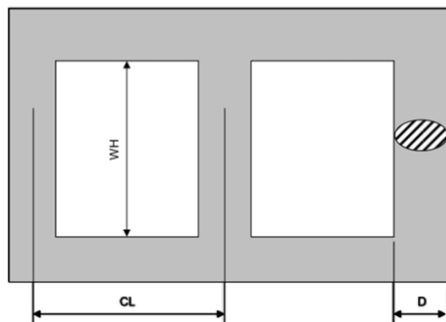
Schedule A: Purchaser's specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

Table 3: Design Parameter Schedules and B for a YNd1 Power trfr

Item	Description	Schedule A	Schedule B
1.	Core Steel		
1.1	Manufacturer of core steel	XXXXXXXXXX	
1.2	Grade of core steel	XXXXXXXXXX	
1.3	Thickness of core steel mm	XXXXXXXXXX	
2	Core Dimensions		
2.1	Window height (WH) mm	XXXXXXXXXX	
2.2	Distance between core limb centres (CL) mm	XXXXXXXXXX	
2.3	Core Diameter (D) mm	XXXXXXXXXX	
2.4	Filling Factor	XXXXXXXXXX	
3	Cross sectional areas		
3.1	Wound limbs mm ²		
3.2	Yoke mm ²		
4	Total Core mass Kg		
5	The design flux density at U_n for:		
5.1	Wound limbs T	XXXXXXXXXX	
5.2	Yoke T	XXXXXXXXXX	
6	Volts/turn at the above flux V/turn		

7. Winding Design



Item	Description	Schedule A	Schedule B
7.1	Winding arrangement (CORE / LV / HV / TAP)	XXXXXXXXXX	
7.2	Conductor Yield strength N/mm ²	XXXXXXXXXX	
7.3	Winding 1	LV	
7.3.1	Type (i.e. multilayer helix)	XXXXXXXXXX	
7.3.2	Lead type (End Fed / Centre Fed)	XXXXXXXXXX	
7.3.3	Number of turns	XXXXXXXXXX	
7.3.4	Inner Diameter mm	XXXXXXXXXX	
7.3.5	Outer Diameter mm	XXXXXXXXXX	
7.3.6	Radial build mm	XXXXXXXXXX	
7.3.7	Magnetic height mm	XXXXXXXXXX	
7.3.8	Conductor configuration	XXXXXXXXXX	
7.3.9	- Size	XXXXXXXXXX	
7.3.10	- Number	XXXXXXXXXX	
7.3.11	Conductor insulation mm	XXXXXXXXXX	
7.3.12	Current density A/mm ²	XXXXXXXXXX	
7.3.13	Temperature gradient winding – oil °C (K)	XXXXXXXXXX	
7.3.14	Total conductor mass kg	XXXXXXXXXX	
7.4	Winding 2	HV	
7.4.1	Type (i.e. multilayer helix)	XXXXXXXXXX	
7.4.2	Lead type (End Fed / Centre Fed)	XXXXXXXXXX	
7.4.3	Number of turns	XXXXXXXXXX	
7.4.4	Inner Diameter mm	XXXXXXXXXX	
7.4.5	Outer Diameter mm	XXXXXXXXXX	
7.4.6	Radial build mm	XXXXXXXXXX	
7.4.7	Magnetic height mm	XXXXXXXXXX	
7.4.8	Conductor configuration	XXXXXXXXXX	
7.4.9	- Size	XXXXXXXXXX	
7.4.10	- Number	XXXXXXXXXX	
7.4.11	Conductor insulation mm	XXXXXXXXXX	
7.4.12	Current density rated A/mm ²	XXXXXXXXXX	
7.4.13	Temperature gradient winding – oil °C (K)	XXXXXXXXXX	
7.4.14	Total conductor mass kg	XXXXXXXXXX	
7.5	Winding 3	TAP	

Item	Description	Schedule A	Schedule B
7.5.1	Type (i.e. multilayer helix)	XXXXXXXXXX	
7.5.2	Lead type (End Fed / Centre Fed)	XXXXXXXXXX	
7.5.3	Number of turns	XXXXXXXXXX	
7.5.4	Inner Diameter mm	XXXXXXXXXX	
7.5.5	Outer Diameter mm	XXXXXXXXXX	
7.5.6	Radial build mm	XXXXXXXXXX	
7.5.7	Magnetic height mm	XXXXXXXXXX	
7.5.8	Conductor configuration	XXXXXXXXXX	
7.5.9	- Size	XXXXXXXXXX	
7.5.10	- Number	XXXXXXXXXX	
7.5.11	Conductor insulation mm	XXXXXXXXXX	
7.5.12	Current density A/mm ²	XXXXXXXXXX	
7.5.13	Temperature gradient winding – oil °C (K)	XXXXXXXXXX	
7.5.14	Total conductor mass kg	XXXXXXXXXX	
8.	Inter-winding Insulation	XXXXXXXXXX	
8.1	CORE - LV winding	XXXXXXXXXX	
8.1.1	Number of barriers	XXXXXXXXXX	
8.1.2	Barrier thickness mm	XXXXXXXXXX	
8.1.3	Distance from windings mm	XXXXXXXXXX	
8.1.4	Distance between barriers mm	XXXXXXXXXX	
8.2	LV winding to HV winding	XXXXXXXXXX	
8.2.1	Number of barriers	XXXXXXXXXX	
8.2.2	Barrier thickness mm	XXXXXXXXXX	
8.2.3	Distance from windings mm	XXXXXXXXXX	
8.2.4	Distance between barriers mm	XXXXXXXXXX	
8.3	HV winding to TAP winding	XXXXXXXXXX	
8.3.1	Number of barriers	XXXXXXXXXX	
8.3.2	Barrier thickness mm	XXXXXXXXXX	
8.3.3	Distance from windings mm	XXXXXXXXXX	
8.3.4	Distance between barriers mm	XXXXXXXXXX	

5. SPEC 240-68973110

Schedule A: Purchasers specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

Table 4: Design Parameter Schedules and B for a YNd1 Power trfr

Item	Description	Schedule A	Schedule B
1	Transformer general information		
1.1	Manufacturer	xxxxxxxxxx	
1.2	Place of manufacture	xxxxxxxxxx	
2	Oil quantities:		
2.1	Transformer tank	xxxxxxxxxx	
2.2	Tap-changer	xxxxxxxxxx	
2.3	Radiators	xxxxxxxxxx	
2.4	Conservator (Main & tap-changer)	xxxxxxxxxx	
3	Masses		
3.1	Mass of core steel	kg xxxxxxxxxxxx	
3.2	Total dry insulation mass	kg xxxxxxxxxxxx	
3.3	Total mass of active part	kg xxxxxxxxxxxx	
3.4	Mass of tank and fittings	kg xxxxxxxxxxxx	
3.5	Mass of coolers (dry)	kg xxxxxxxxxxxx	
3.6	Mass of oil	kg xxxxxxxxxxxx	
3.7	Greatest transportation mass	kg xxxxxxxxxxxx	
4	Primary / Secondary zero sequence impedances	% xxxxxxxxxxxx	
4.1	On principal tapping		
4.2	On extreme plus tapping	% xxxxxxxxxxxx	
4.3	On extreme minus tapping	% xxxxxxxxxxxx	
5	Filling medium for transport	xxxxxxxxxx	
6.	Training of purchaser's staff		

POWER TRANSFORMERS

Item	Description	Schedule A	Schedule B
6.1	Training provided on components	Yes	
6.2	Details provided of how training is going to be conducted on purchaser's staff?	Yes	

SIGNED ON BEHALF OF TENDERER :

COMPANY NAME :

NAME IN BLOCK LETTERS :

DATE :

TSE20 – TECHNICAL SCHEDULE ELECTRICAL

**SPECIFICATION FOR COMBINED THREE-PHASED
NEUTRAL ELECTRO-MAGNETIC COUPLERS WITH
NEUTRAL EARTHING RESISTORS AND AUXILIARY
TRANSFORMERS
(NECRT'S)**

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TABLE OF FIGURES

NO TABLE OF FIGURES ENTRIES FOUND.

NEUTRAL ELECTRO-MAGNETIC COUPLERS WITH NEUTRAL EARTHING RESISTORS AND AUX TRFR (NECRT'S)

1. GENERAL

The general requirements for three phase neutral electro-magnetic couplers with neutral earthing resistors and auxiliary transformers (NECRT'S) are covered by Eskom specification 240-57648848. The detail project requirements shall be covered by the Project Specification, Drawings and Bill of Quantities.

2. TECHNICAL A & B SCHEDULE

11 kV/360 A: Neutral electromagnetic coupler with neutral earthing resistor and auxiliary transformer (NECRT)

Eskom standard number: 34-1690 (240-57648848) 2015/03-30

Schedule A: Purchaser's specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

Table 1: Technical Schedule

Item	Description	Schedule A	Schedule B
1	Identification		
	a) Supplier's name	xxxxxxxxxx	
	b) Manufacturer's name	xxxxxxxxxx	
	c) Type designation	xxxxxxxxxx	
2	Site conditions		
	a) Altitude m	1521	
	b) Maximum ambient temperature °C	45	
	c) Minimum ambient temperature °C	-10	
	d) Maximum diurnal variation °C	35	
	e) Seismic Shocks g	0.3	
	f) Relative humidity %	≤ 100	
	g) Life expectancy y	40	
3	Electrical conditions		
	a) Nominal system voltage (Um) kV	11	
	b) Maximum system voltage (Um) kV	12	
	c) Nominal frequency Hz	50	
4	Rated requirements		
	General		

NEUTRAL ELECTRO-MAGNETIC COUPLERS WITH
NEUTRAL EARTHNG RESISTORS AND AUX TRFR (NECRT'S)

Item	Description	Schedule A	Schedule B
	a) Nominal short time (10 s) current of NEC and NER (r.m.s.)A	360	
	b) Nominal continuous current of NEC and NER (r.m.s.)A	10	
	c) Zero sequence reactance (X_0) Ω/ph	23,7 to 28,4	
	d) Zero sequence resistance (R_0) at 100°C Ω/ph	47,3 to 56,8	
	e) Zero sequence impedance (Z_0) at 100°C Ω/ph	52,32 to 61,5	
	NEC		
	a) Zero sequence reactance (X_c) Ω	xxxxxxxxxx	
	b) Zero sequence resistance (R_c) at 100°C Ω	xxxxxxxxxx	
	c) No load loss of NEC at U_n kW	xxxxxxxxxx	
	d) Flux density of NEC core T	xxxxxxxxxx	
	e) Magnetization current (r.m.s.)A	xxxxxxxxxx	
	f) Current density at nominal short time current A/mm ²	xxxxxxxxxx	
	NER		
	a) Zero sequence reactance (X_r) Ω	xxxxxxxxxx	
	b) Zero sequence resistance (R_r) at 100 °C Ω	xxxxxxxxxx	
	c) Nominal voltage ($U_n/\sqrt{3}$) kV	6,35	
	d) Temperature coefficient at 100 °C $\Omega/^\circ\text{C}$	xxxxxxxxxx	
	e) Specific heat capacity kJ/kg °C	xxxxxxxxxx	
	f) Temperature range in which (d) and (e) apply °C	xxxxxxxxxx	
4.1	Auxiliary transformer		
	a) Nominal rating kVA	100	
	b) Primary nominal voltage kV	11	
	c) No load secondary voltage V	420	
	d) Vector group Dyn11 or Yzn11	xxxxxxxxxx	
	e) Flux density of aux core T	xxxxxxxxxx	
	f) Magnetizing current A	xxxxxxxxxx	
	g) Load loss kW	xxxxxxxxxx	
	h) No-load loss kW	xxxxxxxxxx	

NEUTRAL ELECTRO-MAGNETIC COUPLERS WITH
NEUTRAL EARTHING RESISTORS AND AUX TRFR (NECRT'S)

Item	Description		Schedule A	Schedule B
5	i) Percentage impedance	%	As SANS 780	
	Temperature rise (at site altitude)			
	Conditions:			
	I Passage of maximum continuous neutral	A	xxxxxxxxxx	
	II Passage of rated current of auxiliary transformer	A	xxxxxxxxxx	
	III Passage of nominal short time current for	A	xxxxxxxxxx	
	Top oil temperature for condition:			
	a) I	°C	xxxxxxxxxx	
	b) II	°C	xxxxxxxxxx	
	c) III	°C	xxxxxxxxxx	
	d) I and II	°C	xxxxxxxxxx	
	e) I and II and III	°C	xxxxxxxxxx	
	NEC winding temperature (calculated) for condition			
	a) I	°C	xxxxxxxxxx	
	b) II	°C	xxxxxxxxxx	
	c) III	°C	xxxxxxxxxx	
	d) I and II	°C	xxxxxxxxxx	
	e) I and II and III	°C	xxxxxxxxxx	
	Metallic NER temperature (measured) for condition:			
	a) I	°C	xxxxxxxxxx	
	b) II	°C	xxxxxxxxxx	
	c) III	°C	xxxxxxxxxx	
6	Material			
	a) NEC winding		xxxxxxxxxx	
	b) AUX HV winding		xxxxxxxxxx	
	c) AUX LV winding		xxxxxxxxxx	
	d) Grade of NER elements		xxxxxxxxxx	
7	Material thickness			

NEUTRAL ELECTRO-MAGNETIC COUPLERS WITH
NEUTRAL EARTHING RESISTORS AND AUX TRFR (NECRT'S)

Item	Description	Schedule A	Schedule B
	a) Tank top mm	xxxxxxxxxx	
	b) Tank bottom mm	xxxxxxxxxx	
	c) Tank sides mm	xxxxxxxxxx	
	d) Conservator mm	xxxxxxxxxx	
	e) Radiator tubes (if any) mm	xxxxxxxxxx	
8*	Housing and corrosion protection		
	a) Material - Inland	xxxxxxxxxx	
	- Coastal	xxxxxxxxxx	
	b) Corrosion protection - Inland	As SCSSCAAP9	
	- Coastal	As SCSSCAAP9	
	c) Tank colour	Admiralty Grey	
	d) Conservator colour	White	
9*	HV Bushings		
	a) Profile characteristics - Inland	As IEC 60815	
	- Coastal	As IEC 60815	
	b) Minimum creepage - Inland mm/kV	25	
	- Coastal mm/kV	31	
	c) Material - Inland	xxxxxxxxxx	
	- Coastal	xxxxxxxxxx	
	d) Manufacturer and type - Inland	xxxxxxxxxx	
	- Coastal	xxxxxxxxxx	
10	Current transformers		
	REF and differential		
	a) Manufacturer	xxxxxxxxxx	
	b) Ratio	2400/1	
	c) Accuracy class (on 600/1 ratio)	TPS	
	d) Max excitation current at 300 V mA	100	
	e) Max internal resistance on 600/1 ratio Ω	2,4	

NEUTRAL ELECTRO-MAGNETIC COUPLERS WITH
NEUTRAL EARTHNG RESISTORS AND AUX TRFR (NECRT'S)

Item	Description	Schedule A	Schedule B
	f) Secondary voltage/turn V/turn	0,5	
	g) Secondary internal resistance/turn mΩ/turn	4	
	h) Location: (earthed end of NER nearer to earthed terminal)	xxxxxxxxxx	
	i) Reference number of mag. curve	xxxxxxxxxx	
	IDMTEF		
	a) Manufacturer	xxxxxxxxxx	
	b) Ratio	100/1	
	c) Accuracy class	10P10	
	d) Location: (earthed end of NER near resistor)	xxxxxxxxxx	
	e) Reference number of mag. curve	xxxxxxxxxx	
11	NER elements		
	a) Manufacturer	xxxxxxxxxx	
	b) Type designation	xxxxxxxxxx	
	c) Number of elements	xxxxxxxxxx	
12	Buchholz relay		
	a) Manufacturer	xxxxxxxxxx	
	b) Type designation	xxxxxxxxxx	
	c) Minimum size mm	50	
13	Dial type thermometer	xxxxxxxxxx	
	a) Manufacturer		
	b) Type designation	xxxxxxxxxx	
14	Overall dimensions		
	a) Height mm	xxxxxxxxxx	
	b) Length mm	xxxxxxxxxx	
	c) Width mm	xxxxxxxxxx	
	Mass		
15	a) NEC core and winding kg	xxxxxxxxxx	
	b) NER kg	xxxxxxxxxx	

**NEUTRAL ELECTRO-MAGNETIC COUPLERS WITH
NEUTRAL EARTHNG RESISTORS AND AUX TRFR (NECRT'S)**

Item	Description	Schedule A	Schedule B
	c) AUX core and winding kg	xxxxxxxxxx	
	d) Tank and fittings kg	xxxxxxxxxx	
	e) Oil kg	xxxxxxxxxx	
	f) Total kg	xxxxxxxxxx	
16	Documentation Provide reference number for:		
	a) Outline drawings	xxxxxxxxxx	
	b) Rating and diagram plate	xxxxxxxxxx	
	c) Internal general assembly drawing	xxxxxxxxxx	
	d) AUX transformer wiring diagram	xxxxxxxxxx	
17	Type and special test Provide test report for:		
	a) Power-frequency voltage withstand test.	xxxxxxxxxx	
	b) Impulse test.	xxxxxxxxxx	
	c) Separate source voltage withstand test.	xxxxxxxxxx	
	d) Induced over voltage test.	xxxxxxxxxx	
	e) Measurement of zero sequence	xxxxxxxxxx	
	f) Temperature rise test.	xxxxxxxxxx	
	g) Short-circuit test on AUX	xxxxxxxxxx	
	h) Short-time current test on NEC/NER	xxxxxxxxxx	
	i) Vacuum test	xxxxxxxxxx	
	j) Accelerated ageing test for composite bushings.	xxxxxxxxxx	

NOTE:

*The schedule makes provision for both coastal/high-corrosive environments and inland/low-corrosive applications.

*Insulation shall be based on coastal/high-corrosive environments, even if installed inland.

NEUTRAL ELECTRO-MAGNETIC COUPLERS WITH
NEUTRAL EARTHING RESISTORS AND AUX TRFR (NECRT'S)

3. TECHNICAL A & B DEVIATION SCHEDULE

Table 2: Deviations Schedule

Any deviations offered to this specification shall be listed below with reasons for deviation. In addition, evidence shall be provided that the proposed deviation will at least be more cost effective than the specification.		
Item	Sub-clause	Proposed deviation

Show formulae according to which the zero-sequence inductance and resistance will be designed to limit the fault to 300 A.

SIGNED ON BEHALF OF TENDERER :

COMPANY NAME :

NAME IN BLOCK LETTERS :

DATE :

TSE48 – TECHNICAL SCHEDULE ELECTRICAL

OPTICAL GROUND WIRE (OPGW)

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TABLE OF FIGURES

NO TABLE OF FIGURES ENTRIES FOUND.

1. GENERAL

The general requirements for Optical Ground Wire (OPGW) are covered by NRS 061 and NRS 081. The detail project requirements shall be covered in the Project Specification, Drawings and Bill of Quantities.

2. TECHNICAL A & B SCHEDULE

Schedule A: Purchaser's specific requirements

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

Table 1: NRS 061-1 - Technical Schedule

Item	Clause	Description		Schedule A	Schedule B
1	4.1.4	Grease conductor in accordance with SANS 61089?	Yes/No	Ungreased	xxxxxxxxxx
	4.1.5 a)	Pollution level, if other than heavy		Heavy	xxxxxxxxxx
	4.1.5 b)	Maximum temperature, if other than 50 °C	°C	50 °C	xxxxxxxxxx
	4.1.5 c)	Minimum temperature, if other than –10 °C	°C	-10 °C	xxxxxxxxxx
	4.1.5 d)	Maximum wind speed, if other than 36 m/s	m/s	36	xxxxxxxxxx
	4.1.5 e)	Route altitude, if other than 2 000 m	m	< 2000	xxxxxxxxxx
	4.1.6 a)	Name of manufacturer		xxxxxxxxxx	
	4.1.6 b)	Place of manufacture		xxxxxxxxxx	
	4.1.6 c)	Manufacturer's reference number		xxxxxxxxxx	
2	4.2.1.1	Type of fibre in accordance with NRS 081 (G.652D)	Yes/No	xxxxxxxxxx	
		If no, state fibre type		xxxxxxxxxx	
	4.2.2.1	OPGW 1 s current rating	kA	18.68	
	4.2.2.2	Stranding and wire diameter		xxxxxxxxxx	
3	4.3.1.1	Number of fibres		48	xxxxxxxxxx
	4.3.2.1	Conductor material		xxxxxxxxxx	
	4.3.2.1	Nominal cross-section		xxxxxxxxxx	
	4.3.2.1	Actual cross-sectional area		xxxxxxxxxx	
	4.3.2.1	Maximum overall diameter		xxxxxxxxxx	
	4.3.2.1	Maximum mass per metre of cable	kg/m	xxxxxxxxxx	
	4.3.2.1	Rated tensile strength (RTS)		xxxxxxxxxx	
	4.3.2.1	Initial modulus of elasticity		xxxxxxxxxx	
	4.3.2.1	Final modulus of elasticity		xxxxxxxxxx	
	4.3.2.1	Maximum drum length		xxxxxxxxxx	
	4.3.2.1	Direction of lay of outer layer		xxxxxxxxxx	
	4.3.2.1	Diameter of outer strands		xxxxxxxxxx	

Item	Clause	Description		Schedule A	Schedule B
	4.3.2.1	Short-circuit 1 s current rating		xxxxxxxxxxx	
	4.3.2.1	DC resistance at 20 °C/km		xxxxxxxxxxx	
	4.3.2.1	Continuous current-carrying capability	A	xxxxxxxxxxx	
	4.3.2.2	Complete details of cable construction, including measures to minimize hydrogen absorption and water ingress.		xxxxxxxxxxx	
4	4.4.1	Is a sample required?	Yes/No	Yes	xxxxxxxxxxx
	4.4.3	Length of sample, if not 1 m		1 m	xxxxxxxxxxx
5	5.1.3.2	Specify class of cable 0, 1, 2 or 3		Class 2	xxxxxxxxxxx
6	6.2.1	Maximum drum length of OPGW		xxxxxxxxxxx	
		Mass of drum including max. length of OPGW cable		xxxxxxxxxxx	
7	6.3	Is documentation required?	Yes/No	Yes	

Table 2: NRS 081 - Technical Schedule

Item	Clause	Description	Schedule A	Schedule B
1	4.1	Grease conductor in accordance with SANS 61089?	Comply	
2	4.2	Pollution level, if other than heavy	Comply	
3	4.3	Maximum temperature, if other than 50 °C	Comply	
4	4.3.12	Minimum temperature, if other than –10 °C	≤ 0,35 dB/km at 1 310 nm	xxxxxxxxxxxxx
5	4.3.12	Maximum wind speed, if other than 36 m/s	≤ 0,35 dB/km at 1 383 nm	xxxxxxxxxxxxx
6	4.3.12	Route altitude, if other than 2 000 m	≤ 0,22 dB/km at 1 550 nm	xxxxxxxxxxxxx
7	4.3.16	Name of manufacturer	≤ 0,2 ps/√km	
8	7	Place of manufacture	xxxxxxxxxxxxx	
9	7	Manufacturer's reference number	xxxxxxxxxxxxx	
10	7	Type of fibre in accordance with NRS 081 (G.652D)	xxxxxxxxxxxxx	

3. TECHNICAL A & B DEVIATION SCHEDULE**Table 3: Deviations schedule**

Any deviations offered to this specification shall be listed below with reasons for deviation. In addition, evidence shall be provided that the proposed deviation will at least be more cost effective than the specification.		
Item	Sub-clause	Proposed deviation

SIGNED ON BEHALF OF TENDERER :

COMPANY NAME :

NAME IN BLOCK LETTERS :

DATE :

TSE56 – TECHNICAL SCHEDULE ELECTRICAL

SURGE ARRESTERS

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NO TABLE OF FIGURES ENTRIES FOUND.

1. GENERAL

The general requirements for station class surge arresters are covered by Eskom specification DSP_34-419. The detail project requirements shall be covered by the Project Specification, Drawings and Bill of Quantities.

2. TECHNICAL A & B SCHEDULE – 11 kV SURGE ARRESTER

Schedule A: Purchaser's specific requirements

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

Table 1: Technical Schedule – 11 kV Surge Arrester

Sub clause of 34-419	Description		Schedule A	Schedule B
	1. SURGE ARRESTER IDENTIFICATION			
	a) Supplier		xxxxxxxxxx	
	b) Manufacturer		xxxxxxxxxx	
	c) MOV block manufacturer		xxxxxxxxxx	
	d) Product code: Item 3 (Coastal)		xxxxxxxxxx	
	• Item 4 (Inland)		xxxxxxxxxx	
4.1	2. OPERATING CONDITIONS			
	a) Altitude	m	up to 1800	xxxxxxxxxx
	b) Average humidity	%	30 to 90	xxxxxxxxxx
	c) Minimum ambient temperature	°C	-10	xxxxxxxxxx
	• Maximum ambient temperature	°C	40	xxxxxxxxxx
	• Maximum diurnal variation	°C	30	xxxxxxxxxx
	d) Intensity of solar radiation	kW/m ²	1,1	xxxxxxxxxx
	e) IEC pollution level: Item 3 (Coastal)		HVH	xxxxxxxxxx
	• Item 4 (Inland)		LM	xxxxxxxxxx
	f) Lightning activity		High	xxxxxxxxxx
	g) System earthing		Non-effective	xxxxxxxxxx
	h) System configuration		3-phase, 3-wire	xxxxxxxxxx
	i) Nominal system voltage (Un)	kV	11	xxxxxxxxxx

Sub clause of 34-419	Description	Schedule A	Schedule B
	j) Maximum system voltage (Um) kV	12	xxxxxxxxxx
	k) Supply frequency Hz	50	xxxxxxxxxx
	l) BIL of equipment to be protected kV peak	95	xxxxxxxxxx
4.3	3. ELECTRICAL CHARACTERISTICS OF ARRESTER		
	a) Arrester classification	Station class	
	b) IEC line discharge class	2	
	c) Nominal lightning discharge current (8/20μs) kA	10	
	d) Minimum energy absorption capability for a single high current impulse, 100kA 4/10μs in per unit of MCOV kJ/kV	3,4	
	e) Arrester rated voltage (Ur) kV	xxxxxxxxxx	
	f) MCOV (Uc) kV	12	
	g) Maximum residual voltage (Ures) at 10kA (8/20μs) kV	45	
4.4	4. ARRESTER HOUSING		
	a) Housing material		
	• Item 3 (Coastal)	xxxxxxxxxx	
	• Item 4 (Inland)	xxxxxxxxxx	
	b) Minimum external creepage distance:		
	• Item 3 (Coastal) [Um x 31 mm/kV] mm	372	
	• Item 4 (Inland) [Um x 20 mm/kV] mm	240	
4.4.3	5. ARRESTER HOUSING PROFILE DESIGN		
	IEC 60815 annex D parameters:		
	a) c	≥ 20	
	b) s/p	≥ 0,65	
	c) Ld/d	≤ 5	
	d) P1 – P2	≥ 15	
	e) CF	≤ 3,5	

Sub clause of 34-419	Description	Schedule A	Schedule B
	f) PF	$\geq 0,7$	
4.5	6. ARRESTER MOUNTING DETAILS		
	a) Orientation	Vertical	xxxxxxxxxx
	b) Method of mounting	Base	xxxxxxxxxx
	c) Reference number of drawing showing mounting details	xxxxxxxxxx	
4.6.1	7. ARRESTER LINE TERMINAL		
	a) Type	Threaded	
	b) Diameter	M12	
	c) Minimum length mm	50	
	d) Orientation	Vertical	
	e) Supplied with: M12 nut, two flat washers and spring washer	Yes	
	f) Material	xxxxxxxxxx	
	g) Reference number of drawing showing details of line terminal	xxxxxxxxxx	
4.6.2	8. ARRESTER EARTH TERMINAL		
	a) Type	Threaded	
	b) Diameter	M12	
	c) Minimum length mm	50	
	d) Orientation	Vertical	
	e) Supplied with nut, two flat washers and spring washer	Yes	
	f) Material	xxxxxxxxxx	
	g) Reference number of drawing showing details of line terminal	xxxxxxxxxx	
4.7.1	9. DRAWINGS TO BE SUBMITTED WITH TENDER		
	Single copies of drawings shall be submitted as part of the original tender showing the following detail:		
	a) Outline dimensions of arrester, fit as for service	Reference number	
	b) Mounting details	Reference number	

Sub clause of 34-419	Description	Schedule A	Schedule B
	c) Line and earth terminal, conductor clamping arrangement	Reference number	
	d) Details of grading rings	Reference number	
4.7.2	10. ARRESTER CHARACTERISTIC DATA REQUIRED		
	a) V-I characteristic curve, AC	Reference Number:	
	b) V-I characteristic curve, DC	Reference Number:	
	c) Temporary overvoltage withstands capability curve in per unit of MCOV, with and with-out prior duty.	Reference Number:	
	11. ARRESTER TEMPORARY OVERVOLTAGE CAPABILITY, WITH PRIOR DUTY. (prior duty as defined in annex D, IEC 60099-4)		
	a) Overvoltage applied for 1 s pu of MCOV	xxxxxxxxx	
	b) Overvoltage applied for 5 s pu of MCOV	xxxxxxxxx	
	c) Overvoltage applied for 10 s pu of MCOV	xxxxxxxxx	
	12. PHYSICAL DIMENSIONS OF ARRESTERS		
	d) Overall height of arrester mm	xxxxxxxxx	
	e) Minimum external flashover distance mm	200	
	f) External diameter of arrester housing mm	xxxxxxxxx	
	g) Diameter of voltage grading rings mm	xxxxxxxxx	
	h) Distance of grading ring from top of arrester mm	xxxxxxxxx	
	13. MOV ELEMENTS		
	a) Diameter of elements mm	xxxxxxxxx	
	b) Thickness of elements mm	xxxxxxxxx	
	c) Number of elements per arrester	xxxxxxxxx	
4.2.2	d) Number of stacks in parallel	0	
	14. MISCELLANEOUS		
4.2.1	a) Live spray washing (Yes/No)	No	xxxxxxxxx
	b) Total mass of assembled unit kg	xxxxxxxxx	

Sub clause of 34-419	Description		Schedule A	Schedule B
	c) Minimum expected life of arrester at 40 °C and MCOV	yrs	25	
4.2.7	d) Sample available for inspection		Yes	
5.2.10	e) Declared specified long-term load	kN	xxxxxxxxxx	
5.2.1	15. INSULATION WITHSTAND TEST			
	a) Reference number of test report		xxxxxxxxxx	
	b) Lightning impulse (1,2/50µs) withstand level [(1,3/0,82) × Ures]	kV	71	
	c) 60 s wet power frequency withstand	r.m.s kV	28	
5.2.2	16. RESIDUAL VOLTAGE TEST			
	a) Reference number of test report		xxxxxxxxxx	
	b) Maximum residual voltage for a 10 kA steep current impulse (1/20µs)	kV	49	
	c) Maximum residual voltage for a lightning current impulse (8/20µs) of magnitude:			
	• 5 kA	kV	xxxxxxxxxx	
	• 10 kA	kV	45	
	• 20 kA	kV	xxxxxxxxxx	
	d) Maximum residual voltage for a 500 A switching current impulse	kV	xxxxxxxxxx	
5.2.3	17. LONG DURATION CURRENT IMPULSE WITHSTAND TEST			
	a) Reference number of test report		xxxxxxxxxx	
	b) Charging voltage	pu of U_r	3,2	
	or			
	• charging current	A	xxxxxxxxxx	
	c) Virtual duration of peak	µs	2000	
	d) Number of discharge operations		18	
	e) Number of grouped operations		6	
	f) Operations per group		3	
	g) Maximum interval between operations	s	60	

Sub clause of 34-419	Description		Schedule A	Schedule B
	h) Interval between groups		Cool to ambient	
	i) Maximum permitted change in residual voltage after long duration current impulse withstand test	%	5	
5.2.4	18. OPERATING DUTY TESTS			
	a) Reference number of test report		xxxxxxxxxx	
	Conditioning part 1:			
	b) 10 kA current impulse (8/20 μ s), energized at 1,2 x MCOV	kV	14.5	
	c) Number of discharge operations		20	
	d) Number of grouped operations		4	
	e) Operations per group		5	
	f) Interval between operations	s	60	
	g) Intervals between groups	min	30	
	Conditioning part 2:			
	h) High current impulse (4/10 μ s)	kA	100	
	i) Number of applications		2	
	Conditions for switching surge test:			
	j) Charging voltage	pu of U_r	3.2	
	or			
	• charging current	A	xxxxxxxxxx	
	k) Virtual duration of peak	μ s	2000	
	l) Number of discharge operations		2	
	m) Interval between operations	s	60	
	n) Starting temperature for first impulse	°C	60	
	o) Energy dissipated during second impulse	kJ	xxxxxxxxxx	
	Conditions for power frequency test at elevated levels as in IEC 60099-4, 7.5.2:			
	p) Interval between last long duration current impulse and power frequency test	ms	100	

Sub clause of 34-419	Description		Schedule A	Schedule B
	q) Elevated rated voltage (U_r^*) applied for 10 s	kV	xxxxxxxxxx	
	r) Elevated continuous operating voltage (U_c^*) applied for 30 min	kV	xxxxxxxxxx	
	s) Maximum permitted change in residual voltage after long duration current impulse withstand test	%	5	
5.2.5	19. POWER FREQUENCY VOLTAGE VERSUS TIME CHARACTERISTIC			
	a) Reference number of test report		xxxxxxxxxx	
5.2.6	20. SHORT-CIRCUIT TEST			
	a) Reference number of test report		xxxxxxxxxx	
	b) High current	kA r.m.s.	40	
	c) Low current	kA r.m.s.	0,6 ± 0,2	
5.2.7	21. NATURAL AGEING AND POLLUTION PERFORMANCE TEST			
	a) Reference number of test report		xxxxxxxxxx	
5.2.8	22. INTERNAL PARTIAL DISCHARGE TEST			
	a) Reference number of test report		xxxxxxxxxx	
	b) Power frequency voltage applied [1,05 x MCOV]	kV	7,6	
	c) Maximum partial discharge	pC	10	
5.2.9	23. MOISTURE INGRESS TEST			
	a) Reference number of test report		xxxxxxxxxx	
5.2.10	24. BENDING MOMENT TEST			
	a) Reference number of test report		xxxxxxxxxx	

3. TECHNICAL A & B DEVIATION SCHEDULE – 11 kV SURGE ARRESTER**Table 2: Deviation Schedule – 11 kV Surge Arrester**

Any deviations offered to this specification shall be listed below with reasons for deviation. In addition, evidence shall be provided that the proposed deviation will at least be more cost effective than the specification.

Item	Sub-clause	Proposed deviation

SIGNED ON BEHALF OF TENDERER :

COMPANY NAME :

NAME IN BLOCK LETTERS :

DATE :

4. TECHNICAL A & B SCHEDULE – 66 kV SURGE ARRESTERS

Schedule A: Purchaser's specific requirements

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

Table 3: Technical Schedule - 66 kV Surge Arrester

Sub clause of 34-419	Description		Schedule A	Schedule B
	1. SURGE ARRESTER IDENTIFICATION			
	a) Supplier		xxxxxxxxxx	
	b) Manufacturer		xxxxxxxxxx	
	c) MOV block manufacturer		xxxxxxxxxx	
	d) Product code: Item 9 (Coastal)		xxxxxxxxxx	
	• Item 10 (Inland)		xxxxxxxxxx	
4.1	2. OPERATING CONDITIONS			
	a) Altitude	m	up to 1800	xxxxxxxxxx
	b) Average humidity	%	30 to 90	xxxxxxxxxx
	c) Minimum ambient temperature	°C	–10	xxxxxxxxxx
	• Maximum ambient temperature	°C	40	xxxxxxxxxx
	• Maximum diurnal variation	°C	30	xxxxxxxxxx
	d) Intensity of solar radiation	kW/m ²	1,1	xxxxxxxxxx
	e) IEC pollution level: Item 9 (Coastal)		HVH	xxxxxxxxxx
	• Item 10 (Inland)		LM	xxxxxxxxxx
	f) Lightning activity		High	xxxxxxxxxx
	g) System earthing		Effective	xxxxxxxxxx
	h) System configuration		3-phase, 3-wire	xxxxxxxxxx
	i) Nominal system voltage (Un)	kV	66	xxxxxxxxxx
	j) Maximum system voltage (Um)	kV	73	xxxxxxxxxx
	k) Supply frequency	Hz	50	xxxxxxxxxx

Sub clause of 34-419	Description	Schedule A	Schedule B
4.3	3. ELECTRICAL CHARACTERISTICS OF ARRESTER		
	a) Arrester classification	Station class	
	b) IEC line discharge class	2	
	c) Nominal lightning discharge current (8/20 μ s) kA	10	
	d) Minimum energy absorption capability for a single high current impulse, 100kA 4/10 μ s in per unit of MCOV kJ/kV	3,4	
	e) Arrester rated voltage (Ur) kV	xxxxxxxxxx	
	f) MCOV (Uc) kV	48	
	g) Maximum residual voltage (Ures) at 10kA (8/20 μ s) kV	165	
4.4	4. ARRESTER HOUSING		
	a) Housing material		
	• Item 9 (Coastal)	xxxxxxxxxx	
	• Item 10 (Inland)	xxxxxxx	
	b) Minimum external creepage distance:		
	• Item 9 (Coastal) [Um x 31 mm/kV] mm	2263	
	• Item 10 (Inland) [Um x 20 mm/kV] mm	1460	
4.4.3	5. ARRESTER HOUSING PROFILE DESIGN		
	IEC 60815 annex D parameters:		
	a) c	≥ 20	
	b) s/p	$\geq 0,65$	
	c) Ld/d	≤ 5	
	d) P1 – P2	≥ 15	
	e) CF	$\leq 3,5$	
	f) PF	$\geq 0,7$	
4.5	6. ARRESTER MOUNTING DETAILS		
	a) Orientation	Vertical	xxxxxxxxxx

Sub clause of 34-419	Description	Schedule A	Schedule B
	b) Method of mounting	Tripod base	xxxxxxxxxx
	c) Diameter of mounting holes in base mm	xxxxxxxxxx	
	d) PCD (see Figure 1 of SCSSCAA00) mm	110 - 255	
	e) Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers.	Yes	
	f) Reference number of drawing showing mounting details	xxxxxxxxxx	
4.6.1	7. ARRESTER LINE TERMINAL		
	a) Type	Stem	
	b) Diameter	26	
	c) Minimum length mm	100	
	d) Orientation	Vertical	
	e) Material	xxxxxxxxxx	
	f) Reference number of drawing showing details of line terminal	xxxxxxxxxx	
4.6.2	8. ARRESTER EARTH TERMINAL		
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		
	a) Conductor material	Copper	
	b) Conductor type	Strap	
	c) Conductor dimensions mm	50 x 3	
	d) Material used for clamping arrangement	xxxxxxxxxx	
	e) If dissimilar metals are used for clamping arrangement, state types	xxxxxxxxxx	
	f) Reference number of drawing showing details of earth terminal	xxxxxxxxxx	
4.7.1	9. DRAWINGS TO BE SUBMITTED WITH TENDER		
	Single copies of drawings shall be submitted as part of the original tender showing the following detail:		
	a) Outline dimensions of arrester, fit as for service	Reference number	
	b) Mounting details	Reference number	
	c) Line and earth terminal, conductor clamping arrangement	Reference number	

Sub clause of 34-419	Description	Schedule A	Schedule B
	d) Details of grading rings	Reference number	
4.7.2	10. ARRESTER CHARACTERISTIC DATA REQUIRED		
	a) V-I characteristic curve, AC	Reference Number:	
	b) V-I characteristic curve, DC	Reference Number:	
	c) Temporary overvoltage withstands capability curve in per unit of MCOV, with and with-out prior duty.	Reference Number:	
	11. ARRESTER TEMPORARY OVERVOLTAGE CAPABILITY, WITH PRIOR DUTY. (prior duty as defined in annex D, IEC 60099-4)		
	a) Overvoltage applied for 1 s pu of MCOV	xxxxxxxxx	
	b) Overvoltage applied for 5 s pu of MCOV	xxxxxxxxx	
	c) Overvoltage applied for 10 s pu of MCOV	xxxxxxxxx	
	12. PHYSICAL DIMENSIONS OF ARRESTERS		
	a) Overall height of arrester mm	xxxxxxxxx	
	b) Minimum external flashover distance mm	450	
	c) External diameter of arrester housing mm	xxxxxxxxx	
	d) Diameter of voltage grading rings mm	xxxxxxxxx	
	e) Distance of grading ring from top of arrester mm	xxxxxxxxx	
	13. MOV ELEMENTS		
	a) Diameter of elements mm	xxxxxxxxx	
	b) Thickness of elements mm	xxxxxxxxx	
	c) Number of elements per arrester	xxxxxxxxx	
4.2.2	d) Number of stacks in parallel	0	
	14. MISCELLANEOUS		
4.2.1	a) Live spray washing (Yes/No)	No	xxxxxxxxxxx
	b) Total mass of assembled unit kg	xxxxxxxxxxx	
	c) Minimum expected life of arrester at 40 °C and MCOV yrs	25	

Sub clause of 34-419	Description	Schedule A	Schedule B
4.2.7	d) Sample available for inspection	Yes	
5.2.10	e) Declared specified long-term load kN	xxxxxxxxxx	
5.2.1	15. INSULATION WITHSTAND TEST		
	a) Reference number of test report	xxxxxxxxxx	
	b) Lightning impulse (1,2/50µs) withstand level $[(1,3/0,82) \times U_{res}]$ kV	262	
	c) 60 s wet power frequency withstand r.m.s kV	90	
5.2.2	16. RESIDUAL VOLTAGE TEST		
	a) Reference number of test report	xxxxxxxxxx	
	b) Maximum residual voltage for a 10 kA steep current impulse (1/20µs) kV	183	
	c) Maximum residual voltage for a lightning current impulse (8/20µs) of magnitude:		
	• 5 kA kV	xxxxxxxxxx	
	• 10 kA kV	165	
	• 20 kA kV	xxxxxxxxxx	
	d) Maximum residual voltage for a 500 A switching current impulse kV	xxxxxxxxxx	
5.2.3	17. LONG DURATION CURRENT IMPULSE WITHSTAND TEST		
	a) Reference number of test report	xxxxxxxxxx	
	b) Charging voltage pu of U_r	3,2	
	or		
	• charging current A	xxxxxxxxxx	
	c) Virtual duration of peak µs	2000	
	d) Number of discharge operations	18	
	e) Number of grouped operations	6	
	f) Operations per group	3	
	g) Maximum interval between operations s	60	

Sub clause of 34-419	Description		Schedule A	Schedule B
	h) Interval between groups		Cool to ambient	
	i) Maximum permitted change in residual voltage after long duration current impulse withstand test	%	5	
5.2.4	18. OPERATING DUTY TEST			
	a) Reference number of test report		xxxxxxxxxx	
	Conditioning part 1:			
	b) 10 kA current impulse (8/20 μ s), energized at 1,2 x MCOV	kV	58	
	c) Number of discharge operations		20	
	d) Number of grouped operations		4	
	e) Operations per group		5	
	f) Interval between operations	s	60	
	g) Intervals between groups	min	30	
	Conditioning part 2:			
	h) High current impulse (4/10 μ s)	kA	100	
	i) Number of applications		2	
	Conditions for switching surge test:			
	j) Charging voltage	pu of U_r	3.2	
	or			
	• charging current	A	xxxxxxxxxx	
	k) Virtual duration of peak	μ s	2000	
	l) Number of discharge operations		2	
	m) Interval between operations	s	60	
	n) Starting temperature for first impulse	°C	60	
	o) Energy dissipated during second impulse	kJ	xxxxxxxxxx	
	Conditions for power frequency test at elevated levels as in IEC 60099-4, 7.5.2:			
	p) Interval between last long duration current impulse and power	ms	100	

Sub clause of 34-419	Description		Schedule A	Schedule B
	frequency test			
	q) Elevated rated voltage (Ur*) applied for 10 s	kV	xxxxxxxxxx	
	r) Elevated continuous operating voltage (Uc*) applied for 30 min	kV	xxxxxxxxxx	
	s) Maximum permitted change in residual voltage after long duration current impulse withstand test	%	5	
5.2.5	19. POWER FREQUENCY VOLTAGE VERSUS TIME CHARACTERISTIC			
	a) Reference number of test report		xxxxxxxxxx	
5.2.6	20. SHORT-CIRCUIT TEST			
	a) Reference number of test report		xxxxxxxxxx	
	b) High current	kA r.m.s.	40	
	c) Low current	kA r.m.s.	0,6 ± 0,2	
5.2.7	21. NATURAL AGEING AND POLLUTION PERFORMANCE TEST			
	a) Reference number of test report		xxxxxxxxxx	
5.2.8	22. INTERNAL PARTIAL DISCHARGE TEST			
	a) Reference number of test report		xxxxxxxxxx	
	b) Power frequency voltage applied [1,05 x MCOV]	kV	50.5	
	c) Maximum partial discharge	pC	10	
5.2.9	23. MOISTURE INGRESS TEST			
	a) Reference number of test report		xxxxxxxxxx	
5.2.10	24. BENDING MOMENT TEST			
	a) Reference number of test report		xxxxxxxxxx	

5. TECHNICAL A & B DEVIATION SCHEDULE – 66 kV SURGE ARRESTER**Table 4: Deviation Schedule - 66 kV Surge Arrester**

Any deviations offered to this specification shall be listed below with reasons for deviation. In addition, evidence shall be provided that the proposed deviation will at least be more cost effective than the specification.		
Item	Sub-clause	Proposed deviation

SIGNED ON BEHALF OF TENDERER :

COMPANY NAME :

NAME IN BLOCK LETTERS :

DATE :

6. TECHNICAL A & B SCHEDULE – 132 kV SURGE ARRESTER

Schedule A: Purchaser's specific requirements

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

Table 5: Technical Schedule – 132 kV Surge Arresters

Sub clause of 34-419	Description	Schedule A	Schedule B
	1. SURGE ARRESTER IDENTIFICATION		
	a) Supplier	xxxxxxxxxx	
	b) Manufacturer	xxxxxxxxxx	
	c) MOV block manufacturer	xxxxxxxxxx	
	d) Product code: Item 11(Coastal)	xxxxxxxxxx	
	• Item 12 (Inland)	xxxxxxxxxx	
4.1	2. OPERATING CONDITIONS		
	a) Altitude m	up to 1800	xxxxxxxxxx
	b) Average humidity %	30 to 90	xxxxxxxxxx
	c) Minimum ambient temperature °C	-10	xxxxxxxxxx
	• Maximum ambient temperature °C	40	xxxxxxxxxx
	• Maximum diurnal variation °C	30	xxxxxxxxxx
	d) Intensity of solar radiation kW/m ²	1,1	xxxxxxxxxx
	e) IEC pollution level: Item 11 (Coastal)	HVH	xxxxxxxxxx
	• Item 12 (Inland)	LM	xxxxxxxxxx
	f) Lightning activity	High	xxxxxxxxxx
	g) System earthing	Effective	xxxxxxxxxx
	h) System configuration	3-phase, 3-wire	xxxxxxxxxx
	i) Nominal system voltage (Un) kV	132	xxxxxxxxxx
	j) Maximum system voltage (Um) kV	145	xxxxxxxxxx
	k) Supply frequency Hz	50	xxxxxxxxxx
	l) BIL of equipment to be protected kV peak	550	xxxxxxxxxx

Sub clause of 34-419	Description	Schedule A	Schedule B
4.3	3. ELECTRICAL CHARACTERISTICS OF ARRESTER		
	a) Arrester classification	Station class	
	b) IEC line discharge class	2	
	c) Nominal lightning discharge current (8/20 μ s) kA	10	
	d) Minimum energy absorption capability for a single high current impulse, 100kA 4/10 μ s in per unit of MCOV kJ/kV	3,4	
	e) Arrester rated voltage (Ur) kV	xxxxxxxxxx	
	f) MCOV (Uc) kV	84	
	g) Maximum residual voltage (Ures) at 10kA (8/20 μ s) kV	300	
4.4	4. ARRESTER HOUSING		
	a) Housing material Item 11 (Coastal)	xxxxxxxxxx	
	• Item 12 (Inland)	xxxxxxxxxx	
	b) Minimum external creepage distance:		
	• Item 11 (Coastal) [Um x 31 mm/kV] mm	4495	
	• Item 12 (Inland) [Um x 20 mm/kV] mm	2900	
4.4.3	5. ARRESTER HOUSING PROFILE DESIGN		
	IEC 60815 annex D parameters:		
	a) c	≥ 20	
	b) s/p	$\geq 0,65$	
	c) Ld/d	≤ 5	
	d) P1 – P2	≥ 15	
	e) CF	$\leq 3,5$	
	f) PF	$\geq 0,7$	
4.5	6. ARRESTER MOUNTING DETAILS		
	a) Orientation	Vertical	xxxxxxxxxx
	b) Method of mounting	Tripod base	xxxxxxxxxx

Sub clause of 34-419	Description	Schedule A	Schedule B
	c) Diameter of mounting holes in base mm	xxxxxxxxxx	
	d) PCD (see Figure 1 of SCSSCAA00) mm	110 - 255	
	e) Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers.	Yes	
	f) Reference number of drawing showing mounting details	xxxxxxxxxx	
4.6.1	7. ARRESTER LINE TERMINAL		
	g) Type	Stem	
	h) Diameter	26	
	i) Minimum length mm	100	
	j) Orientation	Vertical	
	k) Material	xxxxxxxxxx	
	l) Reference number of drawing showing details of line terminal	xxxxxxxxxx	
4.6.2	8. ARRESTER EARTH TERMINAL		
	Earth terminal to be provided with clamping arrangement suitable for clamping of the following conductor:		
	a) Conductor material	Copper	
	b) Conductor type	Strap	
	c) Conductor dimensions mm	50 x 3	
	d) Material used for clamping arrangement	xxxxxxxxxx	
	e) If dissimilar metals are used for clamping arrangement, state types	xxxxxxxxxx	
	f) Reference number of drawing showing details of earth terminal	xxxxxxxxxx	
4.7.1	9. DRAWINGS TO BE SUBMITTED WITH TENDER		
	Single copies of drawings shall be submitted as part of the original tender showing the following detail:		
	a) Outline dimensions of arrester, fit as for service	Reference number	
	b) Mounting details	Reference number	
	c) Line and earth terminal, conductor clamping arrangement	Reference number	

Sub clause of 34-419	Description	Schedule A	Schedule B
	d) Details of grading rings	Reference number	
4.7.2	10. ARRESTER CHARACTERISTIC DATA REQUIRED		
	a) V-I characteristic curve, AC	Reference Number:	
	b) V-I characteristic curve, DC	Reference Number:	
	c) Temporary overvoltage withstands capability curve in per unit of MCOV, with and with-out prior duty.	Reference Number:	
	11. ARRESTER TEMPORARY OVERVOLTAGE CAPABILITY, WITH PRIOR DUTY. (prior duty as defined in annex D, IEC 60099-4)		
	a) Overvoltage applied for 1 s pu of MCOV	xxxxxxxxxx	
	b) Overvoltage applied for 5 s pu of MCOV	xxxxxxxxxx	
	c) Overvoltage applied for 10 s pu of MCOV	xxxxxxxxxx	
	12. PHYSICAL DIMENSIONS OF ARRESTERS		
	a) Overall height of arrester mm	xxxxxxxxxx	
	b) Minimum external flashover distance mm	1 100	
	c) External diameter of arrester housing mm	xxxxxxxxxx	
	d) Diameter of voltage grading rings mm	xxxxxxxxxx	
	e) Distance of grading ring from top of arrester mm	xxxxxxxxxx	
	13. MOV ELEMENTS		
	a) Diameter of elements mm	xxxxxxxxxx	
	b) Thickness of elements mm	xxxxxxxxxx	
	c) Number of elements per arrester	xxxxxxxxxx	
4.2.2	d) Number of stacks in parallel	0	
	14. MISCELLANEOUS		
4.2.1	a) Live spray washing (Yes/No)	No	xxxxxxxxxx
	b) Total mass of assembled unit kg	xxxxxxxxxx	
	c) Minimum expected life of arrester at 40 °C and MCOV yrs	25	

Sub clause of 34-419	Description	Schedule A	Schedule B
4.2.7	d) Sample available for inspection	Yes	
5.2.10	e) Declared specified long-term load kN	xxxxxxxxxx	
5.2.1	15. INSULATION WITHSTAND TEST		
	a) Reference number of test report	xxxxxxxxxx	
	b) Lightning impulse (1,2/50µs) withstand level kV [(1,3/0,82) × U _{res}]	476	
	c) 60 s wet power frequency withstand r.m.s kV	230	
5.2.2	16. RESIDUAL VOLTAGE TEST		
	a) Reference number of test report	xxxxxxxxxx	
	b) Maximum residual voltage for a 10 kA steep current impulse (1/20µs) kV	336	
	c) Maximum residual voltage for a lightning current impulse (8/20µs) of magnitude:		
	• 5 kA kV	xxxxxxxxxx	
	• 10 kA kV	300	
	• 20 kA kV	xxxxxxxxxx	
	d) Maximum residual voltage for a 500 A switching current impulse kV	xxxxxxxxxx	
5.2.3	17. LONG DURATION CURRENT IMPULSE WITHSTAND TEST		
	a) Reference number of test report	xxxxxxxxxx	
	b) Charging voltage pu of U _r	3,2	
	or		
	• charging current A	xxxxxxxxxx	
	c) Virtual duration of peak µs	2000	
	d) Number of discharge operations	18	
	e) Number of grouped operations	6	
	f) Operations per group	3	
	g) Maximum interval between operations s	60	
	h) Interval between groups	Cool to ambient	

Sub clause of 34-419	Description	Schedule A	Schedule B
	i) Maximum permitted change in residual voltage after long duration current impulse withstand test %	5	
5.2.4	18. OPERATING DUTY TEST		
	a) Reference number of test report	xxxxxxxxxx	
	Conditioning part 1:		
	b) 10 kA current impulse (8/20 μ s), energized at 1,2 x MCOV kV	101	
	c) Number of discharge operations	20	
	d) Number of grouped operations	4	
	e) Operations per group	5	
	f) Interval between operations s	60	
	g) Intervals between groups min	30	
	Conditioning part 2:		
	h) High current impulse (4/10 μ s) kA	100	
	i) Number of applications	2	
	Conditions for switching surge test:		
	j) Charging voltage pu of U_r	3.2	
	or		
	• charging current A	xxxxxxxxxx	
	k) Virtual duration of peak μ s	2000	
	l) Number of discharge operations	2	
	m) Interval between operations s	60	
	n) Starting temperature for first impulse $^{\circ}$ C	60	
	o) Energy dissipated during second impulse kJ	xxxxxxxxxx	
	Conditions for power frequency test at elevated levels as in IEC 60099-4, 7.5.2:		
	p) Interval between last long duration current impulse and power frequency test ms	100	
	q) Elevated rated voltage (U_r^*) applied for 10 s kV	xxxxxxxxxx	

Sub clause of 34-419	Description		Schedule A	Schedule B
	r) Elevated continuous operating voltage (Uc*) applied for 30 min	kV	xxxxxxxxxx	
	s) Maximum permitted change in residual voltage after long duration current impulse withstand test	%	5	
5.2.5	19. POWER FREQUENCY VOLTAGE VERSUS TIME CHARACTERISTIC			
	a) Reference number of test report		xxxxxxxxxx	
5.2.6	20 Short-circuit test			
	a) Reference number of test report		xxxxxxxxxx	
	b) High current	kA r.m.s.	40	
	c) Low current	kA r.m.s.	0,6 ± 0,2	
5.2.7	20. NATURAL AGEING AND POLLUTION PERFORMANCE TEST			
	a) Reference number of test report		xxxxxxxxxx	
5.2.8	21. INTERNAL PARTIAL DISCHARGE TEST			
	a) Reference number of test report		xxxxxxxxxx	
	b) Power frequency voltage applied [1,05 x MCOV]	kV	89	
	c) Maximum partial discharge	pC	10	
5.2.9	22. MOISTURE INGRESS TEST			
	a) Reference number of test report		xxxxxxxxxx	
5.2.10	23. BENDING MOMENT TEST			
	a) Reference number of test report		xxxxxxxxxx	

7. TECHNICAL A & B DEVIATION SCHEDULE – 88 kV SURGE ARRESTER**Table 6: Deviation Schedule - 88 kV Surge Arrester**

Any deviations offered to this specification shall be listed below with reasons for deviation. In addition, evidence shall be provided that the proposed deviation will at least be more cost effective than the specification.		
Item	Sub-clause	Proposed deviation

SIGNED ON BEHALF OF TENDERER :

COMPANY NAME :

NAME IN BLOCK LETTERS :

DATE :

EMALAHLENI LOCAL MUNICIPALITY

**40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION
OF A 11,5 KM, 132 KV OVERHEAD LINE.**

CONTRACT NUMBER: ELM 07/2021 (READVERT)



THE CONTRACT PART 3: SCOPE OF THE WORK

C3.3: GENERAL SPECIFICATION

EMALAHLENI LOCAL MUNICIPALITY

40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION
OF A 11,5 KM, 132 KV OVERHEAD LINE.

CONTRACT NUMBER: ELM 07/2021 (READVERT)

C3.3. GENERAL SPECIFICATIONS

C3.3.1. PREAMBLE

Note:

Failure to duly complete Technical Schedules in full will result in the disqualification of the tenderer's offer.

No change in supplier is permitted without a written application by the contractor and written consent by the Engineer. Should any change in supplier be noted at any stage during implementation of the project the Engineer will instruct the Contractor to revert back to suppliers as per the tender offer with any time and cost implications for the Contractors account.

It shall be noted that specifications are for the general use of project construction, certain sections or paragraphs may not be relevant to this particular contract in which case such irrelevant items are to be considered as not applicable. Any uncertainties shall be communicated to the Engineer. Where equivalent South African standards (SANS / NRS) exist, such standards are to be used in preference to foreign standards quoted.

The documents referenced contain provisions that constitutes requirements of this specification. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

I / We, the undersigned hereby acknowledge that
I / We have obtained copies of the mentioned documents and confirm that I / We fully understand them and the consequences of non-compliance.

SIGNED AT ON BEHALF OF THE FIRM

ON THIS DAY OF 20.....

NAME:

SIGNATURE:

CAPACITY:

EMALAHLENI LOCAL MUNICIPALITY

40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION OF A 11,5 KM, 132 KV OVERHEAD LINE.

CONTRACT NUMBER: ELM 07/2021 (READVERT)

C3.3.2. LAW - NATIONAL AND INTERNATIONAL STANDARDS

All IEC, NRS, SANS, ASCE, ISO codes and National Law applicable to the disciplines listed below shall apply to this project:

ACT	31	Fencing Act.
ACT	73	1989 Environmental Conservation act.
ACT	85	1993 Machinery and Occupational Safety Act 85 of 1993 with special reference to Section 1 (Act & Regulations), Section 2 (Administrative Regulations), Section 6 (Electrical Installation Regulations) and Section 16 (General Safety Regulations)
ACT	OHS	1993 Occupational Health and Safety Act 1993

The following specifications are included on the Tender CD issued together with the tender. It is the responsibility of the tenderer to ensure that he/she obtains the tender CD.

GSE 11	Subtransmission Overhead Lines
GSE 14	Inspections, Testing, Commissioning and Handing Over
GSE 18	Power Transformer
GSE 20	NECRT
GSE 48	OPGW

Standards are obtainable on the SABS Web store www.store.sabs.co.za.

C3.3.3. ESKOM SPECIFICATIONS / STANDARDS

applicable to this project. This listed specifications included on the Tender CD issued together with the Tender. It is the responsibility of the tenderer to ensure that he/she obtains the tender CD. In addition, these specifications are also available on the Eskom website (www.scot.eskom.co.za).

Table 11: Eskom Specifications/Standards

NO.	REV / YEAR	DESCRIPTION
240-68973110	2014-2019	Specification for power transformers rated for 1.25MVA and above and with highest voltage of 2.2kV or above
240-57648848		Specification for combined three-phase neutral electromagnetic couplers with neutral earthing resisters and auxiliary power transformers (NECRT's)
240-86100853	0	Standard for Barricading prohibited area and live chamber
240-87605434	2015-2020	Quality control process for the checking of distribution substation construction before handing over for commercial operation
34-1245	Latest	Distribution Standard – Part 2: Earthing Section 3. Substation earthing
34-1439	2012-2017	Standard for the labelling of substations and networks

EMALAHLENI LOCAL MUNICIPALITY

**40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION
OF A 11,5 KM, 132 KV OVERHEAD LINE.**

CONTRACT NUMBER: ELM 07/2021 (READVERT)

NO.	REV / YEAR	DESCRIPTION
34-254	Latest	Manufacturing Specification for Distribution Equipment Labels
34-2057	2010-2015	Sweep frequency response analysis test procedure
34-333	1	OHS act requirements to be met by principal contractors employed by Eskom Distribution.
32-94	0	Safety, Health and Environment (SHE) Policy.
32-136	2	Contractor Health and Safety Requirements.
32-345	2	Eskom Vehicle Safety Specification.
240-62196227	5	Life-saving Rules.
EPC_32-36	0	Smoking.
EPC_32-93	2	Vehicle and Driver Safety.
CPL_32-418	0	Working at Height.
TST_41-120	0	Environmental Requirements for Procurement.
ESKPBAAA9	Latest	Environmental impact assessment procedure
ESKPBAAD6	Latest	Environmental management policy
ESKPVAAL7	Latest	Environmental impact assessment procedure
ESKPVAAZ1	2	Environmental Management Programme (EMP) Procedure

EMALAHLENI LOCAL MUNICIPALITY

40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION OF A 11,5 KM, 132 KV OVERHEAD LINE.

CONTRACT NUMBER: ELM 07/2021 (READVERT)

C3.3.4. SANS/IECSPECIFICATIONS

The following National and International standards shall be adhered to and can be obtained through the SABS webstore.

C3.3.4.1. SUBTRANSMISSION OVERHEAD LINE

NRS 061-1	-	Overhead Ground Wire with Optical Fibre
NRS 061-2	-	Specification for Overhead Ground Wire with Optical Fibre
NRS 081	-	Single-Mode Non-Dispersion Shifted Optical Fibres
SANS 182-3	-	Conductors for overhead electrical transmission lines
SANS 10280-1	-	OHL – Minimum Clearances for Power Lines

C3.3.4.2. POWER TRANSFORMER

IEC 60076	-	Power Transformers (all applicable parts)
IEC 60137	-	Bushings for AC voltages above 1000V
NRS 054	-	Design of large Power transformers

Relevant Eskom specifications.

C3.3.4.3. EARTHING AND LIGHTNING PROTECTION SYSTEM

SANS 725/		
IEEE 80	-	Guide for safety in AC Substation Grounding
IEEE 81	-	Guide for measuring earth resistivity, ground impedance and earth surface potentials of a ground system
SANS 10199	-	The design and installation of an earth electrode
IEC 62305	-	Protection against lightning
SANS 10292	-	Earthing of low-voltage (LV) distribution systems
SANSA 10313	-	Protection against lightning – Physical damage to structures and life hazards
NRS 060	-	Code of Practice for clearances for electrical systems with rated voltages up to and including 145 kV, for the safety of persons
IEC 61024	-	Protection of structures against lightning

C3.3.4.4. SURGE ARRESTERS

IEC 60099	-	Surge Arrestors. Metal-Oxide. Surge Arresters without gaps for AC Systems.
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Relevant Eskom specifications.

C3.3.4.5. INSULATION

SANS 1019	-	Standard voltages, currents and insulation levels for electricity supply
IEC 60273	-	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000 V
IEC 60168	-	Tests on indoor and outdoor post insulators of ceramic material

EMALAHLENI LOCAL MUNICIPALITY

40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION OF A 11,5 KM, 132 KV OVERHEAD LINE.

CONTRACT NUMBER: ELM 07/2021 (READVERT)

- IEC 60383 - or glass for systems greater than 1000 V
Insulators for overhead lines with a nominal voltage above 1000 V
- IEC 60815 - Selection and dimensioning of high-voltage insulators intended for use in polluted conditions
- IEC 60168 - Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1 000 V
- IEC 60455 - Resin based reactive compounds used for electrical insulation
- IEC 60071-1 - Insulation co-ordination
- Relevant Eskom specifications.

C3.3.4.6. ELECTROMAGNETIC COMPATIBILITY

- IEC 61000-6-2 - Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments
- IEC 61000-6-4 - Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments
- IEC 61000-6-5 - Electromagnetic compatibility (EMC) – Part 6-5: Generic standards – Immunity for power station and substation
- Relevant Eskom specifications.

I / We, the undersigned hereby acknowledge that I / We have obtained copies of the mentioned documents and confirm that I / We fully understand them and the consequences of non-compliance.

SIGNED AT ON BEHALF OF THE FIRM

ON THIS DAY OF 20.....

NAME:

SIGNATURE:

CAPACITY:

GSE11 – GENERAL SPECIFICATION ELECTRICAL

SUBTRANSMISSION OVERHEAD LINES

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Revisions	Description
2017-07-04	Multi-frequency vibration dampers – use of bolted attachments on the Stockbridge type dampers prohibited. (Marnus)

1. GENERAL

This general specification covers the general requirements for Sub-transmission overhead power lines up to 132 kV.

2. NORMATIVE REFERENCES

The following documents contain provisions that constitute requirements of this specification. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

Table 1: SANS specifications

Document	Rev./issue	Title and Publisher
SANS 121	Latest	Hot Dip Galvanized Coatings On Fabricated Iron And Steel Articles – Specifications And Test Methods
SANS 1200 AA	Latest	Standardized Specification For Civil Engineering Construction Section A: General (Small Works)
SANS 1200 DA	Latest	Standardized Specification For Civil Engineering Construction Section DA: Earthworks (Small Works)
SANS 1200 GA	Latest	Standardized Specification For Civil Engineering Construction Section GA: Concrete (Small Works)
SANS 9001	Latest	Requirements For Quality Management Systems
SANS 10280	Latest	Code Of Practice For Overhead Power Lines For Conditions Prevailing In South Africa
SANS 14001	Latest	Environmental Management Manual International Standards – EMS
SANS 182-3	Latest	Conductors for overhead electrical transmission lines

In addition, the following Eskom specifications shall constitute requirements of this specification. All Eskom standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

Table 2: Eskom specifications

Document	Rev./issue	Title and Publisher
1. TRANSMISSION GUIDELINES, PROCEDURES, SPECIFICATIONS & STANDARDS		
TWN41-675	1	Installation Of Guy Grips
TRMSCAAC1	3	Specification For Transmission Line Towers And Line Construction
TRMSCAAH2	5	Specification For Suspension And Strain Assemblies And For Hardware For Transmission Lines
TRMSCABG8	0	Corrosion Protection Of New And Weathered Steel Power Line Structures

Document	Rev./issue	Title and Publisher
2. DISTRIBUTION GUIDELINES, PROCEDURES, SPECIFICATIONS & STANDARDS		
DST_34-146	1	Authorisation Procedure For Operating On High Voltage Systems
DST_34-962	1	Management Of Certificates Of Compliance For Electrical Installations
DST_34-1954	0	Supervision Of People In Electrically Hazardous Locations
DISSCABA5	2	Specification For A Fall Arrest System
DSP_34-1488	1	Specification For Master Locks And Master Keys For Electrical And Related Equipment
DPC_34-908	0	Procedure For Barricading
EPC_32-846	0	Operating Regulations For High-Voltage Systems
DST_34-2052	0	Power Lines, Buildings, Telecommunication Towers, Wind Turbines And Related Structures With Regards To Aviation
SCSASACF5	0	Planning Of Power Lines In The Vicinity Of Rifle Ranges
DPC_34-1812	0	Statutory Approval Application To Rail Authorities
SCSPVADG6	0	Statutory Applications To Water Authorities
SCSPVADA4	0	Procedure: Statutory Approval Application To Rail Authorities
SCSPVADO3	0	Statutory Applications To Local Authorities
DGL_34-600	0	Building Line Restrictions, Servitude Widths, Line Separations And Clearances From Power Lines
EPL 32-727	0	Safety, Health, Environment, And Quality (SHEQ) Policy
EPL 32-97	0	Land Management Policy
DST_34-132	0	Fire Risk Management
ESKASABG3	0	Standard For Bush Clearing And Maintenance Within Overhead Powerline Servitudes
EPC_32-96	0	Guidelines For The Rehabilitation And Vegetation Management Of Herbicides Treated Sites
DGL_34-190	0	Access To Farms (Includes Strategy On Dealing With Game Farms)
EPC 32-96	0	Environmental Procedure: Environment Control Document
EPC_32-245	0	Environmental Procedure: Waste Procedure
EPC_32-247	0	Environmental Procedure: Bush Clearing
EPC_32-248	0	Environmental Procedure: EMP Guide
DPC_34-350	0	Procedure For The Reporting, Recording, Investigation, Costing And Follow-Up Of Incidents/Accidents
SCSPVABP7	0	Procedure For Environmental Assessment Of Reticulation And Sub Transmission Projects
DPC_34-333	1	OHS Act Requirements To Be Met By Principal Contractors Employed By Eskom Distribution

Document	Rev./issue	Title and Publisher
DGL_34-190	1	Access To Farms (Includes Strategy On Dealing With Game Farms)
DSP_34-1658	0	Corrosion Protection Specification For New Indoor And Outdoor Distribution Equipment, Components, Materials And Structures Manufactured From Steel
DST_34-705	0	Quality Requirements For Qualified Suppliers
DSP_34-1667	0	Hump Back Split Pins For New And Refurbished Power Lines Up To 132kV
DSP_34-1681	0	Standard For Aircraft Warning Devices Used On Overhead Transmission , Sub Transmission And Distribution Lines
DSP_34-1657	0	Specification For Conventional Stay Planting, Percussion Stay And Rock Anchor Installations And Compaction Testing
DSP_34-377	1	Specification For Phase Conductor For Distribution Lines And Substations
DSP_34-194	1	Specification For Helically Formed Line Hardware.
DSP_34-329	1	Colour Coding For Line Hardware, Including Helical, To Be Used On Conductors
DSP_34-1681	0	Specification For Aircraft Warning Devices Used On Overhead Sub Transmission And Distribution Lines
DSP_34-433	1	Requirements And Tests For Stockbridge Type Aeolian Vibration Dampers
DSP_34-510	1	Outdoor Post And Long Rod Insulators For New And Refurbished Power Lines For 66kv And 132kv
DSP_34-1213	1	Zinc-Coated Earth Conductor, Guy And Stay Wire For Distribution Lines
DSP_34-1659	0	Current-Carrying Compression Fittings For Overhead Sub-Transmission Systems
DSP_34-1680	0	Refurbishment Of Steel Power Line Structures
DSP_34-1683	0	Distribution Specification For Steel Mono-Pole Compact Line Towers For Sub Transmission Lines
DSP_34-2051	1	Design, Manufacturing And Testing Requirements For Fabricated Steel Overhead Line Structures And Components
DST_34-1202	0	Sub Transmission Lines Section 1: General
DST_34-1207	2	Conductors
DISASABL1	2	Insulators
DST_34-1204	2	Vibration Dampers
ASABF9	0	Earthing
DST_34-1206	0	Sub Transmission Lines Section 9: Steel Mono Pole 132kV Compact Line Tower Series

Document	Rev./issue	Title and Publisher
DST_34-1231	0	Distribution Standard Part 6: Sub-Transmission Lines Section 9: Steel Mono-Pole 132kV Suspension Structures (Suspension Arm)
DST_34-1230	0	Distribution Standard Part 6: Sub-Transmission Lines Section 11: Steel Guyed Mono-Pole Suspension Structure 132kv (Suspension Arm)
DST_34-1228	0	Sub-Transmission Lines Section 14: Assembly And Informative Drawings For 66kV And 132kV Lines
DST_34-1235	0	Sub Transmission Lines Section 15: Steel H-Structures For 132kv Lines
06TB-08	0	Bifurcation (Splitting) Of Shield Wires
04TB-040	0	Testing Of Compression Fitting Sample Assemblies
00TB-022	0	Dead End Clamping Of Standard Greased Overhead Line Conductors.
13TB-015	0	Standard Greases For Use On Overhead Conductors
DST_34-1454	0	Clearing And Maintenance Of Servitude Routes
SCSASAAAX8	0	Standard On The Implementation Of The Standardisation Of Disc Insulators To IEC 120 Standards
34-1439	0	Standard For The Labelling Of High Voltage Equipment
SCSASAAAY0	0	Standard For Blasting Under Or Adjacent To Eskom Overhead Power lines and Substations
DSP_34-254	1	Manufacturing Specification for Distribution Equipment Labels
DSP_32-1290	1	OPGW Hardware and installation requirements for overhead lines
DGL_34-550	0	Guide For The Storage, Transport And Handling Of Composite Insulators.

3. TEMPORARY WORKS

All temporary construction roads shall be constructed by the **Contractor**, only if required for the successful execution of the construction activities or as instructed by the **Engineer**.

All temporary construction stays installed for the erection and securing of structures and for stringing purposes shall be completely removed after completion of these activities.

All temporary installations (Scaffolding, Goal posts, etc.) required for the crossing of roads, railway lines, power lines, telephone lines, etc. shall be completely removed after completion of the stringing activities.

Temporary By-passes shall be constructed for the duration of the complete construction of the new overhead line section where required and indicated on the project drawings.

At completion of construction at the new overhead power line section By-passes shall be disconnected and completely dismantled.

4. CONSTRUCTION SEQUENCE AND PROPOSED PLANNED OUTAGES

The *Contractor* for the *Works* has to make arrangements for pre-arranged outages to perform activities which need to be done under “de-energized” conditions. The outages are to be arranged to have the least impact on the relevant sub-transmission and distribution networks and shall take place as far as possible over weekends. The *Contractor* shall make provision for working during weekends in the construction programme and planning.

5. WORKS INFORMATION

5.1.PLANT

- a) The Employer will not supply any plant for the execution of the Works.
- b) All plant required for the successful completion of this project shall be provided by the Contractor.

5.2.MATERIALS

- a) For a detailed Detail Design Bill for Materials, refer to the Bill of Quantities and/or Bill of Materials which forms part of the tender/contract document.
- b) Apart from items specified in clauses below, the Contractor shall be responsible for the supply of all relevant construction material such as sand, stone, cement, reinforcing, concrete manhole sections, HD bolts, HD bolt top and bottom templates, shoring, steel shutters, temporary crossing installations and any miscellaneous items which might be required for the successful completion of the project.
- c) A Detail Design Bill of Materials, of all materials to be supplied to the Contractor, it will however remain the contractor’s responsibility to verify all quantities with the Engineer before any orders are placed. In some instances additional material are allowed for in the case of unforeseen circumstance, such equipment should not be ordered as part of the normal scope of works.
- d) The Contractor will supply the following:
 - All foundation material below ground, including stubs casted in foundations and concrete caps above ground level
 - Temporary stay material including stay wire;
 - (Note: Only the minimum amount of temporary stays required per structure will be specified by the Employer. The Contractor shall make provision for all additional temporary stays, which he thinks might be required for the safety of his workmen.)
 - All line designation, structure identification, phase colour disc and line crossing labels, complete with buckles and strapping;
 - All tower anti-climbing devices strain and razor wires.
- e) Suppliers samples and/or detail drawings of all line material, supplied by the Contractor shall be technically evaluated and approved by the Engineer prior to the purchasing thereof.

- f) If some materials are supplied by the Employer the following shall apply: Once any material delivered by the Employer to the Contractor's yard on site, the loading, transporting to the construction site, off-loading and safekeeping thereof becomes the responsibility of the Contractor. The Contractor must make the necessary arrangements for safe storage on site, offering adequate protection against theft, damage, wind and weather.
- g) The Contractor will be responsible for the insurance of materials against any form of damage or theft after delivery thereof.
- h) At all times it will be assumed that the Contractor has been ensured upon the acceptance of material supplied by the Employer, that no visible damage has occurred to it and that it also complies with the latest relevant Standard. In the case of damaged and/or unacceptable material, acceptance thereof must be refused.
- i) Should a dispute arises, with regards to the quality of any material delivered to site the assistance of the Engineer must be called upon for a decision.
- j) If any damaged material is found on site after delivery and acceptance thereof, it will be replaced at the cost of the Contractor and no extension of contract time will be granted for the extra delivery time.
- k) It is essential that a good "Record-keeping System" exist whereby control over quantities on site can be maintained. All new deliveries to the site-store and all materials and structures issued for construction must be recorded. At any time, it must be possible for the Engineer to establish from these records exactly what material or structures is kept in site store/yard or has been installed. These figures will regularly be compared to the actual quantities measured on site and the formal delivery notes.
- l) Liability for inherent defects in material issued by the Employer does not lie with the Contractor. If defects in material or in the Works, due to the use of patently defective material are discovered, new material will be replaced by the Supplier free of charge.
- m) If, however, it is established that defects in material or the Works were due to damage caused to material after issue, the Contractor will be held responsible for all replacement and repair costs to the material or the Works, as well as loss of time. The decision concerning the caused and responsibility of defects, as well as the extent of compensation (if any), rests with the Project Manager.

5.3.EQUIPMENT

- a) No equipment will be supplied by the *Employer* for the completion of this project.
- b) All equipment required for the successful completion of this project shall be provided by the Contractor.

5.4.SITE SERVICES PROVIDED BY THE EMPLOYER

- a) A new power line servitude, with limited and restricted access will be made available to the *Contractor* for the executing of the *Works* where applicable. No servitudes are required on the property of the power line owner (a servitude cannot be registered in favour of the owner over the owners own property)

- b) The line route, all structure and stay positions will be pegged by the Contractor's Surveyor. The Engineer shall supply the contractor with a staking report. Reinstating of any pegs removed during construction shall be the contractor's responsibility at no additional cost. After completion of excavation the staking reference pegs shall be available to confirm the support structures position – this shall be a holding point on the project programme.
- c) The contractor will be required to liaise with all Landowners.

6. ACTIVITY STAGE 1

PRELIMINARY, GENERAL & SHEQ

- a) Preliminary and general costs include any other costs not required for site establishment, as specified below:
 - Contractual requirements i.e., insurance's, statutory contributions, etc.;
 - Material Surety Bond;
 - Contract Programming;
 - Off-site staff & overhead costs;
 - Additional provision to conduct a planned outage inclusive of all transport, labour and material (To be re-measured at completion);
 - Environmental requirements;
 - Health and Safety requirements.
- b) The **Contractor** is referred to the contract documents for the full intent and meaning of each clause or item and he shall allow opposite each clause or item herein contained whatever payments he may consider necessary for the carrying out and observance of such item.
- c) The Contractor shall price the Preliminaries and General Bill in respect of all payments required for any item of work, risk, contingency or obligation whatsoever that is not described in the Bills of Quantities and which is the responsibility of the Contractor under the contract.
- d) The Contractor shall, when requested by the Employer, make available the detailed breakdown of each priced.
- e) In the event of the Contractor not pricing the items of the Preliminaries and General Bill in sufficient detail, the Employer reserves the right to exercise his own discretion in the apportionment to individual items of the total Preliminary and General Prices within the contract documents.

6.1. ENVIRONMENTAL REQUIREMENTS

- a) The **Contractor** will see that the **Environmental Requirements** for this project is strictly adhered to.
- b) The Contractor shall:
 - Appoint his internal or external Environmental Control Officer to ensure proper implementation and day-to-day monitoring of the Environmental Requirements;
 - Demonstrate environmental competence by providing evidence of his / her companies' environmental policy;
 - Keep an Environmental Incident Register on site, which must be regularly updated by the Contractor throughout the entire construction period.
- c) Sanitary Facilities and Refuse Disposal:

- Temporary and/or mobile toilet facilities shall be provided at the Contractor's yard by the Contractor and removed on completion of the Works.
 - Under no circumstances shall the use of the veld be permitted. To prevent the occurrence of measles in cattle, Construction Employees may be required to be examined for tapeworm and treated or treated irrespective of whether they are infected or not. Proof of such treatment must be supplied to the Engineer. The drug "Niclosamide" (Yomesan, Bayer) is freely available and highly effective against tapeworms in humans.
 - The use of only chemical toilets as temporary facilities will be accepted. No other temporary system will be allowed on site.
 - The Contractor shall establish a refuse control system. All waste shall be collected and disposed of as required by the Landowner, Engineer and the Environmental Practitioner.
 - The Contractor shall make his own arrangements for the disposal of unsuitable excavated material, surplus material and construction waste resulting from the Works, to the Clerk of Works approval.
 - The Contractor shall furthermore ensure:
 - That waste is disposed of on a permitted waste site, for the applicable waste type, in terms of the Environment Conservation Act, 73 of 1989.
 - A disposal certificate is issued to the Employer prior to final payment, as proof of disposal.
 - That where appropriate, waste is being recycled or re-used.
- d) Vegetation Management:
- The Contractor shall ensure:
 - That all indigenous and protected trees (in terms of National and Provincial Legislation) are identified and permits obtained from the relevant authority prior to the cutting of such trees.
 - That written permission is obtained from the owner of protected trees prior to the cutting of such trees.
 - That permits be available on site where such trees are cut.
 - That the owner is consulted, and his/her consent being obtained, prior to the cutting of trees.
- e) Environmental Risks:
- The Contractor shall ensure:
 - That all environmental risks associated with the activity be assessed and documented prior to the execution of the activity.
 - Identified environmental risks must be avoided where possible and where it cannot be avoided, be remediate to the satisfaction of the Employer, the relevant Landowner, or any relevant Government Authority.
 - That all environmental incidents and complaints are reported to the Clerk of Works within 24 hours after the occurrence thereof.
- f) Other special environmental restrictions which must be adhered to and as stipulated in the Environmental Management Plan are:
- The irresponsible use of welding equipment, oxy-acetylene torches and other naked flames which could result in veld fires or constitute a hazard.
 - Indiscriminate disposal of rubbish or rubble.
 - Deliberate littering of the site.
 - Spillage of potential pollutants, such as petroleum products.

- Lighting of fires for cooking, heating or other purposes, and failure to exterminate any fires.
- Use of any facility other than the chemical toilets provided.
- Burning of wastes and cleared vegetation under any circumstances.
- The use of rivers, streams, dams or any watercourses/surface water for washing purposes.
- Entering areas outside of the demarcated construction area.
- The presence of construction staff at the construction site outside of the designated construction times (06h00-18h00) i.e. no construction staff are allowed to overnight on site, outside of the demarcated construction camp.

6.2.HEALTH & SAFETY REQUIREMENTS

- a) The Employer's Health and Safety Specifications and the Department of Labour's Construction Regulations for this project are specified in Combined Project Specific Policies, Guidelines & Standards.
- b) The Contractor shall:
 - Submit with this Tender, a complete Health and Safety Plan for this project, for the Employer's approval;
 - Comply in full with all the Employer's requirements for Security and Safety;
 - Maintain an active accident prevention program;
 - Appoint a responsible Health and Safety Officer and he is to co-operate fully with the Project Manager in all matters pertaining to accident prevention and safety on the construction site;
 - Hold safety meetings as required under the Occupational Health and Safety Act 85 of 1993, and shall submit copies of the minutes to the Project Manager no later than 2 days after the date of the meeting.
 - Provide first aid facilities as required by the Occupational Health and Safety Act, 85 of 1993.
 - Allow and ensure safe access for other Contractor's and the Employer's personnel when required.
 - Make provision for special transport of workers to, at and from site as per OHS Act/Construction Regulations requirements; i) Complete and submit an Expanded Public Works Programme report, prior to the commencements of any construction activities; j) Compile and submit for acceptance by the Employer "Detailed Construction Method Statements" for any test and construction activities to be executed on site;
 - Keep a Health and Safety Incident Register on site, which must be updated daily throughout the entire construction period.
- c) The Employer's Standard "Occupational Health and Safety Requirements" forms part of the Health and Safety Specification of this document and applies for the compilation of the 'Health & Safety Plan' for this project.
- d) The Contractor as well as the Clerk of Works shall ensure that the proper implementation, co-ordination and management of safety aspects during the project life cycle and that all statutory and supply authority Regulations are implemented and adhered to, as specified.

6.3. SITE ESTABLISHMENT

- a) The Contractor will be responsible to locate a suitable site to establish a construction camp.
- b) Site establishment costs include any other costs not specified as preliminary and general costs, as stated below:
 - Establish, use and maintain notice boards and construction access road indicators. The notice boards and erection thereof shall comply with the advertising bylaw of the Local Authority;
 - Establish, use and maintain site office;
 - Establish, use and maintain site stores & construction camp;
 - Establish, use and maintain staff accommodation and sanitation;
 - Establish, use and maintain all telecomm and telephone installations and remove on completion, if required;
 - Establish, use and maintain Contractor's water supply, if required;
 - Establish, use and maintain Contractor's electricity supply, if required;
 - Establish, use and maintain Contractor's drainage and waste disposal at all camps;
 - Establish, use and maintain site toilet facilities;
 - Establish, use and maintain temporary works;
 - Establish, use and maintain all constructional plant.
 - The Contractor shall submit a Site Establishment application to the Building and Land Use Department.
- c) Erection of a site office & construction camp:
 - A fully equipped site office, suitable for regular site meetings must be erected, which must also serve as the office for the Contractor's Site Supervisor.
 - Adequate workspace must also be provided for the Clerk of Works, as well as a place of safekeeping of his site plans and documentation.
 - On completion of the project, all temporary structures and installations shall be removed from site and the site shall be re-instated to the satisfaction of the Project Manager.
 - For temporary installations, only chemical toilet facilities will be allowed at the construction office/camp for the use by construction workers and visitors to the construction camp.
 - The Contractor shall:
 - Ensure that the entire camp site(s) is fenced and gates locked after hours and over weekends.
 - Ensure that firebreaks are made along the inside perimeter of the fence (where appropriate).
 - Ensure that appropriate sanitation and cooking facilities are provided and maintained at all work sites.
 - Ensure that no open fires are permitted at the camp site(s). The establishment of fencing and firebreaks must be negotiated with the relevant Landowner(s).
- d) Erection of Stores for safekeeping of materials:
 - The responsibility for the safe storage of material on site as well as protection against damage due to wind or weather lies with the Contractor.

- The construction camp and material yard shall be properly fenced off and all access gates shall be kept locked during periods where no construction activities are taking place.
 - No conductor, shield wire, line hardware, insulators and steel structures shall be stockpiled directly on the ground.
 - The construction camp and material yard shall be maintained and kept in a clean and tidy condition, throughout the construction period and also to the satisfaction of the Engineer.
- e) Laboratory Facilities:
- The Contractor shall provide laboratory facilities for his own use on site to carry out all routine testing of materials and construction, as required by the specifications;
 - The Contractor may make use of approved commercial laboratories, if he so wishes.
- f) Telephone and Telecommunications:
- The Contractor shall be responsible for the supply, on site, of his own telephone or radio-telephone, if required.
- g) Accommodation of Employees:
- The Contractor shall make his own arrangements for the provision of married and single accommodation for his employees.
- h) Electrical Equipment/Appliances:
- Any electrical equipment or appliance used by the Contractor shall be maintained in safe and proper working conditions;
 - The Project Manager shall have the right to stop the Contractor's use of any electrical equipment or appliance, which, in his opinion, does not conform to the foregoing.
- i) Concrete Batching and Mixing Plant:
- The Contractor shall negotiate a proper site for the establishment of a batching plant with the Landowner;
 - The Contractor will be responsible for the proper management of the batching plant and it shall be dedicated solely to the Works;
 - Upon completion of the Works, the soil at the batching plant area shall be rehabilitated and the site cleaned and left in its original state or to the approval of the Clerk of Works and Landowner.
 - The use of local water for concrete mixing must first be negotiated with the relevant Landowner and/or appropriate authorities.
 - Such water shall be analysed for its suitability for the use in concrete. The water analyses shall be submitted to the Project Engineer for the approval thereof.
- j) Fuel depots:
- The Contractor shall when making use of bulk fuel tanks on site, shall have these fuel depot sites protected with under laying plastic sheeting with a trench and/or bund wall around it to avoid unnecessary soil pollution.
 - In cases of severe soil pollution at fuel depots a certified Contractor shall remove the polluted soil to an approved toxic dumping site or otherwise the soil must be treated chemically. In both cases a certificate for the removal and/or rehabilitation of the soil must be submitted to the Project Manager.
- k) Provision of Standard Specifications:
- Where any specification is listed and references are made to other published standards, or specifications of a similar nature, the Contractor shall arrange at

the inception of the contract, to make available at least one complete control set of the latest edition of all documents so referenced.

- The documents shall be kept in the Contractor's site office where they shall be made available for reference at all times by the Contractor's personnel or the Project Manager until completion of the Works.

7. ACTIVITY STAGE 2

ESTABLISH CONSTRUCTION ACCESS

7.1.SUPPLY AND TRANSPORT OF NEW POWER LINE SERVITUDE GATES

- a) The following Standards, Specifications, Guidelines and Drawings apply:
 - **TRMSCAAC1 Rev. 3 -Section 4.5** Transmission line tower and Line construction;
 - Fencing Act No. 31 of 1963
 - **DGL 34-190** Guideline for access to farms;
 - **DGL 34-600** Building line restrictions, servitude widths, line separations and clearances from power lines;
 - PLS Cadd design profile sheets.
- b) All new power line servitude and access required for this project shall be completely supplied and transported to site by the Contractor.
- c) Gate quantities measured on the Route Plan are subjected to re-measurement based on a proper site evaluation by the Contractor in conjunction with the Clerk of Works.
- d) Prior to the commencement of any other construction activities on this project, proper construction access on and to the line route/construction site shall be established.

7.2.COMPLETE REFURBISHMENT OR REPLACEMENT OF EXISTING POWER LINE SERVITUDE AND ACCESS GATES

- a) The Contractor in conjunction with the Clerk of Works shall do a proper assessment on the conditions of all existing gates along the line route.
- b) Existing farm gates situated near and/or in the power line servitude and which are required for access, but are unsuitable for construction-vehicle access must be thoroughly assessed and evaluated.
- c) All existing access/servitude gates shall be refurbished/replaced ensure proper construction access, as follow:
 - Existing gates in a still good workable condition shall be properly cleaned and repainted. All fencing wires shall be properly tightened.
 - Existing gates in a poor not workable condition shall be completely removed and replaced with new gates.
- d) Gates requiring refurbishment shall be:
 - Repaired to the satisfaction of the Clerk of Works;
 - Any parts, members, etc. to be replaced by the Contractor where required;
 - Fence wires to be re-tensioned and/or replaced where required;
 - Gate frame, posts and struts to be properly sanded and all severe corrosion and loose paint to be removed;

- Prepared gate frames, pots and struts to be painted.
- e) Gate refurbishment specification:
- Sand all paint surfaces properly and remove all loose paint, rust and foreign matter;
 - Apply one coat red lead primer to all surfaces;
 - Apply two final coats of aluminium based paint;
 - Allow sufficient time between coats to dry;
 - Apply two coats of bitumen coating around gate posts and struts entering the ground;
 - Cast concrete collars around gate posts and struts, only if there are no caps present and/or the existing caps are in a poor condition.
 - Concrete thresholds to be constructed at existing gates, only if required.
 - The existence of an earth bonding strap be gate posts must be investigate by the Clerk of Works and new earth bonding straps shall be installed where required.
- f) Existing access gates outside the power line servitude shall only be used after written approval is obtained from the relevant Landowner, for the use thereof.
- g) The Contractor shall temporarily remove the existing standard supply authority padlocks from existing gates and replace it with his own padlocks for the full duration of the construction period.

7.3.COMPLETE INSTALLATION OF NEW POWER LINE SERVITUDE GATES

- a) New power line access/servitude gates shall be installed at all points where the power line crosses any fence in which there is no suitable gate within extend of the power line servitude, unless otherwise determined on site by the Clerk of Works.
- b) All construction vehicles shall pass through gates when crossing fences and the Contractor shall not be allowed to drop fences temporarily for the purpose of driving over it. No construction work shall be allowed to commence on any section of the power line, unless all gates in that line section have been installed.
- c) The Contractor in conjunction with the Clerk of Works shall do a proper assessment of all the marked fences for new gate installations to obtain proper access to the construction site.
- d) The Clerk of Works will be responsible to evaluate all marked fences and gates, prior to the installation of new power line servitude gates and/or replacement of existing gates.
- e) The Contractor's work comprises:
- Supply, safe handling, storage and transport to peg of all power line servitude gates, gate & fencing material and all other gate construction material;
 - Setting-out of gate & fence post and strut positions;
 - Evaluating sub-soil conditions for foundation nominations;
 - Drilling/excavating of holes for poles and struts;
 - Excavating of earth strap trenches;
 - Complete installation of all gate & fence posts and struts in 15MPa concrete footings;
 - Curing of concrete footings;
 - Install gate leafs and cut and re-tension existing fence wires;
 - Install earth straps, backfill and compact trenches;

- Treatment of all damaged sections on gate leaf frames, poles, struts, etc.
- f) The in-situ soil condition at each gate position will determine the type of gate post foundation to be installed.
- g) Power line servitude gates shall be erected with a gap not larger than 100mm between the bottom of the gate leaf and the natural ground level.
- h) Where gates are to be installed in jackal proof fences and game fences, a suitable concrete threshold as shown on the detail drawings shall be constructed at the gate opening. Gate leafs shall be covered with diamond mesh as specified on detail drawings.
- i) All gate and fence posts as well as post struts are to be installed in 15MPa concrete footings. The concrete footings must be properly cured, in the most suitable method, for at least 14 days prior to the tensioning of the fence wires.
- j) Earth strap trenches to backfilled slightly watered and thoroughly compacted in layers not exceeding 250mm in thickness.
- k) For soil formations with a very high resistivity the earth strap trenches to be backfilled with a 3:1 soil/agricultural gypsum mixture.
- l) The initial tensions to be maintained in all existing fence wires. Where required, the Contractor shall replace rusted or damaged wire strands on either side of the gate with similar new wiring to prevent the movement of livestock and other animals. The Clerk of Works will determine the extent of replacing fence wires and a written instruction shall be given accordingly.
- m) The Contractor shall supply and install all servitude gate numbering labels. Gate labels shall be installed on all access and servitude gates used for construction purposes.
- n) Gate labels specifications:
 - Labels shall be max. 150 x 150 mm with 15 mm radius rounded corners and 6 mm diameter holes drilled at each corner.
 - Labels shall be manufactured from a material equivalent to Mittal Steel Chroma prep (Z275) having a minimum thickness 1,0mm;
 - The primary colour of the label shall be powder coated with an exterior type powder coating according to SANS 1274 (Type 6) with a minimum thickness of 70µm. The primary colour needs to be on the same side of the substrate where the legend is going to be applied;
 - After the cast vinyl legend is positioned on the coloured substrate the label shall be powder coated on both sides of the label with an exterior type clear coat powder coating according to SANS 1274 (Type 6) with a minimum thickness of 70µm;
 - The font for label legend shall be Helvetica Medium, with a minimum height of 75 mm. The inscription shall be detailed in the Design Bill of Materials. All alphabetical inscriptions shall only be capital letters;
 - The legend shall be of cast vinyl having a guarantee of 7-10 years;
 - Label shall have Black Cast Vinyl lettering on Yellow background;
 - 2,5 mm galvanised binding wire to be used to tie the label to the top centre of the gate leaf.
- o) The Contractor shall provide padlocks for all servitude gates for the entire construction period, where after it will be replaced by the Employer with standard maintenance padlocks, on completion of the project.

- p) Landowners will be allowed to attach their personal padlocks in the lock chain, only after the approval of the Clerk of Works.
- q) Installation of gates in fences on National Road Reserves shall comply with the ordinances of the relevant Provincial Authority. No power line servitude gates shall be installed in Freeway servitude fences.
- r) No power line servitude gate shall be installed in the Spoornet Railway Servitude fences, unless otherwise negotiated and agreed upon with the relevant Transnet Authorities.

7.4.COMPLETE ESTABLISHMENT OF PROPER CONSTRUCTION ACCESS

- a) The Clerk of Works and the Contractor will see that the Landowner's Conditions stipulated during the negotiations for this project is strictly adhered to.
- b) No property will be entered by the Contractor or his employees, prior to an acceptable official notification to the specific Landowner.
- c) The Contractor shall only use the private farm roads with the necessary permission from the specific Landowner, use it with the necessary respect and maintain it throughout the construction period.
- d) The access to the site to be clearly marked by Contractor in the form of access road indicators. The Contractor shall also establish and maintain notice boards or sign posts at private roads used for construction purposes and special conditions clearly stipulated on these notice boards.
- e) Maximum use of both the existing servitudes and the existing roads shall be made. In situations where private roads must be used for construction purposes, the condition of the said roads must be recorded (e.g. Photographed) prior to the use thereof and be agreed upon by the Employer, the Landowner and the Contractor.
- f) All private roads used for access to the servitude shall be maintained by the Contractor and upon completion of the works, be left in at least the original condition.
- g) Access shall not necessarily be continuous along the line, and the Contractor must therefore acquaint himself with the physical access restrictions such as rivers, railways, motorways, mountains, etc. along the line. As far as possible, access roads shall follow the contour in hilly areas, as opposed to winding down steep slopes.
- h) Access is to be established by vehicles passing over the same track on natural ground, multiple tracks are not permitted. Access roads shall only be constructed where necessary at watercourses, on steep slopes or where boulders prohibit vehicular traffic.
- i) The Contractor is to inform the Clerk of Works before entering any of the following areas:
 - Naturally wetland areas, swamps, etc.
 - Any area after rain.
 - Any environmentally sensitive area.
- j) If access is across running water, the Contractor shall take precautions not to impede the natural flow of water. If instructed, the Contractor is to stone pitch the crossing point. There shall be no pollution of water. Access across running water and the method of crossing shall be at the approval of the Clerk of Works and the landowner.

- k) Where in the opinion of the Clerk of Works and/or Project Manager, inordinate and irreparable damage would result from the development of access roads, the Contractor shall use alternative construction methods compatible with the access and terrain, as agreed with the Project Manager.
- l) Existing water diversion berms are to be maintained during construction and upon completion be repaired as instructed by the Clerk of Works.
- m) Where access roads have crossed cultivated farmlands, the lands shall be rehabilitated by ripping to a minimum depth of 600mm.
- n) Construction of new roads:
 - Where construction of a new road has been agreed, the road width shall be determined by need, such as equipment size, and shall be no wider than necessary.
 - In areas over 4% side slope, roads may be constructed to a 4% out slope. The road shall be constructed so that material will not be accumulated in one pile or piles, but distributed as evenly as possible.
 - The material shall be side-cast as construction proceeds, and not overhang the road cut, and shall if necessary be trimmed back at an angle which would ensure stability of the slope for the duration of the works. The sides or shoulders of roads shall not act as a canal or watercourse.
 - Water diversion berms shall be built immediately after the opening of the new access road. In addition, water outlets shall be made at intervals where berms are installed, and suitably stone pitched if instructed by the Clerk of Works.
 - No cutting and filling shall be allowed in areas of 4% side slope and less.
 - Existing land contours shall not be crossed by vehicles and equipment unless agreed upon, in writing, by the Landowner and the Clerk of Works.
 - Existing drainage systems shall not be blocked or altered in any way.
- o) Closure of roads
 - Upon completion, only roads as indicated by the Clerk of Works shall be closed.
 - In areas where no cut or fill has been made, barriers of earth, rocks or other suitable material shall affect closure.
 - In areas 30% slope and less, the fill of the road shall be placed back into the roadway using equipment that does not work outside the road cut (e.g. back-hoe). In areas of greater than 30% slope, the equipment shall break the road shoulder down so that the slope nearly approximates to the original slope of the ground. The cut banks shall be pushed down into the road, and a near normal side slope shall be re-established and re-vegetated.
 - Replacement of earth shall be at slopes less than the normal angle of repose for the soil type involved.
- p) Construction of water diversion berms
 - Water diversion berms shall be spaced according to the ground slope and actual soil conditions, but no greater than the following:
 - Where the track has a slope of less than **2%: 50m** apart;
 - Where the track has a slope of **2%-10%: 25m** apart;
 - Where the track has a slope of **10%-15%: 20m** apart;
 - Where the track has a slope of more than **15%: 10m** apart.
 - Berms shall be suitably compacted to a minimum height of 350mm.
 - The breadth of the water diversion berm shall be 4m at the base, and extend beyond the width of the road for 2,0m on the outlet side to prevent water flowing

back into the road. It shall be angled to a gradient of 1% to enable the water to drain off slowly.

- Berms to be constructed so that a canal is formed at the upslope side.
- Where the in-situ material is unsuitable for the construction of water diversion berms, alternative methods of construction must be investigated and proposed by the Contractor and submitted to the Project Manager for acceptance.
- Loose boulders which obstruct the construction access as well as for running out the conductors shall be removed from the power line servitude.

q) Borrow pits

- The Contractor's decision as to the location of borrow pits, shall be at the Clerk of Works acceptance.
- The Contractor shall be responsible for the rehabilitation and re-vegetation of the borrow pits. It is the Contractor's responsibility to negotiate the royalties for the borrow pits with the Landowner.

r) Levelling at structure/tower sites

- No levelling at tower sites shall be permitted unless approved by the Clerk of Works.
- The steep slopes formed by the cut-banks and respective fillings when building the structure/tower platforms are to be trimmed back to an angle that ensures stability of the slope. When the ground is loose, berms are to be built on the top of the slope, 2,0m long logs spaced evenly must be pegged across the down-slope, re-vegetated with appropriate local grass seeds together with fertiliser.

7.5. BUSH CLEARING AND CUTTING OF TREES

a) The following Standards, Specifications, Guidelines and Drawings apply:

- **TRMSCAAC1 Rev. 3 -Section 4** Transmission line tower and line construction;
- Environmental Conservation Act No. 73 of 1989
- Conservation of Agricultural Resources Act No. 43 of 1983;
- Environmental Management Plan
- **EPC 32-96** Guidelines for the rehabilitation and vegetation management of herbicides treated sites;
- **ESKASABG** Standards and Specifications for the control and cutting of trees and bush within overhead line servitudes;

b) Trees and bush to be cut and/or trimmed on a careful and selective basis to ensure the required electrical clearances from all conductive equipment and to ensure the safety of the power line structures.

c) All equipment required for bush clearing shall be supplied by the Contractor.

d) All approved herbicides required for the prohibiting of re-growth of trees and bush to be supplied by the Contractor.

e) All actual bush clearing areas and quantities of trees cut by the Contractor shall be measured and recorded by the Clerk of Works. Actual measured bush clearing records shall be submitted to the Employer for acceptance.

f) Minimum One Week written notice must be given to the Employer's Environmental Practitioner before commencement with bush clearing activities.

- g) The Contractor shall use only well trained approved and/or accredited weed killer applicators.
- h) The Contractor will not be allowed to cut and/or trim any endangered trees or shrubs in the servitude, unless written prove of the required permits, obtained by the Contractor, is submitted to the Clerk of Works.
- i) Any endangered trees or shrubs to be cut shall be identified and marked by the Contractor in conjunction with the Environmental Control Officer and Clerk of Works.
- j) The use of existing gates and private roads in or outside the power line servitude for bush clearing purposes must be discussed with and accepted by the relevant Landowner, prior to the use thereof.
- k) All vehicles used for bush clearing shall pass through gates when crossing fences and the Contractor shall not be allowed to drop fences temporarily for the purpose of driving over it.
- l) A minimum 5,0m wide strip on the centre of the power line servitude all trees, bush and shrubs shall be cut at ground level to ensure proper access for construction purposes along the line.
- m) Additional maximum 5,0m wide strips on either side of the mentioned 5,0m centre strip all trees, bush and shrubs shall be cut at maximum 150mm above ground level to ensure no interference with construction activities along the power line.
- n) All trees, bush and shrubs shall be cut at ground level for 15,0m radius circles construction working areas at all guyed intermediate suspension and in-line strain structure sites.
- o) All trees bush and shrubs shall be cut at ground level for 25,0m radius circles construction working areas at all guyed angle strain structure sites.
- p) All wood from the cut trees, bush and shrubs shall be removed from the power line servitude to ensure proper construction access.
- q) Where tall trees are to be cut in the power line servitude, the total width of the servitude must be cleared, as well as the selective trimming of trees outside the servitude to ensure the safety of the overhead conductors and power line structures. The Clerk of Works will give the Contractor a written instruction for any trees to be trimmed outside the power line servitude.
- r) Trees that are felled shall be cut within 150mm above ground level, with the exception of a five meter (5,0m) wide access down the centre of the power line servitude in which the trees shall be cut as close as possible to ground level. Stumps need not to be removed, unless conflict with a structure, guy anchor or access is involved, or if requested by the Clerk of Works.
- s) All stumps from trees, bush and shrubs shall be chemically treated immediately after cutting, to prevent any re-growth thereof. The chemical treatment must be approved by the Employer's Environmental Practitioner prior to the purchasing and application thereof.
- t) All felled trees shall be cut into short manageable logs maximum 3,0m in length, unless otherwise required by the relevant Landowner.
- u) Where no trees, bush or shrubs are present the clearing of access shall be done by crushing of small brush rather than the uprooting thereof. Scalping of the earth, or any unnecessary disturbance, will not be allowed as any means of clearing the servitude, except on steep side slopes where cuts and fills are required.
- v) Between structures, where no traffic is required, there shall be no removal of grasses except as required for stringing of the power line. Access for the stringing of the power line shall be limited to one single track for all pulls.

- w) No cutting of bush and shrubs will be permitted across bush filled ravines or gullies where the bush will not interfere with the strung conductor. Alternative means shall be used to string the power line conductors.
- x) All chopped trees and bush will remain the property of the relevant Landowners, unless otherwise negotiated with the Clerk of Works.

8. ACTIVITY STAGE 3

SURVEY ACTIVITIES

8.1.PEGGING OF LINE ROUTE, STRUCTURE SETTING-OUT & STAYS POSITIONS

- a) The following Standards, Specifications, Guidelines and Drawings apply:
 - **TRMSCAAC1 Rev. 3 -Section 5** Transmission line tower and Line construction;
 - Provide pegging data and reference
- b) Setting Out of the Works:
 - The Contractor will be responsible to set out the works as per the staking table provided by the Engineer.
 - The bends will be pegged with dia 20mm steel pegs, protected with medium sized stone piles and clearly marked with "White Wash".
 - These bend pegs will be officially handed over to the Contractor at pre-arranged dates prior to the commencement of any construction activities.
 - The contractor will also be responsible for the pegging and marking of all intermediate suspension and angle strain structure positions, as well as the setting-out of all structure stay positions, temporary stay positions and structure line pegs and determining of structure off-set distances (if required), according to the line profile drawings and within the tolerances stated in TRMSCAAC1, Sections 5.5.3 & 6.2.4.3 (a). Unless otherwise specified in this contract.
 - All material required for the detail pegging of the line will be supplied by the Employer.
 - Other reference pegs (Line pegs and bi-sector line pegs) required for construction purposes will be provided and set out by the Employer.
 - Line pegs and flags at max. 1 500m intervals along the centre line of the power line servitude will be provided and pegged by the Employer, only on special written request from the Contractor.
 - A completed list of scaled co-ordinates for all structure, stay, line peg and bi-sector line peg positions will be submitted by the Project Engineer, for the use by the Employer's Surveyor and the Contractor.
 - All "As-staked" structure and structure stay positions, to be checked and verified by the Contractor prior to the commencement of any construction activities. The Contractor must immediately report any discrepancies between the "As-staked" and "Design" information to the Clerk of Works or Project Engineer.
 - All other detailed setting-out of the works will be the Contractor's responsibility.
 - The Contractor will be responsible for the securing of the Employer Servitude Pegs, by casting a concrete collar with minimum dimensions of 300mm x 300mm x 300mm deep at the line bend positions, see TRMSCAAC1, Section 5.3.

- c) Standard setting-out, structure and stay peg colour codes:
- Terminal and bend position -20mm x 1,0m long steel rod;
 - In-line strain position -10mm x 300mm long steel rod;
 - Mono-pole structure centre position -RED wooden peg;
 - H-pole structure centre position -WHITE wooden peg;
 - 2-Pole structure centre position -WHITE wooden peg;
 - Lattice tower centre position -WHITE wooden peg; H-pole structure leg positions -RED wooden pegs;
 - 2-Pole structure leg positions -RED wooden pegs;
 - Lattice tower leg positions -RED wooden pegs;
 - Permanent stay position -BLUE wooden peg;
 - Construction/Temporary stay position -BLUE/WHITE wooden peg;
 - Bi-sector setting-out line -WHITE wooden pegs;
 - Line peg position -WHITE wooden peg.
- d) Structure position labelling:
- Every structure position (RED or WHITE peg) to be marked with a steel, wooden, PVC tubing or steel dropper $\pm 1,5$ m long and painted RED/WHITE or with a RED/WHITE fabric attached to it. Each rods shall carry a tag, with a structure identification description similar to the structure identifications on the applicable PLS Cadd Profile Design Sheets.
 - The structure number, structure type and pole length shall be clearly legible on the identification tag
 - Each peg shall be left in its position until the structure is assembled and approval is given by the Clerk of Works for the erection thereof.
- e) Marking of power line route for bush clearing purposes
- The power line route shall be clearly marked by the Employer's Surveyor for bush clearing purposes, measured as part of the Bush Clearing Activities.
 - At dense bush terrain, the centre of the power line route shall be marked entering the bush as well as at the exit of the bush.
 - At scattered bush terrain, the centre of the power line route shall be marked at max. 250m intervals.
 - At tall tree plantations, trees to be cut only within the power line servitude shall be marked for clear identification by the Contractor.

8.2.MARKING OF SERVITUDE AND ACCESS GATES

- a) All fences in which servitude gates are to be installed, at the point where the fence intersects with the centre of the power line servitude, shall be marked by the *Employer's* Surveyor.
- b) In situations where a structure position is close to the fence in which a power line servitude gate needs to be installed, the gate position must be marked off-line in such a position that the structure and/or structure stays will not obstructed the access through the gate along the line.
- c) All fences in which servitude gates are to be installed, shall be marked as follow:
- A Red coloured fabric strip will be tied onto the fence wire, inside the power line servitude, at positions where servitude gate centre must to be installed;

- A Red & White coloured fabric strip will be tied onto the gate frame, inside or outside the power line servitude, at positions where existing farm gates are to be refurbished and/or replaced with new access/servitude gates.
 - A White coloured fabric strip will be tied onto the gate frames, outside the power line servitude, at positions where existing farm gates can be used by the Contractor, for construction purposes only.
- d) Permission and written approval for the use and/or replacement of private access gates inside and outside the power line servitude must first be obtained from the relevant Landowners, prior to the use and/or replacement thereof.

8.3.MEASURING OF ALL OVER AND UNDER CROSSING CLEARANCES

- a) The Employer's Surveyor will also be responsible for the measuring and recording of all over and under crossing clearances, after the completion of the stringing activities on the line and prior to the commissioning of the line.
- b) Ambient temperature measurements shall be taken and recorded by the Surveyor in conjunction with the clearance measurements. The complete set of 'Clearance & Ambient Temperature Records' shall be submitted to the Project Engineer for evaluation and acceptance thereof.

9. ACTIVITY STAGE 4

COMPLETE CONSTRUCTION OF TEMPORARY BY-PASS LINES

For complete installation and dressing of By-pass structures, refer to **Activity Stages**.

- a) Supply and transport of By-pass connecting hardware.
- b) All connecting clamps required for the by-pass connections shall be transported to site by the **Contractor**.
- c) Complete installation and removal of temporary bypass lines
- d) The temporary by-passes lines -Include the detail and references of the by-pass lines to be constructed.
- e) After the complete construction of the following new line sections by-pass line shall be connected to the existing lines at allocated positions to minimize the duration of the temporary use of the name inter-connector line:
- Provide detail of by-pass
- f) At completion of construction at the mentioned new overhead power line section the by-pass lines name shall be disconnected and completely dismantled.
- g) Both sets of temporary by-pass structures including stay assemblies shall be completely dismantled.
- h) All dismantled material and structures from the temporary By-passes shall be loaded, transported to the Employers Works and off-loaded by the Contractor.
- i) The sites of the dismantled by-pass lines shall be properly re-instated to the satisfaction of the Clerk of Work and Environmental Control Official.

10. ACTIVITY STAGE 5

FOUNDATIONS – GEOTECHNICAL INVESTIGATION, FOUNDATION DESIGN OR VERIFICATION, EXCAVATING OF HOLES AND INSTALLATION OF STRUCTURE FOUNDATIONS AND STAYS

10.1. GEOTECHNICAL INVESTIGATION AND SOIL/FOUNDATION TYPE NOMINATIONS

- a) The following Standards, Specifications, Guidelines and Drawings apply:
 - TRMSCAAC1 Rev. 3 -Section 6 Transmission line tower and Line construction;
 - SANS 1200 D -1988 Earthworks;
 - Relevant foundation drawings;
 - Relevant support structure drawings;
 - Line Route Plan;
 - PLSCADD design profile sheets.
- b) Prior to the commencement of any drilling/excavation activities, the Contractor's shall do proper investigations of the sub-soil conditions at all structure positions, in the presence of the Clerk of Works and/or Project Engineer.
- c) The Contractor shall appoint his own professional Civil Engineer/Civil Technologist to do the sub soil geotechnical survey and nomination of the specific soil types at each structure position.
- d) Proper profile test holes to be excavated to the maximum founding depth of each structure, where possible, with a TLB back-actor. Any other method proposed for the sub-soil investigations and soil nominations must be approved by the Project Engineer, prior to the implementation thereof.
- e) A soil profile with identified material layers and depths, including a photograph thereof, as well as the nominated foundation type schedule to be submitted to the Project Engineer for acceptance, prior to the commencement of the foundation excavations.
- f) If any dispute with regards to the nominated foundations types arises between the Contractor and the Employer, the assistance of an independent professional Civil and/or Geotechnical Engineer shall be called upon.
- g) Standard soil classifications:
 - **"Type 1" soils:** Competent soil with equal or better consistency (strength or toughness) than one would encounter in stiff cohesive soils or dense cohesion less soils above the water table. This soil must have a broad balanced texture (constituent particle sizes) with high average combinations of un-drained shear strength and internal angle of friction, with minimum values of 80kN/m² and 30° respectively. The minimum natural specific weight shall not be less than 18kN/m³. Maximum soil bearing pressure 300kPa.
 - **"Type 2" soils:** A less competent soil than "Type 1", with equal or weaker consistency than one would encounter in firm to stiff swelling cohesive soils, or dry poorly graded loose to medium dense cohesion less soils above the water table. The minimum un-drained shear strength shall be 40kN/m², and the minimum natural specific weight shall not be less than 16kN/m³. Maximum soil bearing pressure 150kPa.
 - **"Type 3" soils:** Dry loose cohesion less soil or very soft to soft cohesive soil. Maximum soil bearing pressure 100kPa.
 - **"Type 4" soils:** Submerged cohesion less and cohesive soils. This includes all soils below the permanent water table, including soils below a re-occurring perched water table, or permeable soil in low-lying areas subjected to confirmed seasonal flooding. Maximum soil bearing pressure 50kPa.
- h) Standard rock classifications:

- **“Type A” hard rock:** Hard to very hard solid or moderately fractured continuous rock, and including hard to very hard rock of any other description which meets the strength requirements. The maximum bearing or toe pressure at foundation depth shall be 2 000kPa.
 - **“Type B” soft rock:** Weathered or decomposed very soft to soft continuous rock, and including **rock** of any other description which does not satisfy the requirements for classification under clause 5.1.8 a). The maximum bearing or toe pressure at foundation depth shall be 800kPa.
- i) Standard boulder classifications:
- **“Class A”** Boulder excavation shall be excavations in material containing more than 40% by volume of boulders of size in the range 0,03m³-20m³ in a matrix of soft material or smaller boulders; Excavations in dolomite formations other than solid dolomite will be classed as boulder excavations “Class A” if the formation contains more than 40% by volume of lumps of hard dolomite of size in the range 0,03m³-20m³ in a matrix of soft material or smaller lumps of hard dolomite; Excavations of solid boulders or lumps of size exceeding 20m³ will be classed as hard rock excavations; Excavations of fissured or fractured rock will not be classed as boulder excavations but as hard rock or intermediate excavations, according to the nature of the material.
 - **“Class B”** Boulder excavation shall be excavations in material containing less than 40% by volume of boulders of size in the range 0,03m³-20m³ in a matrix of soft material or smaller boulders and which require individual drilling and blasting in order to be loaded by a track type front-end loader or back-acting excavator; The excavation of the rest of the material shall be classed as soft or intermediate excavations, according to the nature of the material.
- j) Geotechnical design parameters for various soil types:

Table 3: Geotechnical design parameters for various soil types

	“Type 1”	“Type 2”	“Type 3”	“Type 4”
Maximum soil bearing pressure (kPa)	300	150	100	50
Maximum toe bearing pressure (kPa)	375	200	125	65
Frustum angle degrees	30	20	0	0

- k) For maximum soil bearing pressure and maximum toe bearing pressure, use the tabled pressure or 80% of the ultimate tested bearing pressure determined from appropriate tests.
- l) The soil profile excavations shall be suitably backfilled immediately after the relevant inspections and tests have been completed.
- m) Where site conditions, such as difficult access or environmentally sensitive areas, etc. preclude the excavation of a soil profile hole, alternative soils identification procedures shall be proposed by the Contractor and acceptance obtained from the Project Engineer.
- n) Should the foundation conditions at the actual foundation location be found to differ from those identified at the corresponding soil profile, the Contractor shall immediately inform the Clerk of Works and a revised assessment shall be made.

- o) Foundation type excavation quantities measured in the Volume 3 Part 1 are based on assumptions and will be subjected to final re-measurement based on the detail sub-soil geotechnical investigation and soil nominations at each structure and stay position.

10.2. STRUCTURE FOUNDATIONS DESIGN OR VERIFICATION

- a) The appointment of a professional civil engineer will be the responsibility of the contractor and will be paid by the contractor -costs must be included in the tender. Foundation designs are provided for all possible soil types but needs to be verified and approved by a Prof Civil Engineer for each installation. Should the contractor wish to construct a foundation of a different design, all design drawings will be submitted to the Engineer for acceptance. The contractor will accept full responsibility for these designs. The Employer will not pay for these designs. This decision will be taken by the Engineer. Foundation designs for all structures shall be in accordance with **0501KR-01 rev 1, 240-47172520 (TRMSCAAC5) and SCSASABK8** by a registered professional in each type of soil (type 1, 2, 3, 4 soft rock and hard rock).

10.3. FOUNDATION INSTALLATION

10.3.1. Detail setting-out of structure foundation excavations

- a) After acceptance of the geotechnical survey and the foundation nominations by the Project Engineer and prior to the commencement of any drilling/excavation activities the Contractor's shall do the following preparations:
- Check and verify all structure pole and stay anchor positions, as per design and detail drawings and within the tolerances specified in **TRMSCAAC1 Section 6.2.4.3**;
 - Set-out of all nominated foundation details as per Employers Standard foundation design details for each structure.
 - All stay excavation positions to be marked $\pm 1,48\text{m}$ in-line and backwards from the pegged stay positions.

10.3.2. Drilling/excavating of holes for structure foundations

- a) All loose top soil containing grass, plants and /or plant roots whatsoever, shall be removed and temporary stockpiled for re-use at the structure site re-instatement. None of these materials are to be re-used for backfilling in structure foundations.
- b) Drill and/or excavate of holes for structure foundations/poles, as specified in TRMSCAAC1 Section 6.2, as per detail designs or as agreed upon with the Project Engineer for alternative methods suitable for site conditions.
- c) At each structure position, the Contractor shall excavate the appropriate foundation. Excavations in this instance shall be the removal of soil/rock by any accepted means for the purpose of constructing a particular foundation system.
- d) No excavation work, other than for soil investigation, shall be commenced on a section of line until the following conditions have been met:

- The Contractor has submitted the proposed foundation and soil type schedule to the Project Manager;
 - If drilled cast-in-situ piles or rock anchors are proposed, soil samples and pile/anchor tests have been conducted, if so instructed by the Project Manager.
- e) Excavations shall be made to the full dimensions required and shall be finished to the prescribed lines and levels. The bottom or sides of excavations upon or against which concrete is to be poured shall be undisturbed. If, at any point in excavation, the natural material is disturbed or loosened, it shall be filled with 10MPa concrete, including the application of a blinding layer at the base of foundations where these eventualities are likely to occur during the construction process. Soil backfilling will not be accepted.
 - f) In soil type which is incapable of withstanding the design loads which will be imposed upon it by a pad foundation, the Contractor shall propose a method of increasing the effective bearing area of the foundation. This may entail the installation of a foundation with a larger pad or other suitable solutions proposed by the Contractor. Any such proposal shall be submitted to the Project Manager for acceptance prior to excavation.
 - g) When the material at foundation depth is found to be partly rock or incompressible material, and partly a soil or material that is compressible, all compressible material shall be removed for an additional depth of 200mm and filled with 10MPa concrete.
 - h) Excavations for cast-in-situ concrete, including pile caps cast against earth, shall be concreted within seventy-two hours after beginning the excavations. In addition to this general requirement, pile and/or anchor holes that are not adequately protected against the elements to the satisfaction of the Clerk of Works, shall be cast on the same day that drilling/excavation has taken place.
 - i) Excavations that remain not concreted longer than seventy-two hours may, at the option of the Clerk of Works, be required to be enlarged by 150mm in all dimensions.
 - j) The Contractor shall notify the Clerk of Works upon completion of the excavation for the foundations. No concrete is to be placed until the excavation finishes, shuttering and reinforcing steel has been inspected and accepted in writing by the Clerk of Works.
 - k) Structure foundation excavation side walls and edges shall be smooth and square.
 - l) Excavations shall be properly cleaned, all loose sand; stones, vegetation, etc. shall be removed from the excavations prior to the casting of concrete and/or backfilling of excavations.
 - m) All excavated material suitable for backfilling and compaction of structure foundations to be kept clean and free from any vegetation and/or plant roots.
 - n) All unsuitable backfill material, such as soft clay and loose non-compactable sand shall be spoiled and dumped at a suitable dumping site or re-used for structure site re-instatement

10.3.3. Excavation shoring

- a) The Contractor shall supply and install temporary shoring for securing of all structure foundations excavation side walls in collapsible **“Type 3 & 4” soils**.
- b) Shoring shall only be installed for the first two thirds (2/3) of the excavation depth, unless otherwise instructed by the Clerk of Works.

- c) Temporary shoring shall only be removed immediately before the backfilling of excavation commences.
- d) The Contractor shall ensure that excavation shoring strictly conforms to the Occupational Health and Safety Act 85 of 1993 – Construction Regulations Section 11 "Excavations"

10.3.4. Supply of all foundations material and complete construction of all structure foundations

- a) The following foundation material to be supplied by the Contractor:
 - Excavation shoring, where required;
 - Foundation formwork required for all specified foundation types;
 - Concrete material such as, sand, stone, cement and water, if concrete is batched on site;
 - Ready Mix concrete as per specification, if concrete is delivered to site;
 - All reinforcing required for concrete foundations;
 - Galvanized HD Bolts as specified for base plate structures;
 - Cement required for planted structure backfilling stabilization;
 - Imported soil required for planted structure backfilling stabilization, where specified only;
 - I.D. 1,2m "Rocla" pre-cast concrete manhole sections or alternatively purpose manufactured steel rings;
 - Any other material and/or equipment for the proper construction of the structure foundations.
- b) Structure foundations shall be proof load tested as per specification TRMSCAAC1 Rev 3 Section 6.2.5.2. The Contractor shall provide equipment on site during the construction of the pole foundation capable of loading the pole foundation to two-thirds of the maximum design moment. Where instructed by the Clerk of Works, the Contractor shall apply a construction proof load test of two-thirds the maximum design moment to the completed pole.
- c) As part of Activity Stage 5.1 the soil types for foundation installation will be identified by means of a Geotechnical sub-soil investigation done by a Civil Engineer/Technologist appointed by the Contractor. The foundation types will be nominated and recorded accordingly. Nominated foundation type records shall be submitted to the Employer for acceptance.
- d) Foundation excavation side walls and edges shall be smooth and square. Foundation excavations shall be clean prior to the casting of concrete and/or backfilling of excavations. All loose sand, stones, vegetation, etc. shall be removed from the excavations prior to the casting of concrete and/or backfilling of excavations.
- e) Concrete caps as per detail D-DT-7857 at all planted structures only to be constructed after the complete installation and testing of standard and/or additional structure earthing systems.
- f) Concrete mix designs shall be proportioned to obtain a minimum required strength of 25MPa at 28 days, and a target strength of 35MPa, with a maximum water/cement ratio of 0,59. No individual 28 day concrete test cube result shall fall below 85% of the specified strength.
- g) In the absence of any previous statistical data, the mix designs shall be proportioned to attain a characteristic strength of 33MPa at 28 days.

Notwithstanding the above requirements, the minimum cement content shall be 340 kg/m³.

- h) Grout mix designs for rock anchors shall be proportioned to attain a minimum strength of 35MPa at 28 days with any expansive additives included. The use of epoxy grouts is to be used only with the Project Engineer's approval.
- i) Water for the use in concrete shall be clean and free from all earthy, vegetable or organic matter, acids or alkaline substances in solution or suspension.
- j) Prior to any concrete placement the Contractor shall submit the trial mix designs and results of seven and twenty-eight day test cube strengths to the Employer for acceptance.
- k) If ready-mixed concrete is to be used, the Contractor shall obtain, from the ready-mix supplier, aggregate test reports and mix designs that satisfy the requirements. "7-Day" Test cube strength reports of all mix designs and submit to the Employer for acceptance prior to placement of any concrete.
- l) Foundation construction tolerances
 - The intent of this paragraph is to establish tolerances that are consistent with construction practice and the effect that permissible deviations will have upon the structural action or operational function of the structure.
 - Where tolerances are not stated for any individual structure or feature, permissible deviations will be interpreted in conformity with the provisions of this paragraph.
 - The Contractor shall be responsible for setting out and maintaining concrete excavations, shuttering and structural steelwork within the tolerance limits so as to ensure completed work within the specified tolerances.
 - Concrete work, that exceeds the tolerance limits specified shall be remedied, or removed and replaced.
 - Variation in structure location:
 - Transverse to centre-line: Less than 50mm
 - Longitudinal displacement: Less than 300mm
 - Variation in relative vertical elevation of structural steelwork (one leg to another)
 - Less than 5mm
 - Variation in horizontal distance between structural steelwork from that computed
 - Adjacent legs: Less than 5mm
 - Diagonal legs: Less than 7mm
 - Rotation -maximum deviation of transverse axis of structure from bisector of interior line angle
 - Less than 0°12'
 - Elevation -variation of tower base from centre-line peg
 - Minus 150mm
 - Plus 1 000mm
 - Height of concrete foundations above ground level
 - Minimum 150mm
 - Maximum 550mm
 - Variation in relative placement of foundation components from those indicated on drawings, including piles, shuttering and structural steelwork
 - Less than 50mm
 - Tolerances for placing reinforcing steel
 - Variation of protective cover: 5mm

- Variation from indicated spacing: 25mm m)
- Tolerances for guy anchors Guy anchors shall be installed such that the attachment point of the anchor is within 250mm of the correct calculated position.
- The attachment point shall be a minimum of 150mm and a maximum of 650mm above the ground level.
- Guy anchors designed for use with anchor rods extending below ground level shall have the anchor rod installed in line with the guy wire slope, within 5% or such lesser tolerance as required by the design.
- Tolerances for pole foundations.
- Pole foundations shall be constructed such that the pole, and the associated foundation works are within 50mm of the correct calculated position.

m) Workmanship

- Concrete shall be proportioned, mixed, placed and finished in such a manner as to be free of honeycomb, segregation and other defects of workmanship.

n) Formwork

- Forms shall be of wood, metal or other suitable material.
- The forms shall be mortar-tight and shall be designed, constructed, braced and maintained such that the finished concrete will be to true line and elevation, and will conform to the required dimensions and contours.
- Formwork shall be designed to withstand the pressure of concrete, the effect of vibration as the concrete is being placed and all loads incidental to the construction operations without distortion or displacement.
- Where the bottom of the form is inaccessible, provision shall be made for cleaning out extraneous material immediately before placing the concrete.
- All exposed corners of the concrete shall be chamfered approximately 25mm. A suitable nosing tool may be used for horizontal chamfers only if approved by the Clerk of Works.
- All formwork dimensions shall be checked, and if necessary, corrected before any concrete is placed.
- All forms shall be treated with a form-release agent accepted by the Clerk of Works before concrete is placed.
- Any material, which will adhere to, discolour or be deleterious to the concrete, shall not be used.

o) Proportioning of concrete

- The concrete mix shall consist of ordinary Portland cement, fine aggregate, coarse aggregate and water proportioned in accordance with the mix design accepted by Project Engineer.
- Adjustments in these proportions may be directed at any time when found necessary as a result of field tests of the concrete. No change in proportioning shall be made unless instructed by the Clerk of Works.
- As an alternative to the use of ordinary Portland cement, the Project Engineer may consider the use of other approved types of cement or blends thereof.
- No change in the source, character or gradation of materials shall be made without notice to the Clerk of Works and without a revised proportioning mix design being prepared and accepted by the Project Engineer prior to use of the materials.
- During the concrete operations, the concrete mixture shall be tested for each batch by the Contractor to determine the slump of the fresh concrete in

accordance with SANS Method 862. Records of slump tests shall be supplied to the Clerk of Works.

- Test cubes shall be prepared, in accordance with SANS Method 863 at the initiation of concrete placement of each mix design and every day that concrete is batched thereafter.
- Test cubes shall only be made out of a concrete batch at the point of discharge.
- If the Contractor does not make use of independent facilities for the crushing of test cubes and the reporting there-on, then suitable on-site facilities for the crushing of test cubes must be provided by the Contractor, and the Clerk of Works shall witness such tests.
- Additional test cube sets shall be prepared and crushed as requested by the Clerk of Works. Each set of test cubes shall consist of four cubes.
- One to be crushed at seven days, two to be crushed at twenty eight days and one to be held as a spare in the event of a suspect result from one of the other three cubes. The written results of the test cube strength tests shall be immediately forwarded to the Project Engineer upon receipt.
- All cement shall be batched by mass. Cement shall be measured to within 2% accuracy.
- Aggregates may be batched by mass or by volume, provided that volumetric batching equipment is calibrated at the start of concrete operations by weighing a typical discharge.
- The quantities of aggregate batched shall be measured within 3% accuracy. Adjustments of fine aggregate volumes due to "bulking" shall be accounted for in batching.
- The amount of moisture in the aggregates shall be determined daily by a method accepted by the Clerk of Works and the water requirements as per the mix design altered accordingly.
- Water quantities, including aggregate moisture allowances, shall be determined within 2% accuracy. The use of water meters for dispensing water shall be subject to the Clerk of Works acceptance.

p) Mixing of concrete

- Concrete shall be mixed sufficiently to ensure that the various sizes of aggregate are uniformly distributed throughout the mass and each particle of aggregate is adequately coated with cement paste of uniform consistency.
- Concrete delivered to site that lacks homogeneity should be mixed for a longer time or discarded, as directed by the Clerk of Works.
- For mixers of one cubic metre or less, the mixing time shall be not less than ninety seconds after all ingredients have been charged in the mixer.
- For mixers of larger capacities, minimum-mixing times shall be increased by fifteen seconds for each additional half cubic metre of mixer capacity, or fraction thereof.
- Concrete delivered to the construction site shall be mixed en-route. Mixing shall be rigorously controlled for agitating time, mixing time and overall time upon arrival at the foundation site. Concrete discharge shall be completed within one and one-half hours after introduction of the water to the cement and aggregate.
- In exceptional cases only, the Contractor may at his own risk add water to a concrete mix at the point of delivery.
- The maximum amount of water that may be added at site is three litres per cubic metre of concrete.

- At no time shall the water/cement ratio of 0.59 be increased.
 - Non-shrink grout shall be mixed in a suitable mechanical grout mixer/pump accepted by the Clerk of Works.
- q) Placement of reinforcing steel
- After acceptance of the excavation by the Clerk of Works, the Contractor shall install all the reinforcing steel required for foundations.
 - Reinforcing steel shall be fabricated and bent in strict accordance with the drawings and SABS 82.
 - Reinforcing steel, before being positioned, shall be thoroughly cleaned of mill scale and any coatings that will destroy or reduce bond.
 - Reinforcing steel shall be accurately positioned and secured against displacement during placing and vibrating of concrete.
 - Reinforcing bars shall be tied at all intersections with no less than No.18 gauge annealed wire.
 - Reinforcing bars shall be lapped forty-five diameters at all splices, unless shown otherwise on the detail drawings.
 - Reinforcing steel shall be provided and placed as detailed on the detail drawings. h) Unless otherwise shown on the detail drawings, the minimum cover to the main reinforcing bars in a slab, pile cap, chimney, pile or anchor, shall be 50mm.
 - Use of suitable accepted spacers or supports shall be made, to ensure that the minimum concrete cover to the reinforcement is maintained during the placement of concrete.
- r) Placement of embedded items
- The Contractor shall install all required embedded items shown on the detail drawings, prior to placing of concrete.
 - Structural steelwork or holding down bolts shall be accurately positioned and securely held in place during the placement of concrete.
 - The minimum cover to all embedded items, but excluding angle stubs, shall be 150mm.
 - The minimum cover to angle stubs and cleats shall be 75mm unless otherwise shown on the detail drawings.
 - Angle stubs may be supported on the bottom of excavations by either pre-cast concrete slabs set at the correct level by placing suitable grout or concrete underneath it, or on a previously placed binding layer installed up to the correct level.
 - The pre-cast slab shall be square in plan with a side dimension of 300mm and a depth of 75mm and shall be constructed using reinforced concrete with a minimum characteristic strength of 25MPa. g) The placing of loose rubble, stones, bricks, etc. under the pre-cast slab will not be acceptable. h) Structural steelwork or anchor bolts shall be embedded such that the top of the concrete of the foundation correctly coincides with the designed level.
- s) Placement of concrete
- No concrete for foundations shall be placed until each foundation has been inspected and accepted by the Clerk of Works.
 - The foundation at the time of this inspection shall be ready for concrete placement including reinforcing steel, embedded items and any necessary shuttering.

- All surfaces of the foundation upon or against which concrete is to be placed shall be free from mud and/or loose or disturbed material.
- A blinding layer of 10MPa concrete not less than 50mm thick is to be installed on all bottom surfaces of a "Type 3" or "Type 4" foundations.
- The surfaces of dry absorptive materials, against which concrete is to be placed, shall be moistened prior to the placing of concrete to prevent moisture being drawn from the fresh concrete.
- At least two suitable concrete vibrators shall be ready for operation at the site prior to placement of concrete.
- Freshly mixed concrete shall be handled, transported and deposited in such a manner as to prevent segregation or loss of material.
- When discharging by chute, the slope of the chute shall be uniform throughout its length and shall not be flatter than 1 in 3 or steeper than 1 in 2.
- Baffles shall be provided at the end of the chute to ensure a vertical discharge into the foundation.
- The maximum discharge height shall be 3,0m and for heights in excess of this, a tremie pipe shall be used.
- Placement of concrete shall not commence when the air temperature is below 2°C and rising, or below 5°C and dropping.
- The temperature of the concrete mixture immediately before placement shall not exceed 32°C.
- Concrete exceeding this temperature shall be discarded. During hot weather concreting operations, the Contractor shall take the temperature of each batch of concrete.
- No concrete shall be placed which has taken its initial set, regardless of whether the specified one and one-half hour period has elapsed or not.
- If a retarder, accepted by the Project Engineer, has been used, the one and one-half hour period may be exceeded provided the concrete has not taken its initial set.
- The Contractor must dispose of waste concrete in a place acceptable to the Clerk of Works.
- If concrete must be placed under water, a suitable watertight tremie pipe, accepted by the Clerk of Works, of sufficient length to reach the bottom of the excavation shall be used. The tremie pipe shall be free of water when filled with concrete to the bottom of the excavation. The tremie pipe shall be kept full of concrete during the entire placing operation. The discharge end of the tremie pipe must not be lifted out of the freshly placed mass of concrete until placement has been completed.
- Concrete shall be thoroughly settled and compacted into a dense homogeneous mass throughout the whole depth of each layer being consolidated, using internal vibrators.
- Excessive vibration, causing segregation, is to be avoided. Concrete vibrators shall not be used to move concrete.
- The concrete in cast-in-situ piles must be vibrated from the bottom upwards.
- Unless authorised by the Clerk of Works, the Contractor shall not place concrete, unless the Clerk of Works is present during the entire placement operation. v) When alternative foundations consisting of multiple cast-in-situ piles and pile caps are utilised, the Contractor shall at approximately one tower

in twenty, open up on two sides of the completed foundation of one leg, the pile cap and top 500mm of the piles, if so instructed by the Clerk of Works.

- If the foundation is rejected for any reason, the Contractor shall open up as many additional foundations as determined by the Clerk of Works, as is necessary to fully assess the problem.
- Foundations accepted are to be backfilled using 10MPa concrete up to a level at least 150mm above the base of the pile cap.

t) Construction joints

- In general, foundations shall be placed monolithically. Construction joints are to be avoided. If construction joints cannot be avoided and are accepted by the Clerk of Works, the Contractor may be permitted to make a construction joint if the following criteria are met:
 - The concrete is reinforced and the reinforcing steel will develop full bond strength both sides of the construction joint.
 - No construction joints will be allowed in un-reinforced concrete.
 - In single cast-in-situ piles, the construction joint is located one third the depth of the excavation, $\pm 300\text{mm}$ and at least 150mm below the bottom of the structural steelwork or anchor bolts.
 - In multiple cast-in-situ piles, the construction joint is to be 75mm, and in rock anchors 100mm, above either the base of the pile cap excavation or the top of blinding level.
 - If the piles are constructed after the excavation for the pile cap has taken place, suitable ring shutters of the same diameter of the piles shall be used to construct the above mentioned pile/anchor projections.

u) No construction joints will be allowed in pile caps.

v) At all construction joints, the surfaces of the previously placed and hardened concrete shall be thoroughly cleaned of all foreign matter and primed with a 15mm thick layer of a wet mix of cement and sand in equal proportions, in the presence of the Clerk of Works before new concrete is placed. The grout coating shall be brushed over the concrete surface to ensure thorough coverage, particularly between the reinforcing bars. The new concrete shall be placed before the grout coating has taken its initial set.

w) Concrete finish

- The top surface of the foundation shall be at least a wood float finish and shall be contoured to shed water.
- All concrete placed against shuttering shall be free from irregularities, fins, rock pockets or other imperfections.
- Any rock pockets, porous or defective concrete shall be removed to the extent instructed by the Clerk of Works and repaired by filling with concrete, cement mortar or dry packed, as instructed by the Clerk of Works.
- All exposed concrete shall be shuttered to a minimum of 200mm below ground level.
- All exposed concrete edges shall be 25mm chamfered at 45°.

x) Concrete curing

- The Contractor shall provide means of maintaining concrete in a moist condition for at least seven days after the placement of concrete.
- Exposed surfaces shall be kept thoroughly wet 24 hours a day for this period.
- At the Contractor's option, concrete may be cured either by retaining shuttering in place and applying a liquid curing compound which forms a moisture

retaining membrane on un-shuttered concrete surface, or by removing shuttering and applying a curing compound as described to all exposed concrete surfaces.

- Curing compounds utilised shall be of a type accepted by the Project Engineer.
- Notwithstanding these requirements, formwork shall not be removed until at least 36 hours after the final placement of the concrete against such formwork. The Contractor shall remove formwork in such a way that shock and damage to the concrete is avoided.

y) Steelwork

- All galvanised structural steel at the steel/concrete interface shall be cleaned with a suitable cleaner before painting with two protective coats of paint acceptable to Project Engineer.
- This protection shall extend 500mm above and 400mm below the top surface level of the protruding foundation blocks.
- In the case of concrete foundations, no part of the structural steelwork of the tower shall be buried or come into contact with the soil.
- Anchors utilising steel extending below ground line shall be galvanised and then painted with two coats of an accepted bituminous paint, or be encased in concrete with at least 50mm cover. In addition to this requirement, the hot dip galvanised steel guy anchor link plate or bar utilised for the "Deadman" type of anchor foundation, shall be epoxy coated from 300mm below top of concrete level to the top end of the link above ground level.
- Apply in accordance with the manufacturer's specifications one coat of galvanising epoxy primer followed by one coat of aluminium filled epoxy paint.

z) Pole foundations

- The Contractor shall provide equipment on site during the construction of the pole foundation capable of loading the pole foundation to two-thirds of the maximum design moment.
- Where instructed by the Clerk of Works, the Contractor shall apply a construction proof load test of two-thirds the maximum design moment to the completed pole.
- The pole foundation shall be loaded in increments of 50%, 75%, 90% and 100% and then unloaded 50% in 3 cycles of 50% to 100% of the proof test.
- If creep exceeds 1mm/minute at ground level, additional load shall be applied until the creep is less than the stated limit.
- The three 50% loads and three 100% loads shall each be maintained on the pole for 5 minutes.
- If the creep is less than 1mm/minute, the final creep measurements shall be taken after each holding period.
- The pole foundation shall be considered acceptable if the total ground level creep from 50% to 100% load over 3 cycles is less than 30mm. If the creep exceeds 30mm, the foundation shall be modified or replaced by the Contractor and re-tested.
- All pole foundation tests shall be conducted in the presence of the Clerk of Works.

aa) Material mixture for structure backfilling shall consist of:

- 8 Parts of good, clean compactable excavated or imported soil;

- 1 Part of ordinary Portland cement.
- bb) Backfilling material shall be well mixed, slightly watered and thoroughly compacted in layers not exceeding 250mm in thickness.
- cc) Planted guyed and self-supporting structure foundations and backfilling to be constructed as follows:
- All backfilling and compacting of pole excavations to be done in strict accordance with the relevant detail drawings;
 - The excavated material from suitable soil types must be properly cleaned from vegetation and plant roots, etc.
 - After cleaning the excavated material must be mixed with cement in the relation 1 part of cement to 10 parts of soil, prior to the backfilling thereof;
 - Unsuitable excavated material, such as vegetation contaminated topsoil, soft clay or very loose sand, must be spoiled and a good compactable type of material such as natural gravel shall be imported and used for backfilling, as described in (c), above;
 - The stabilized soil must be backfilled, slightly watered and thoroughly compacted in layers not exceeding 250mm in thickness;
 - Proper Dynamic Cone Penetrometer (DCP) compaction tests, as specified in TMH6 Method ST6, to be executed during the backfilling and compaction of each pole foundation;
 - Random backfilling compaction tests as instructed by the Clerk of Works shall be done by the Contractor;
 - A copy of all compaction test records taken must be submitted to the Project Engineer for approval and the approved copies must be kept on file for future references;
 - A section of the pole 300mm above and 500mm below natural ground level shall be properly treated with at least two coats of an approved corrosion protection coating, prior to the casting of the concrete caps.
 - Weathered and/or damaged factory applied bitumen coatings shall be re-treated prior to the casting of the concrete caps.
 - All required standard and/or additional structure earthing systems shall be completely installed, prior to the construction of the concrete caps.
 - I.D. 1,2m x 0,25m-1,0m high "Rocla" pre-cast manhole sections must be installed in pole excavations where poor, collapsible and sandy soil conditions are present;
 - A 25MPa reinforced concrete cap, 1,2 x 1,2 x 0,5m deep as per drawing D-DT-7857 must be cast around all planted structure legs.
 - Alternatively a dia 1,2m x 500mm deep mass concrete cap can be cast around planted structure legs, using a I.D. 1,2m x 500mm high "Rocla" pre-cast manhole section as permanent formwork, with levels as per detail drawing, unless otherwise specified by the Project Engineer;
 - All over-excavations outside manhole rings and also deeper as required holes shall be backfilled and compacted as specified in (b) and (c) above, at the Contractor's own cost;
 - All excess excavated and/or spoiled material not required for backfilling must be removed from site and dumped at a suitable dumping site, unless otherwise specified by the Clerk of Works;

- All concrete spatter around the structure base must be properly cleaned from the structure prior to the hardening thereof.

dd) Supply anti-theft compound and treatment of lattice steel tower members and stay assemblies

ee) The following Standards and Specifications apply:

TSP_474-285 Specification for anti-theft measures;

12TI-013 Technical instruction for the implementation of member anti

theft strategies.

ff) The Contractor shall supply all bitumastic paint and tile cement/glue required for the anti-theft treatment of lattice tower members and adjustable stay assemblies.

gg) After the complete construction of the entire new line, the bottom part members of all lattice towers (Foundation top level to and including anti-climbing device level) shall be thoroughly treated with minimum 2 coats of a bitumastic paint/tile glue 1:2 ratio mixture as per Technical Instruction 12TI-013.

hh) After the complete installation and tensioning of all permanent stays, the Contractor shall thoroughly treat the bottom part (150mm below ground level to $\pm 1,5$ m above ground level) of all permanent stay assemblies with minimum 2 coats of a bitumastic paint/tile glue 1:2 ratio mixture as per Technical Instruction 12TI013.

10.3.5. Barricading/protecting of all open excavations

- a) All excavated/drilled holes for poles and stays shall be kept covered, protected and/or barricaded in a manner acceptable for the Clerk of Works and also to prevent any possible injuries to pedestrians, livestock, game and smaller wild animals and rodents.
- b) Failure to maintain proper protection of excavated holes by the Contractor shall result in the suspension of all excavation/drilling activities until proper protection has been restored.
- c) The Contractor shall ensure that excavation barricading/protection strictly conforms to the Occupational Health and Safety Act 85 of 1993 – Construction Regulations Section 11 “Excavations”

10.4. STAY ROD & FOUNDATIONS DESIGN OR VERIFICATION

- a) The appointment of a professional civil engineer will be the responsibility of the contractor and will be paid by the contractor -costs must be included in the tender. Foundation designs are provided for all possible soil types but needs to be verified and approved by a Prof Civil Engineer for each installation. Should the contractor wish to construct a foundation of a different design, all design drawings will be submitted to Eskom for acceptance. The contractor will accept full responsibility for these designs. Eskom will not pay for these designs unless the submitted Eskom designs cannot be used due to prevailing site conditions. This decision will be taken by the Engineer. Foundation designs for all structures shall be in accordance with 0501KR-01 rev 1, 240-47172520 (TRMSCAAC5) and SCSASABK8 by a registered professional in each type of soil (type 1, 2, 3, 4 soft rock and hard rock).

10.5. STAY ROD AND FOUNDATION INSTALLATION

10.5.1. Drilling/excavating of holes for permanent and temporary structure stays

- a) Drill and/or excavate maximum 1,75m deep holes for conventional stay installations, complete with a 45°-55°x max. 80mm wide stay slot for the stay rod, or as agreed upon with the / for alternative methods suitable for site conditions.
- b) The stay installation angles to be between 45°-35° with the vertical, unless otherwise specified by the Project Engineer.
- c) At site conditions where solid rock/granite is present at very shallow levels, alternative methods for structure and stay anchor installations will be evaluated and considered as a cost saving measure, only. The Project Engineer shall evaluate and approve the Contractor's proposal for such rock anchor installations.
- d) Rock anchors shall be installed at the specified angles between 45°-35° with the vertical.

10.6. BARRICADING/PROTECTING OF ALL OPEN EXCAVATIONS

- a) All excavated/drilled holes for poles and stays shall be kept covered, protected and/or barricaded in a manner acceptable for the Clerk of Works and also to prevent any possible injuries to pedestrians, livestock, game and smaller wild animals and rodents.
- b) Failure to maintain proper protection of excavated holes by the Contractor shall result in the suspension of all excavation/drilling activities until proper protection has been restored.
- c) The Contractor shall ensure that excavation barricading/protection strictly conforms to the Occupational Health and Safety Act 85 of 1993 – Construction Regulations Section 11 “Excavations”

11. ACTIVITY STAGE 6

INSTALLATION OF POWER LINE STRUCTURES

11.1. SAFE STOCK-PILING/STORAGE, HANDLING AND TRANSPORT OF STRUCTURES AND STRUCTURE MATERIAL AND STAYS

- a) The Employer shall transport all steel mono-pole, H-pole structures and steel lattice towers required for this project. The structure segments and tower members will be delivered to a pre-determined bulk stockpiling site/s.
- b) The Contractor will be responsible for the proper and safe stockpiling of the structure segments and tower members as well as the safe handling and delivery to peg thereof. Refer to Volume 3 Part 1 section 6.1 of this document for all structure quantities and details to be supplied by the Employer for this project.
- c) The “Type 247A” double circuit intermediate suspension tower (Twin Bear, 2 x single 7x3.35 earth wires) shall have body extensions according to the bottom conductor attachment heights CAH requirements of 14.1m, 15.1m, 16.1m, 17.1m, 19.1m and 20.1m. Structure and position specific leg extensions as determined by soil topography will be ordered by the contractor after verification by the contractor.

Foundation stubs are part of the foundation and will be supplied by the contractor based on the soil condition requirements.

- d) The "Type 247B" 0°-40° double circuit angle strain tower (Twin Bear, 2 x single 7x3.35 earth wires) shall have body extensions according to the bottom conductor attachment heights CAH requirements of 14.1m, 15.1m, 16.1m, 17.1m, 19.1m and 20.1m. Structure and position specific leg extensions as determined by soil topography will be ordered by the contractor after verification by the contractor. Foundation stubs are part of the foundation and will be supplied by the contractor based on the soil condition requirements.
- e) The "Type 247C" 40°-90° double circuit angle strain tower (Twin Bear, 2 x single 7x3.35 earth wires) shall have body extensions according to the bottom conductor attachment heights CAH requirements of 14.1m, 15.1m, 16.1m, 17.1m, 19.1m and 20.1m. Structure and position specific leg extensions as determined by soil topography will be ordered by the contractor after verification by the contractor. Foundation stubs are part of the foundation and will be supplied by the contractor based on the soil condition requirements.
- f) The "Type 247C" 0°-40° double circuit terminal tower (Twin Bear, 2 x single 7x3.35 earth wires) shall have body extensions according to the bottom conductor attachment heights CAH requirements of 14.1m, 15.1m, 16.1m, 17.1m, 19.1m and 20.1m. Structure and position specific leg extensions as determined by soil topography will be ordered by the contractor after verification by the contractor. Foundation stubs are part of the foundation and will be supplied by the contractor based on the soil condition requirements.
- g) The "Type 248A" single circuit horizontal intermediate suspension tower (Single Zebra, 2 x single 7x3.35 earth wires) shall have body extensions according to the bottom conductor attachment heights CAH requirements of 14.1m, 15.1m, 16.1m, 17.1m, 19.1m and 20.1m. Structure and position specific leg extensions as determined by soil topography will be ordered by the contractor after verification by the contractor. Foundation stubs are part of the foundation and will be supplied by the contractor based on the soil condition requirements.
- h) The "Type 248B" 0°-40° single circuit angle strain tower (single Zebra, 2 x single 7x3.35 earth wires) shall have body extensions according to the bottom conductor attachment heights CAH requirements of 14.1m, 15.1m, 16.1m, 17.1m, 19.1m and 20.1m. Structure and position specific leg extensions as determined by soil topography will be ordered by the contractor after verification by the contractor. Foundation stubs are part of the foundation and will be supplied by the contractor based on the soil condition requirements.
- i) The "Type 248C" 40°-90° single circuit angle strain tower (Single Zebra, 2 x single 7x3.35 earth wires) shall have body extensions according to the bottom conductor attachment heights CAH requirements of 14.1m, 15.1m, 16.1m, 17.1m, 19.1m and 20.1m. Structure and position specific leg extensions as determined by soil topography will be ordered by the contractor after verification by the contractor. Foundation stubs are part of the foundation and will be supplied by the contractor based on the soil condition requirements.
- j) The "Type 248C" 0°-45° single circuit terminal tower (single Zebra, 2 x single 7x3.35 earth wires) shall have body extensions according to the bottom conductor attachment heights CAH requirements of 14.1m, 15.1m, 16.1m, 17.1m, 19.1m and 20.1m. Structure and position specific leg extensions as determined by soil topography will be ordered by the contractor after verification by the contractor.

Foundation stubs are part of the foundation and will be supplied by the contractor based on the soil condition requirements.

- k) The "Type 255A" single circuit intermediate suspension tower (single Wolf, 1 x single 7x3.35 earth wires) shall have body extensions according to the bottom conductor attachment heights CAH requirements of 13.1m, 16.1m and 19.1m. Structure and position specific leg extensions as determined by soil topography will be ordered by the contractor after verification by the contractor. Foundation stubs are part of the foundation and will be supplied by the contractor based on the soil condition requirements.
- l) The "Type 255B" 0°-10° single circuit angle strain tower (single Wolf, 1 x single 7x3.35 earth wires) shall have body extensions according to the bottom conductor attachment heights CAH requirements of 12.1m, 13.1m, 14.1m, 15.1m, 16.1m and 17.1m. Structure and position specific leg extensions as determined by soil topography will be ordered by the contractor after verification by the contractor. Foundation stubs are part of the foundation and will be supplied by the contractor based on the soil condition requirements.
- m) The "Type 255C" 10°-45° single circuit angle strain tower (single Wolf, 1 x single 7x3.35 earth wires) shall have body extensions according to the bottom conductor attachment heights CAH requirements of 12.1m, 13.1m, 14.1m, 15.1m, 16.1m and 17.1m. Structure and position specific leg extensions as determined by soil topography will be ordered by the contractor after verification by the contractor. Foundation stubs are part of the foundation and will be supplied by the contractor based on the soil condition requirements.
- n) The "Type 255C" 0° single circuit terminal tower (single Wolf, 1 x single 7x3.35 earth wires) shall have body extensions according to the conductor attachment heights CAH requirements of 14.1m, 15.1m, 16.1m, 17.1m, 19.1m and 20.1m. Structure and position specific leg extensions as determined by soil topography will be ordered by the contractor after verification by the contractor. Foundation stubs are part of the foundation and will be supplied by the contractor based on the soil condition requirements.
- o) The "Type 255D" 10°-90° single circuit angle strain tower (single Wolf, 1 x single 7x3.35 earth wires) shall have body extensions according to the bottom conductor attachment heights CAH requirements of 12.1m, 13.1m, 14.1m, 15.1m, 16.1m and 17.1m. Structure and position specific leg extensions as determined by soil topography will be ordered by the contractor after verification by the contractor. Foundation stubs are part of the foundation and will be supplied by the contractor based on the soil condition requirements.
- p) The "Type 255D" 0°-30° single circuit terminal tower (single Wolf, 1 x single 7x3.35 earth wires) shall have body extensions according to the bottom conductor attachment heights CAH requirements of 12.1m, 13.1m, 14.1m, 15.1m, 16.1m and 17.1m. Structure and position specific leg extensions as determined by soil topography will be ordered by the contractor after verification by the contractor. Foundation stubs are part of the foundation and will be supplied by the contractor based on the soil condition requirements.
- q) The "258C" Intermediate Two-pole Braced Double Circuit Structures shall be flange bolted jointed steel pole self-supporting structures. Back to back angle-ion braces will join the poles with bolted connections to the poles. A braced insulator arrangement will be used to attach the phase conductors.

- r) The "2-ET/15049" Intermediate Double Circuit Structures shall be a telescopically jointed mono-pole. A 1290mm double earth wire bracket for twin suspension earth wires shall be supplied as part of the structure
- s) All "2-WT/1294" Twin Kingbird/Bersfort single circuit intermediate suspension structures shall be a planted telescopically jointed steel mono-pole self-supporting structures. It will be equipped with bird perching brackets as per detail drawing D-DT-7347. A double earth wire bracket for an earth wire and OPGW suspension shall be supplied with the structures.
- t) The "2-WT/1295" Twin Kingbird/Bersfort single circuit strain structures shall be a telescopically jointed, planted steel mono-pole guyed structure. Phase conductor and stay position arrangements will be designed to suit application conditions.
- u) The "2-WT/1296" Twin Kingbird/Bersfort single circuit, strain 3-pole structure is a planted steel mono-pole guyed structure. The poles are telescopically jointed and one phase of the circuit is attached per pole. Earth wires will be strung on the outside poles of the structure. The stay position arrangements will be designed to suit application conditions.
- v) The "2-WT/1297" Twin Kingbird/Bersfort single circuit, terminal 3-pole structure is a planted steel mono-pole, guyed structure. The poles are telescopically jointed and one phase of the circuit is attached per pole. Earth wires will be strung on the outside poles of the structure. The stay position arrangements will be designed to suit application conditions.
- w) All "2-WT/1281" Bersfort single circuit intermediate suspension structures shall be a telescopically jointed steel mono-pole guyed structure. A braced insulator arrangement will be used to attach the phase conductors. It will be equipped with bird perching brackets as per detail drawing D-DT-7347. A double earth wire bracket for an earth wire and OPGW suspension shall be supplied with the structures.
- x) The "2-WT/1284" Bersfort single circuit strain structures shall be a telescopically jointed, steel mono-pole guyed structure. Phase conductor and stay position arrangements will be designed to suit application conditions.
- y) The "2-WT/1285" Bersfort single circuit, inline strain 3-pole structure is a guyed steel mono-pole structure. The poles are telescopically jointed and one phase of the circuit is attached per pole. Earth wires will be strung on the outside poles of the structure. The stay position arrangements will be designed to suit application conditions.
- z) The "2-WT/1286" Bersfort angle strain single circuit, terminal 3-pole structure is a guyed steel mono-pole structure. The poles are telescopically jointed and one phase of the circuit is attached per pole. Earth wires will be strung on the outside poles of the structure. The stay position arrangements will be designed to suit application conditions.
- aa) The "Type 7611" single circuit intermediate suspension structures shall be telescopically jointed steel mono-pole self-supporting structures having a minimum tip load of 23kN and shall be equipped with bird perching brackets as per detail drawing D-DT-7347. Special designed OPGW suspension brackets shall be supplied with the structures.
- bb) The "Type 7615" angle strain structures shall be telescopically jointed, planted steel mono-pole guyed structures having a minimum tip load of 23kN. The stay position arrangements will be designed to suit application conditions.
- cc) The "Type 7618" angle strain 3-pole structure is a guyed steel mono-pole structure. The poles are telescopically jointed and one phase of the circuit is attached per

- pole. Earth wires will be strung on the outside poles of the structure. The stay position arrangements will be designed to suit application conditions
- dd) The "2-WT-1213" terminal 3-pole structure is a guyed steel mono-pole structure. The poles are telescopically jointed and one phase of the circuit is attached per pole. Earth wires will be strung on the outside poles of the structure. The stay position arrangements will be designed to suit application conditions
 - ee) All "Type 7649" single circuit intermediate suspension structures shall be telescopically jointed steel mono-pole self-supporting structures with "Raptor Friendly" suspension arms having a minimum tip load of 23kN and shall be equipped with bird perching brackets as per detail drawing D-DT-7347. Special designed OPGW suspension brackets shall be supplied with the structures.
 - ff) All "Type 7621" double circuit steel mono-pole intermediate structures shall be telescopically jointed steel mono-pole self-supporting structures with a minimum tip load of 37kN and shall be equipped with bird perching brackets as per detail drawing D-DT-7347. Special designed OPGW suspension brackets shall be supplied with the structures.
 - gg) All "Type 7649DC" double circuit steel mono-pole intermediate suspension structures shall be telescopically jointed steel mono-pole self-supporting structures with "Raptor Friendly" suspension arms having a minimum tip load of 37kN and shall be equipped with bird perching brackets as per detail drawing D-DT-7347. OPGW suspension brackets shall be supplied with the structures.
 - hh) All "Type 7800" single circuit intermediate suspension structure legs shall be flange jointed steel H-pole self-supporting structures, having minimum diameter 324mm legs with a 8,2m specially designed cross-arm and shall be equipped with bird perching brackets for each leg as per detail drawing D-DT-7347. Special designed OPGW suspension brackets shall be supplied with the structures.
 - ii) All "Type 7801" in-line strain structures shall be flange jointed steel H-pole guyed structures having leg diameters of 219mm-324mm and shall have a 8,2m x 70kN cross braced cross-arm as per structure detail.
 - jj) All "Type 7802" in-line strain structures shall be flange jointed steel H-pole guyed structures having leg diameters of 219mm-324mm and shall have a 8,2m x 120kN cross braced cross-arm as per structure detail.
 - kk) All "Type 7807" terminal structures shall be flange jointed steel H-pole guyed structures having a leg diameters of 219mm and shall have a 8,2m x 70kN cross braced cross-arm as per structure detail.
 - ll) All "Type 7808" terminal structures shall be flange jointed steel H-pole guyed structures having leg diameters of 219mm-324mm and shall have a 8,2m x 120kN cross braced cross-arm as per structure detail.
 - mm) All "Type 7810" single circuit intermediate suspension structure legs shall be flange jointed steel H-pole self-supporting structures, having minimum diameter 324mm legs with a 10,2m specially designed cross-arm and shall be equipped with bird perching brackets for each leg as per detail drawing D-DT-7347. Special designed OPGW suspension brackets shall be supplied with the structures.
 - nn) All "Type 7811" in-line strain structures shall be flange jointed steel H-pole guyed structures having a leg diameters of 219mm and shall have a 10,2m x 70kN cross braced cross-arm as per structure detail.
 - oo) All "Type 7812" in-line strain structures shall be flange jointed steel H-pole guyed structures having leg diameters of 219mm-324mm and shall have a 10,2m x 120kN cross braced cross-arm as per structure detail.

- pp) All "Type 7817" terminal structures shall be flange jointed steel H-pole guyed structures having a leg diameters of 219mm and shall have a 10,2m x 70kN cross braced cross-arm as per structure detail.
- qq) All "Type 7818" terminal structures shall be flange jointed steel H-pole guyed structures having leg diameters of 219mm-324mm and shall have a 10,2m x 120kN cross braced cross-arm as per structure detail.
- rr) All "Type 7645" in-line and angle strain structures shall be telescopically jointed steel mono-pole guyed structures having a minimum tip load of 23kN and shall be equipped with dia 12mm x 450mm long steel rod spikes as per structure detail.
- ss) All "Type 7645" double circuit in-line and angle strain structures shall be telescopically jointed cross braced steel 2-pole guyed structures having a minimum tip load of min. 23kN/pole and shall be equipped with dia 12mm x 450mm long steel rod spikes for each pole as per structure detail.
- tt) All "Custom" or "site specific" structure may be complete new structure designs or revisions of existing structure designs to the specific site conditions. For these type of structures the Engineer will provide the wire load on the structure. The contractor shall allow for a detail structure and foundation design by the manufactures, the wind load on the structure must be included by the manufacturers Engineer.
- uu) Flange mounted poles shall preferably be telescopic steel monolithic self-supporting structures. All HD bolts, top and bottom templates shall be included by the contractor into the priced material rate. The contractor shall allow for raking of all flange mounted structures.
- vv) All mono-pole structures shall be provided with 2 x "Earth lugs", One lug on each transversal side of the structure at natural ground level for all planted poles.
- ww) All H-pole and 2-pole structures shall be provided with 2 x "Earth lugs", One lug per structure leg at natural ground level for all planted poles.
- xx) All 3-pole structures shall be provided with 3 x "Earth lugs", One lug per structure leg at natural ground level for all planted poles.
- yy) All structure shafts to be provided with cleats for removable steps, installed at 8,0m from natural ground level to maximum level of 1,0m from the structure top.
- zz) Complete set removable steps will be supplied by the Employer for this project. The removable steps shall be used by the Contractor for construction purposes only and will be handed over to the local Field Services Department for future maintenance use.
- aaa) All structural steel shall be Grade S355JR steel to SANS 1431 and hot dipped galvanised to SANS 121. Structure bolts shall be Grade 4.6 ordinary bolts, nuts and washers to be shall be hot dipped galvanized to SANS 121.
- bbb) The appointed Structure/Tower Manufacturers and Project Engineer shall meet to discuss all non-standard requirements on all for the structures and towers for this project, prior to the manufacturing thereof.
- ccc) All structure segments and tower members shall bear a legible permanent identification mark, which must be easily visible after completion of the assembling and erection of the structures. Except for the Manufacturer's own identification marks, the following information shall be included on the identification label, name:
- ddd) Structure type (PLSCADD design code);
- eee) The actual structure length;
- fff) Examples: "247C -17.1m"; "7615 -23kN -21,0m"; "7611 -23kN -24,0m "

ggg) One complete set of the Manufacturer's detail structure/tower assembly drawings shall be submitted by the Structure Manufacturer to the Project Engineer for final approval prior to the manufacturing thereof.

hhh) The following care shall be taken by the Manufacturer's transport contractor and Contractor during the handling and transport of the structure segments and tower members:

- Method statements shall be compiled by the relevant manufacturer for the proper and safe handling and transport of all structure segments and tower members;
- Tower members shall be securely bundled and each bundle shall be clearly marked for identification;
- Structure segments and tower members shall be properly loaded with wooden spacers between segments, when transported;
- Structure segments and tower members shall not be dropped from transporting vehicles, but shall be carefully off-loaded and stacked on the wooden block spacers; e) Structure segments and tower members shall be handled with nylon or fabric slings. The use of unprotected wire rope slings or chains will not be allowed;
- Structure segments and tower members, when off-loaded at peg, shall be off-loaded onto wooden blocks in the veld and not left lying in direct contact with the ground;
- Structure segments and tower members, when layout at peg, must be off-loaded in the correct proportions to avoid dragging of the sections on the ground and/or unnecessary double handling.

iii) Any damages caused to the structure segments due to careless and reckless handling by the Contractor shall be rectified by the Contractor at his own cost and to the approval of the Clerk of Works/Project Engineer.

jjj) Assembly and erection of structures

- The telescopic jointed structure segments shall be fitted and compressed on the ground to obtain the nominal length of the structure as specified on the Manufacturer's detail drawings.
- The telescopic jointed structure segments shall be fitted and compressed on the ground to obtain the nominal length of the structure as specified on the Manufacturer's detail drawings.
- Tools and equipment used by the Contractor for the assembly of structures shall not scar or deform the steel material, nor damage the protective coating on the steel and must be approved by the Clerk of Works, prior to the use thereof.
- Suspension arms, bird perching brackets, shield wire and OPGW suspension brackets and suspension assemblies shall be fitted to all "Types 7611, 7612 & 7649 & 7649DC" structures, prior to the erection thereof.
- The threads of all torqued structure bolts shall be properly punched at minimum three positions at the "nut-neck" and completely covered with at least one coat of a "Carboline Rustbond Penetrating Sealer ZA", "Exotropic Etch coat" or similar product approved by the Project Engineer.
- No structure shall be erected by the Contractor prior to the complete installation of permanent and temporary underground stay assemblies, the approval of the pole excavations as well as foundation base construction and curing by the Clerk of Works.

- The erection of H-pole and mono-pole structures shall be subjected to the following criteria:
 - All structures shall be erected vertically within 2mm in 1,0m in both transversal and longitudinal directions. For the correct structure orientations in relation to the line direction refer to layout drawings;
 - During the structure erection the tension in all stays shall be 10%
- All structures shall be properly cleaned prior to the erection thereof. Sand, mud and other dirt must be thoroughly cleaned with nylon brushes.
- The planting depths of the supporting intermediate suspension structures vary and are specified on according to each structure length. For structure foundation backfilling specifications refer to structure foundation detail drawings.
- The guyed in-line and angle strain structures shall be planted max. 2,0m deep. Variations on the planting depth will be indicated in the design document and as a comment on the PLSCADD drawings. For structure foundation backfilling specifications refer to structure foundation detail drawings.
- The "Type 7801, 7802, 7807, 7808, 7811, 7812, 7817 & 7818" guyed H-pole strain and terminal structure legs to be planted max. 2,0m deep with the assemble cross-arm to be 100% level as specified on detail drawings. For structure foundation backfilling specifications refer to structure foundation detail drawings D-DT-7851. The "Type 7800 and 7810" structures have planting depths according to the pole length as indicated on the structure and foundation drawings.
- The bottom parts of all lattice steel towers including the anti-climbing device clamps shall be assembled with swaged bolts as per Specification TSP 474-285 and treated with an anti-theft compound as per Technical Instruction 12TI-013.

12. ACTIVITY STAGE 7

TRANSPORT AND INSTALLATION OF POWER LINE STRUCTURE EARTHING

12.1. TRANSPORT AND INSTALLATION OF POWER LINE STRUCTURE EARTHING

12.1.1. Transport of power line structure earthing material

- a) The following Standards, Specifications, Guidelines and Drawings apply:
 - SCSASABF9 Sub-transmission line Earthing Specification;
 - Project File PLSCADD design profile sheets;
 - Project File PLSCADD design staking table;
 - Design Bill of Material.
- b) The Contractor shall deliver to site all earthing material required for the power line structure earthing, as well as Agricultural Gypsum required for earth trench backfilling.
- c) The Employer supply and deliver to site all flat copper earth bonding straps required for underground substation bonding.

12.2. COMPLETE INSTALLATION OF POWER LINE STRUCTURE EARTHING

All power line structures shall be earthed to the required earth resistance.

12.2.1. Standard structure earthing

- a) A 3 point star earth electrode (D-DT-0640) consists of:
- x dia 16mm x 1.5m long copper clad high tensile steel earth rod, with 4 x earth rod clamps to connect 16mm² 7/1.63 bare annealed copper conductor.
 - x 7/1.63 bare annealed copper conductor lengths are connected with a 4 x 16SQ line tap.
 - x 6m lengths of the above bare copper are connected to the earth rods.
 - 1 x 1m lengths of the bare copper are connected to the forth earth rod
 - 1 x 6m length of the bare copper are bolted to the pole's 50mm x 50mm x 8mm thick earth pad with a 16.0 SQ M12 crimp lug.
- b) Installation: A 3 point star earth electrode (D-DT-0640) shall be installed as follow:
- The electrode layout is in the shape of a crow foot as indicated on D-DT-0640
 - A min. 300mm wide earth rod trench shall be excavated to a depth of 1m in the layout shape.
 - The 4 earth rods will be vertically installed at the ends of the trenches.
 - The bottom ± 150 mm of the earth trenches shall be backfilled with a well mixed 3:1 clean top soil/agricultural gypsum mixture, after installation of the earth rods.;
 - The contact surfaces between the structure and the earth rod shall be clean and treated with a thick application of contact grease to ensure a proper conductive connection, prior to the bolt connection;
 - Backfill and thoroughly compact earth trenches.
 - At planted structure or structure legs, the standard and additional earthing systems shall be completely installed flat next to the structure/leg surface, prior to the construction of the concrete cap.
- c) An alternative earthing system for high theft areas consists of:
- 1 x dia 16mm x 3,6m long copper coated high tensile steel earth rod, with and 50 x 50 x 8mm thick mild steel earth lug factory welded to one end. Earth to have a dia 18,0mm hole drilled in the centre of the lug.
 - Earth rod to be bent to suit site conditions. Minimum bend radii to be 100mm.
 - One x M16 x 40mm long Grade 4.8 hexagon bolt nut and two x M16 flat round washers.
 - The earth rod shall be bolt jointed to the structure earth lug.
- d) Installation: The alternative systems for all structures shall be installed as follows:
- All steel pole structures shall be provided with Two 50mm x 50mm x 8mm thick earth pads welded to the structure base and/or leg;
 - The copper coated earth rod shall be bent and installed in alternating diagonal directions with the power-line direction;
 - The earth rod shall be smoothly bent with an approved rod-bender at min. 100mm radii. No sharp and/or kinked bends shall be allowed in the earth rods;

- The one end of the earth rod shall bolt jointed to the structure at the allocated earth pad;
 - The opposite end of the earth rod shall be installed in a min. dia 100mm x max. 1,5m deep vertically drilled earth rod hole;
 - The earth rod hole shall be drilled $\pm 1,5\text{m}$ deep at positions $\pm 2,0\text{m}$ away from the structure in alternating diagonal directions with the power-line direction;
 - A min. 300mm wide earth rod trench shall be excavated in the alternating diagonal directions min. 550mm deep, between the structure or structure leg to the drilled earth rod hole;
 - The total earth rod hole as well as the bottom $\pm 150\text{mm}$ of the earth trenches to be backfilled with a well mixed 3:1 clean top soil/agricultural gypsum mixture, after installation of the earth rods;
 - A section of the earth rod (From and including the structure connection point to $\pm 500\text{mm}$ below natural ground level) must be properly treated with at least two coats of an approved Bitumen or Aluminium based coating;
 - The contact surfaces between the structure and the earth rod shall be clean and treated with a thick application of contact grease to ensure a proper conductive connection, prior to the bolt connection;
 - Backfill and thoroughly compact earth trenches.
 - As a rule each line terminal structure shall be provided with two standard structure earthing systems, unless otherwise specified.
 - At planted structure or structure legs, the standard and additional earthing systems shall be completely installed flat next to the structure/leg surface, prior to the construction of the concrete cap.
- e) Counterpoise earthing installed for lattice towers consist of:
- Install a 40 x 3 mm galvanized steel strap within each lattice tower foundation to connect the steel stub to the foundation reinforcement
 - Install 10mm copper clad steel at each tower leg until the footing resistance of 20Ω are reached or
 - Install 15m lengths of 25mm^2 bare copper at each tower leg until the footing resistance of 20Ω are reached
- f) Installation: Counterpoise earthing
- The electrode layout is radially away from the tower legs.
 - A min. 300mm wide earth rod trench shall be excavated to a depth of 1m according to the layout.
 - The bottom $\pm 150\text{mm}$ of the earth trenches shall be backfilled with a well mixed 3:1 clean top soil/agricultural gypsum mixture, after installation of the earth rods.;
 - The contact surfaces between the structure and the earth rod shall be clean and treated with a thick application of contact grease to ensure a proper conductive connection, prior to the bolt connection;
 - Backfill and thoroughly compact earth trenches.
 - At planted structure or structure legs, the standard and additional earthing systems shall be completely installed flat next to the structure/leg surface, prior to the construction of the concrete cap.
- g) Bonding of 3-Pole structures and the bonding of terminal structures to the substation earth mat:
- Bond the terminal structures to the substation earth mat by using 50 x 3mm flat Cu strap or 2 x parallel lengths of 10mm copper clad steel,

- Bond the 3 poles of 3-Pole structures to each other by using 50 x 3mm flat Cu strap or or 2 x parallel lengths of 10mm copper clad steel.
- h) Installation: Bonding of 3-Pole structures and the bonding of terminal structures to the substation earth mat
- Install the bonding electrodes at a depth of 1m.
 - A min. 300mm wide earth rod trench shall be excavated to a depth of 1m according to the layout.
 - The bottom ± 150 mm of the earth trenches shall be backfilled with a well mixed 3:1 clean top soil/agricultural gypsum mixture, after installation of the earth rods.;
 - The contact surfaces between the structure and the earth rod shall be clean and treated with a thick application of contact grease to ensure a proper conductive connection, prior to the bolt connection;
 - Backfill and thoroughly compact earth trenches.
- i) After the complete installation of the standard structure earthing systems all structure footing resistances shall be measured by the Contractor in the presence of the Clerk of Works and results shall be recorded. Structure footing resistance records shall be submitted to the Project Engineer for evaluation.
- j) All structure footing resistances on 33-132kV lines shall be less than 20 Ohm, except for the terminal structure footing resistances which must be less than 10 Ohm and bonded to the substation main earth mat.
- k) Structure footing resistance measurements of each structure shall be taken by the Contractor immediately after installation of the standard structure earthing system, prior to the installation and connection of the overhead shield wire onto the structures and the construction of the concrete caps.
- l) The 61.8% Method shall be used to do the structure footing resistance measurements. Refer to Distribution Standard SCSASABF9 Section 4.13 for recommended structure footing resistance measurement methods.
- m) The HW2A high frequency instrument shall be treated as any other meter requiring the Project Engineer's approval. The meter shall be calibrated to match the surge impedance of the line, otherwise the impact of the other associated towers connected to the shielding wire, will not be excluded from the result.
- n) Should the Contractor wish to use another type of instrument, the details of its intended application and test methodology shall be submitted to the Project Engineer for acceptance.
- o) In situations where the required structure footing resistances cannot be obtained with the installed standard earthing systems, due to soils with a very high resistivity, the methods for additional and/or counterpoise earthing must be clarified with the Project Engineer, see paragraphs below.

12.2.2. Additional structure earthing

- a) After the complete installation of a standard structure earthing system at all structures, the footing resistances shall be measured by the Contractor and in situations where the measured structure footing resistance doesn't comply with the required 20 Ohm-specification, additional earthing systems shall be installed until the required footing resistance are met or otherwise instructed by the Project Engineer.

- b) After the complete installation of the additional earthing systems the relevant structure footing resistances shall be re-measured by the Contractor in the presence of the Clerk of Works and results shall be recorded at each measuring attempt. Structure footing resistance records shall be submitted to the Project Engineer for acceptance.
- c) Additional/counterpoise earthing system methods:
- Soil resistivity tests shall be done by the Project Engineer at structures with high footing resistances, to determine the correct method for the installation of additional/counterpoise earthing;
 - The basic methods for the installation of additional/counterpoise earthing must be done in the following sequence:

STEP 1:

- Drill a **min. dia 100mm x ±1,5m deep hole, ±2,0m** away and in the opposite diagonal direction as the standard earthing system, from the structure or structure leg.
- Excavate a min. 300mm wide x ±0,55m deep trench between the drilled hole and the structure or structure leg;
- Install 1 x dia 16mm x 3,6m long copper coated earth rod in the trench and drilled hole from the structure or structure leg;
- The one end of the earth rod, must be bolt jointed to the structure or structure leg at the earth pad;
- The earth rod hole as well as the bottom ±150mm of the earth trenches to be backfilled with a well mixed 3:1 clean top soil/agricultural gypsum mixture, after installation of the earth rods;
- A section of the earth rod (From and including the connection point up to ±500mm below natural ground level) must be properly treated with at least two coats of an approved Bitumen or Aluminium based coating;
- The contact surfaces between the structure and the earth rod shall be clean and treated with a thick application of contact grease to ensure a proper conductive connection, prior to the bolt connection;
- For the backfilling of earth trenches refer to paragraph 7.2.3, below.
- The structure footing resistance measurement of the structure shall be taken by the Contractor immediately after installation of the additional structure earthing system, prior to the installation and connection of the overhead shield wire onto the structures.
- In situations where the required 20 Ohm structure footing resistance specification cannot be obtained after the installation of the STEP 1 additional earthing system installation, STEPS 2 & 3 additional earthing systems might be required, only after instructed by the Project Engineer.
- STEPS 2 & 3 additional earthing system installations shall be similar to the STEP 1 installation, but in opposite diagonal directions.

12.2.3. Backfilling of earth trenches

- a) Drilled earth spike holes:
- The complete drilled hole to be backfilled with 1 part of Agricultural Gypsum properly mixed with 3 parts of clean topsoil free from vegetation and plant roots.

- The well mixed backfill material for the drilled holes shall be wetted to form a stiff paste and poured into the holes. The backfill shall be thoroughly compacted inside the drilled hole;
 - The earth rod shall be installed in the hole immediately after compaction of the backfilling.
- b) Earth trenches:
- The first 150mm thick backfill layer in the earth trenches to consist of 1 part of Agricultural Gypsum properly mixed with 3 parts of clean imported topsoil.
 - The backfilling to be slightly watered and thoroughly compacted in layers not exceeding 150mm in thickness;
 - The final backfill layers to consist of clean excavated material from the earth trenches. The backfilled material to be slightly watered and thoroughly compacted in layers not exceeding 250mm in thickness.
- c) For earth trenches in rocky-terrain where the required earth trench depths can't be reached:
- The backfilling of earth strap trenches in rocky areas where no proper trenching can be done, a conductive mixture of carbonaceous aggregate (e.g. graphite, bentonite or any other approved conductive mixture shall be used.
 - A 3:1 sand/conductive cement (D-DT-3205) mixture shall be used;
 - The trenches shall be backfilled completely and immediately after the installation of the earth rods/straps.

13. ACTIVITY STAGE 8

DRESSING OF ALL STRUCTURES

13.1. SAFE STORAGE OF ALL PHASE CONDUCTOR AND SHIELD WIRE LINE HARDWARE AND INSULATORS

- a) The following Standards, Specifications, Guidelines and Drawings apply:
- TRMSCAAC1 Rev. 3 -Section 8.2 Transmission line tower and Line construction;
 - BOM, Project File, Project design bill of materials;
 - Project File PLSCADD design profile sheets.
- b) The quantities for the supply and transport of insulators and fittings shall be in strict accordance with the Design Bill of Materials for each structure.
- c) All insulators, hardware for all suspension and strain assemblies supplied for the project shall comply with the relevant items specified in the Eskom Distribution Standards Part 9 -Buyer's Guide unless otherwise specified. For bundled and heavy conductors 7.3kN MDCL post insulators shall be used if intermediate standoff post insulators aren't braced.
- d) All insulators and line hardware fittings supplied for the project, shall be technically evaluated and approved by the Engineer prior to the installation thereof.

13.2. SAFE STORAGE, HANDLING AND TRANSPORT TO PEG OF LINE HARDWARE AND INSULATORS

- a) The Contractor will be responsible for the safe storage, handling and transport to peg of insulators and fittings.

- b) Special care and precautions shall be taken by the Contractor not to cause any damage and/or deformation what so ever to the suspension, strain and horizontal stand-off insulators, in the storage, handling, transportation thereof.
- c) Insulators with defects shall be brought to the attention of Clerk of Works, who will determine the extent of the damage for possible use thereof.
- d) Any damage and/or deformation caused to any insulator, due to negligence by the Contractor will be replaced by the Contractor at his own costs.

13.3. ASSEMBLY AND INSTALLATION OF STAY ASSEMBLIES

13.3.1. Safe stock-piling/storage, handling and transport of all stay assembly material

- a) The Contractor shall transport all stay assembly material and deliver it to a pre-determined bulk stockpiling site/s.
- b) The Contractor will be responsible for the proper and safe stockpiling of the stay assembly material as well as the safe handling and delivery to peg thereof. Refer to the BoQ / BoM for all stay quantities and details.
- c) The following Standards, Specifications, Guidelines and Drawings apply:
 - TRMSCAAC1 Rev. 3 -Section 6 Transmission line tower and Line construction;
 - D-DT-7325 Transmission line tower and Line construction;
 - 2-WT/1288 16mm 1400MPa Steel Rope 210kN Stay assembly;
 - 2-WT/1299 19mm 1400MPa Steel Rope 272kN Stay assembly;
- d) All permanent and temporary stay material and stay wire shall be safely handled and transported to peg by the Contractor for the complete installation thereof.
- e) The Contractor shall transport all permanent and temporary stay material and stay wire as specified.
- f) The quantities specified for temporary stays are the minimum required to keep the structures as plumb as possible during stringing activities. The Contractor shall add to these quantities to ensure the safety of his workmen during stringing activities.
- g) All construction/temporary stays will remain the Contractor's assets and shall be removed from site at completion of the clamping of the phase conductors, shield wire and OPGW, unless otherwise agreed by the engineer and instructed by the Clerk of Works.

13.3.2. Installation of permanent and temporary stay assemblies

- a) All underground stay assembly types as well as soil types in which permanent stays are to be installed shall be recorded by the Clerk of Works and records shall be submitted to the Employer for acceptance
- b) All underground stay assembly types as well as soil types in which permanent stays are to be installed shall be recorded by the Clerk of Works and records shall be submitted to the Employer for acceptance.
- c) Permanent stay arrangements for guyed structures are as follow, unless otherwise specified by Project Engineer:
 - Standard permanent conventional strain structure stay-assembly 115kN

Table 4: Standard Permanent Conventional Strain Structure Stay Assembly 115kN

1	120kN Straight standard shackle – to drawing: D-DT-7017 Rev. 5	1
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2	Thimble; 16mm wire rope – to drawing: D-DT-3026 Rev. 16	1
3	19/2,65mm -Galvanized steel preformed guy grip – to drawing: D-DT-7035 Rev. 2	1
4	19/2,65mm Galvanized steel stay wire 1100MPa – to drawing: D-DT-7036 Rev. 4	Varies
5	19/2,65mm -Galvanized steel preformed guy grip – to drawing: D-DT-7035 Rev. 2	1
6	Thimble; 16mm wire rope – to drawing: D-DT-3026 Rev. 16	1
7	M24 x 2,4m long adjustable stay assembly -drawing: D-DT-7023 Rev. 13	1
8	600 x 600 x 6mm thick stay plate -drawing: D-DT-3172 Rev. 3	1

- Standard permanent conventional strain structure stay-assembly 210kN

Table 5: Standard Permanent Conventional Strain Structure Stay Assembly 210 kN

1	120kN Straight standard shackle – to drawing: D-DT-7017 Rev. 5	1
2	Thimble; 16mm wire rope – to drawing: D-DT-3026 Rev. 16	1
3	19/2,65mm -Galvanized steel preformed guy grip – to drawing: D-DT-7035 Rev. 2	1
4	19/2,65mm Galvanized steel stay wire 1100MPa – to drawing: D-DT-7036 Rev. 4	Varies
5	19/2,65mm -Galvanized steel preformed guy grip – to drawing: D-DT-7035 Rev. 2	1
6	Thimble; 16mm wire rope – to drawing: D-DT-3026 Rev. 16	1
7	M24 x 2,4m long adjustable stay assembly -drawing: D-DT-7023 Rev. 13	1
8	600 x 600 x 6mm thick stay plate -drawing: D-DT-3172 Rev. 3	1

- Standard permanent conventional strain structure stay-assembly 296kN

Table 6: Standard Permanent Conventional Strain Structure Stay Assembly

1	300kN Straight standard shackle	1
2	Eye Bolt crimp fitting to fit 19mm 1400MPa Wire Rope	1
3	19mm (19/3.81) 1400MPa Wire Rope	Varies
4	Eye Bolt crimp fitting to fit 19mm 1400MPa Wire Rope	1
5	Anchor -dead man	1

- For the complete installation of underground permanent stay assemblies, the Contractor's work comprises:
 - Install all permanent 115kN M24 x 2,4m adjustable stay assemblies at structure specified guyed angle suspension, in-line & angle strain and terminal structures, complete with 600 x600 x 6mm stay plates and 150 x 150 x 6mm backing washers, angles between 45°and 35° with the vertical, unless otherwise specified by the Project Engineer;
 - Install all permanent 215kN dead man adjustable stay assemblies at structure specified guyed angle suspension, in-line & angle strain and terminal structures, complete with dead man anchor, angles between 45°and 35° with the vertical, unless otherwise specified by the Project Engineer;
 - Install all permanent 296kN dead man adjustable stay assemblies at structure specified guyed angle suspension, in-line & angle strain and terminal

structures, complete with dead man anchor, angles between 45° and 35° with the vertical, unless otherwise specified by the Project Engineer;

- Rock anchors shall be installed to prescribed stay angles into solid rock formations only, as per manufacturer's specification.
 - For conventional stays installations the stay plates shall be positioned as firm as possible against the virgin soil inside the excavation;
 - A maximum 80mm wide stay rod slot shall be cut into the stay excavation side wall at the prescribed stay angles;
 - Stabilize backfill and compact stay excavation as specified below.
 - Proper Dynamic Cone Penetrometer (DCP) tests, as specified in TMH6 Method ST6, to be executed during the backfilling and compaction of each stay.
- d) All permanent stays shall be proof load tested. For the installation and testing of all conventional stays and rock anchors refer to documents TRMSCAAC1 Rev 3 Section 6.2.5.1 and Eskom Procedure DSP_34-1657 for the conventional stay planting and compaction and rock anchor installation and testing.
- e) Bottom guy grips of all permanent adjustable stay assemblies shall be secured with guy grip crimp ferrules supplied and installed by the Contractor. Galvanized mild steel ferrules shall only be crimped after the complete installation and tensioning of the adjustable stay assemblies.
- f) A 2500 x 40mm OD HDPE UV stabilized Type 5 Class 6 pipes shall be supplied and installed with all permanent adjustable stay assemblies, by the Contractor.
- g) The Contractor shall provide equipment on site, during the installation of the guy anchors, capable of loading the anchor to a load equal to the un-factored foundation reaction for critical loading conditions.
- h) All rock anchor stay installations shall be proof load tested by the Contractor.
- i) All conventional installed stay anchors to be witnessed by the Clerk of Works, the Contractor shall apply a construction proof load test equal to the un-factored foundation reaction for critical loading conditions to the completed anchors. The method of the load application shall be subject to the Project Engineer's acceptance.
- j) All anchor tests shall be conducted in the presence of the Clerk of Works.
- One of the following proof load procedures will be accepted:**
- Test load of the installed stay anchor assembly should be not less than 10% above the stay wire working load. In absence of any specified value, the stay wire (used in the stay assembly) working load shall be taken as 40% of the wire Ultimate Tensile Strength (UTS). In that case the minimum test load is defined as 44% of the UTS. The stay anchor shall be marked in such a way that movement relative to the ground level can easily be detected. A tensile load of about 10% of the UTS of the stay wire shall be applied in the direction of the stay wire, normally at 45° to the ground level. For this load a creep / settling movement of the stay anchor amounting to approximately 15 mm will be acceptable. Position of the point corresponding to load of 10% UTS shall be marked. The load shall be steadily increased to 44% of the UTS and maintained for 2 minutes. There shall be no movement of the stay anchor assembly relative to the marked previously point, due to slip during this period of 2 minutes and no failure of the stay anchor.
 - The load shall be applied to the anchor in appropriate increments to 50%, 75%, 90% and 100% of the proof test load, and then unloaded to 50% and again loaded to **100%** of the proof test load, twice, i.e. during two further cycles of

loading. The *Contractor* shall monitor anchor movement along the guy slope. Successive load increments shall not be applied until the rate of creep is less than or equal to 0,5mm/minute. The **three cycles** of loading from **50% to 100%** shall each be of duration of not **less than 5 minutes**. The anchor shall be considered acceptable if the total creep from **50% to 100% load over 3 cycles** is **less than 15mm**. If the creep exceeds **15mm**, the anchor shall be modified or replaced by the *Contractor* and re-tested.

- k) Where stay excavations are done in very poor, loose sandy or soft clayey cohesion less soils, the first third of the backfill material to be imported. Imported material to consist of a clean and good compactable material such as natural gravels.
- l) Where stay excavations are done in cohesion less non-compactable material the first third of the backfilling to be stabilized. Vegetation and plant roots to be removed from excavated material, well mixed to a 1:8 cement/soil mixture, slightly watered, backfill and compacted.
- m) Backfill material to be slightly watered and thoroughly compacted in layers not exceeding 300mm in thickness to a height ± 500 mm above stay plate level as specified in the Eskom Procedure DSP_34-1657. The remaining part of the stay excavation to be backfilled and thoroughly compacted excavated material.
- n) The Contractor shall make provision for the sufficient quantity of temporary stays at all in-line and angle strain structures, to ensure the stability and plumpness of the structures, as well as the safety of the Contractor's Workmen.
- o) All temporary stays shall remain intact and tensioned until completion of the stringing, regulating and clamping activities of the phase conductors, shield wires and OPGW.
- p) The Contractor can install temporary stays on the conventional method or alternatively pre-cast stay anchor blocks per phase can be used. For both situations all temporary installed stays and stay anchor blocks must be completely removed from site after completion of the stringing activities.
- q) All excavations left from the removed conventional installed stay assemblies must be properly backfilled, compacted and sites re-instated.
- r) A maximum 45° with the horizontal or flatter stay installation angle is required for temporary stays, under all circumstances.
- s) After the complete installation and tensioning of all permanent stays, the Contractor shall supply anti-theft compound and treat the bottom part (150mm below ground level to $\pm 1,5$ m above ground level) of all permanent stay assemblies.

13.4. SAFE HANDLING AND DRESSING OF STRUCTURE WITH LINE HARDWARE AND INSULATORS

- a) The Contractor shall assemble all components used for attaching phase conductor and shield wires to the structures, and install the appropriate attachment points on the structures.
- b) Insulators shall be clean when hung by the Contractor. Clean rags, free from abrasive material, or other methods accepted by the Clerk of Works, shall be used to remove mud, grease, dirt and other foreign matter.
- c) Wire brushes shall not be used by the Contractor for the cleaning of any parts, metal surfaces shall be free from any noticeable contamination.
- d) The cleaning the insulators with a high-pressure water spray by the Contractor during structure erection will be permitted; only if done with a non-conductive degreasing solvent.

- e) Security clips shall be fully inserted in insulator caps. Insulator assemblies shall be lifted to the structure from one end of the assembly only. Bending of insulator strings to the point of bending ball pins, deforming security clips or damaging hardware is prohibited.
- f) The Contractor's Workmen shall not climb insulators after installation, nor shall such insulators be exposed to possible damage or contamination by any other means.
- g) During construction, loads shall not be imposed on insulator strings in excess of the Manufacturer's recommended safe working load. Any insulator that is exposed to such overload shall be rejected by the Clerk of Works, and shall be replaced at the Contractor's expense.
- h) Overall dimensions shown on drawings of insulator and hardware assemblies are approximate only. Assemblies shall be measured for accurate determination of jumper length and conductor cut-offs before installing dead-end accessories.
- i) Orientation of socket fittings:
 - All sockets fitted with "W" security clips. On single insulator strings the mouth of the socket must face the structure;
 - Sockets fitted with "P" security clips. On single insulator strings the eye of the "P" clip must face the structure.
- j) All split pins required on the hardware, when fitted, shall be split and bent back tightly around the bolt. The use of hump back split pins must be in strict accordance with the specifications DSP 34-1667.

13.5. PHASE CONDUCTOR ASSEMBLIES

- a) Phase conductor single “I-String A” suspension assembly for single “Conductor” ACSR intermediate suspension structures according to design BOM:

Table 7: Phase Conductor single “I-String A” Suspension Assembly For Single “Conductor”

1	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5 (Tower shackle)	1
2	120kN Ball/Oval eye – to drawing: D-DT-7008 Rev. 4	1
3	IEC 120; 132kV Composite suspension insulator; 120kN– to drawing: D-DT-7014 Rev. 9	
4	120kN Socket/tongue -to drawing: D-DT-6061 Rev. 8	
5	Armor rod set; Aluminium alloy; suitable for “Conductor Specific according to design Bom” ACSR – to drawing: D-DT-7034 Rev. 2	
6	Pivoted suspension clamp; suitable “Conductor Specific according to design BOM” ACSR – to drawing: D-DT-7009 Rev. 7	

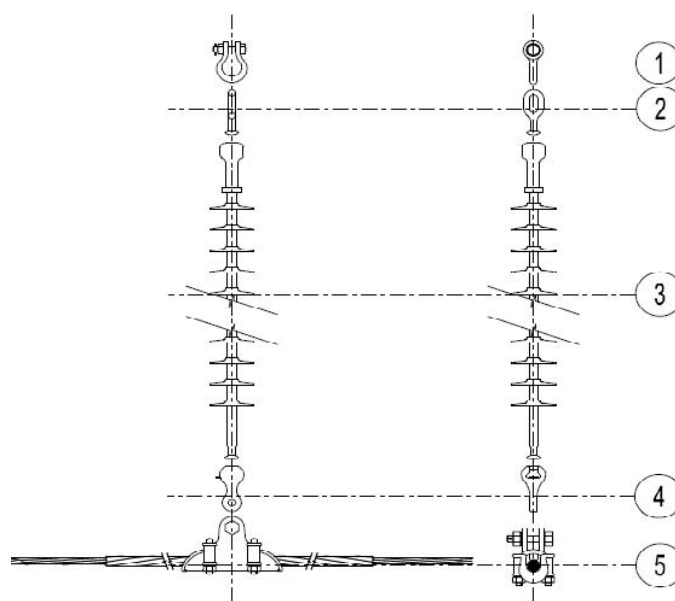


Figure 1: Phase Conductor Single “I-String A” Suspension Assembly for Single “Conductor”

Required:-Specified in Design BOM

b) Phase conductor twin “I-String A” suspension assembly for twin “Conductor” ACSR intermediate suspension structures according to design BOM:

Table 8: Phase Conductor Twin “I-String A” Suspension Assembly for Twin “Conductor”

1	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5 (Tower shackle)
2	120kN Ball/Oval eye – to drawing: D-DT-7008 Rev. 4
3	IEC 120; 132kV Composite suspension insulator; 120kN– to drawing: D-DT-7014 Rev. 9
4	120kN Socket/Clev 16mm -to drawing: D-DT-7021 Rev. 5
5	Plate,Yoke Triang 260mm CRS 120kN 16mm Thick: : D-DT-7015 Rev. 7
6	Shackle, twisted bolt type 120kN WITH 18mm Gap: D-DT-7019 Rev. 5
7	Pivoted suspension clamp; suitable “Conductor Specific according to design BOM” ACSR – to drawing: D-DT-7009 Rev. 7
8	Armor rod set; Aluminium alloy; suitable for “Conductor Specific according to design Bom” ACSR – to drawing: D-DT-7034 Rev. 2

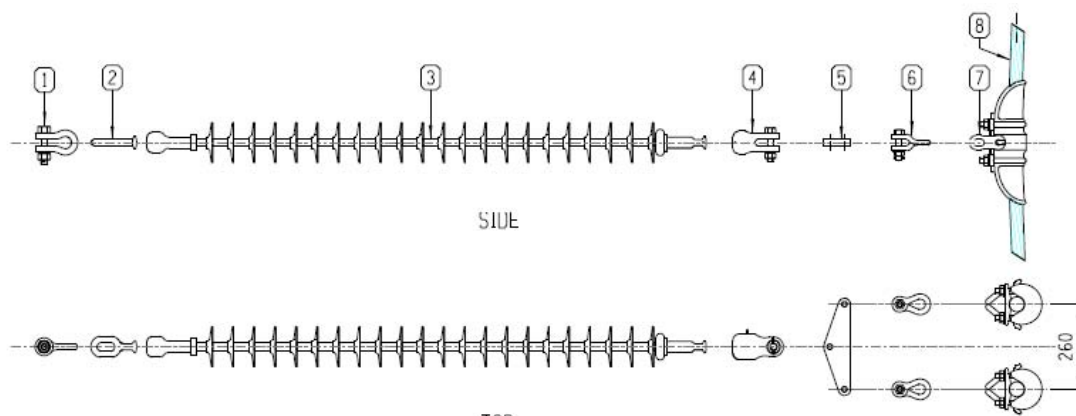


Figure 2: Phase Conductor Twin “I-String A” Suspension Assembly for Twin “Conductor”

Required:-Specified in Design BOM

**c) OPTION A: Phase conductor single strain assembly for single “Conductor”
ACSR for strain structures according to design BOM: strain towers:**

Table 9: Option A: Phase Conductor Single Strain Assembly for Single “Conductor”

1	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5 (Tower shackle)
2	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5
3	120kN Sag adjustor – to drawing: D-DT-7042 Rev. 6
4	120kN Clevis/ball, bolt type, 100mm – to drawing: D-DT-6059 Rev. 9
5	IEC 120; 132kV Composite strain insulator 120kN – to drawing: D-DT-7014 Rev. 9
6	120kN Socket/tongue - to drawing: D-DT-6061 Rev. 8
7	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5
8	Compression dead-end assembly; Aluminium; suitable “Conductor Specific according to design BOM” – to drawing: D-DT-7000 Rev. 7

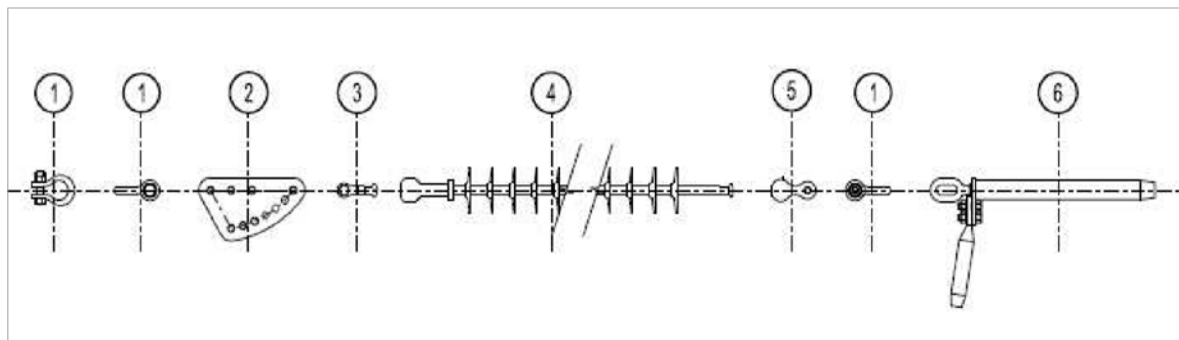


Figure 3: Option A - Phase Conductor Single Strain Assembly for Single “Conductor”

Required:-Specified in Design BOM

**e) OPTION B: Phase conductor single strain assembly for single “Conductor”
ACSR conductor for H-pole in-line strain structures and H-pole terminal
structures according to design BOM (Line side only):**

Table 10: Option B: Phase Conductor Single Strain Assembly for Single “Conductor”

1	Shackle strap, M20 bolt type – to drawing: Component drawing	1
2	120kN Twisted shackle, bolt type – to drawing: D-DT-7019 Rev. 5 (Tower shackle)	1
3	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	1
4	120kN Sag adjustor – to drawing: D-DT-7042 Rev. 6	1
5	120kN Clevis/ball, bolt type, 100mm – to drawing: D-DT-6059 Rev. 9	1
6	IEC 120; 132kV Composite strain insulator 120kN – to drawing: D-DT-7014 Rev. 9	1
7	120kN Socket/tongue - to drawing: D-DT-6061 Rev. 8	1
8	Compression dead-end assembly; Aluminium; suitable for “Conductor Specific according to design BOM” – to drawing: D-DT-7000 Rev. 7	1

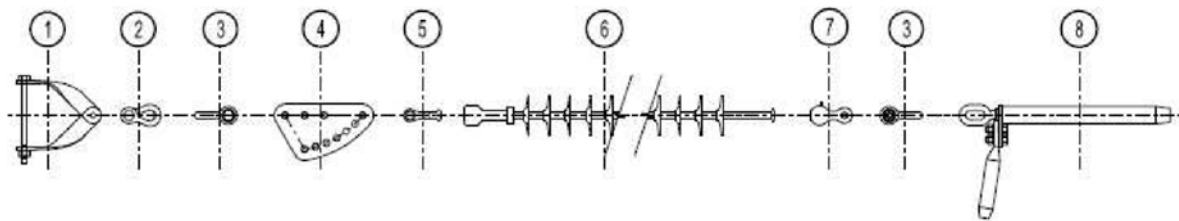


Figure 4: Option B: Phase Conductor Single Strain Assembly for Single “Conductor”

Required:-Specified in Design BOM

**f) OPTION C: Phase conductor single strain assembly for single “Conductor”
ACSR conductor for 3-pole terminal structures, H-pole terminal structures
(One side only) and H-pole terminal structures (Closing span side):**

Table 11: Option C: Phase Conductor Single Strain Assembly for Single “Conductor”

1	Shackle strap, M20bolt type – to drawing: Component drawing NB: Shackle strap not required for “Type 7618NS” structures	1
2	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5 (Tower shackle)	1
3	120kN Oval eye/tongue turnbuckle – to drawing: D-DT-7007 Rev. 4	1
4	120kN Clevis/ball, bolt type, 80mm – to drawing: D-DT-6059 Rev. 9	1
5	IEC 120; 132kV Composite strain insulator 120kN – to drawing: D-DT-7014 Rev. 9	1
6	120kN Socket/tongue - to drawing: D-DT-6061 Rev. 8	1
2	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	1
7	Compression dead-end assembly; Aluminium; suitable “Conductor Specific according to design BOM” – to drawing: D-DT-7000 Rev. 7	1

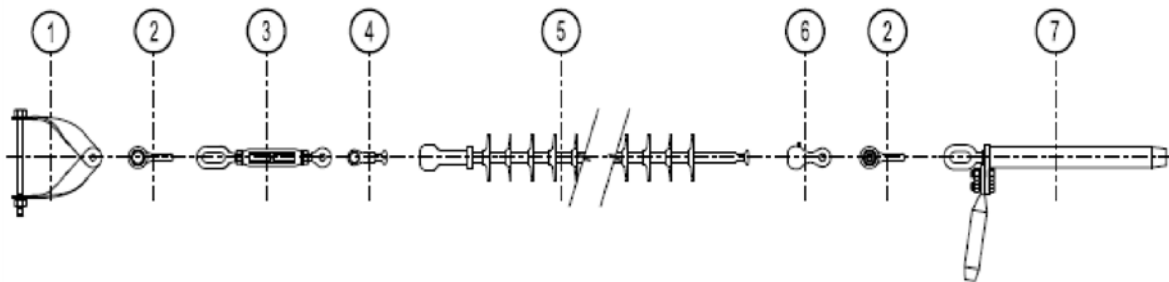


Figure 5: Option C: Phase Conductor Single Strain Assembly for Single “Conductor”

Required:-Specified in Design BOM

**g) OPTION D: Phase conductor single strain assembly for single “Conductor”
ACSR conductor for “ H-pole structures and H-pole terminal structures (One
side only):**

Table 12: Option D: Phase Conductor Single Strain Assembly for Single “Conductor”

1A	Shackle strap, M20 bolt type – to drawing: Component drawing	1
1B	Shackle strap, M20bolt type – to drawing: Component drawing	1
2	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5 (Tower shackle)	1
3	120kN Ball/Oval eye – to drawing: D-DT-7008 Rev. 4	1
4	IEC 120; 132kV Composite strain insulator 120kN – to drawing: D-DT-7014 Rev. 9	1
5	120kN Socket/tongue -to drawing: D-DT-6061 Rev. 8	
2	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	
6	Compression dead-end assembly; Aluminium; suitable for “Conductor Specific according to design BOM”– to drawing: D-DT-7000 Rev. 7	

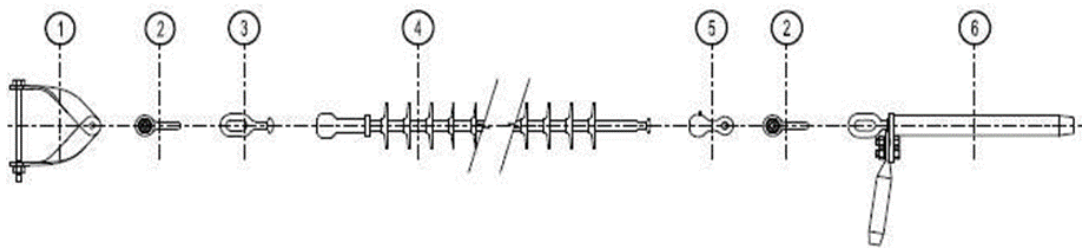


Figure 6: Option D: Phase Conductor Single Strain Assembly for Single “Conductor”

Required:-Specified in Design BOM

h) Phase conductor twin strain assembly for twin “Conductor” ACSR angle, in-line strain and terminal structures according to design BOM (Line side only):

Table 13: Phase Conductor Twin Strain Assembly for Twin “Conductor”

1a	Shackle twisted, bolt type 210kN 21.5mm Gap – to drawing: Supplier drawing	1
1b	Shackle Straight, bolt type 210kN 20mm Gap – to drawing: D-DT-7018 Rev. 5	1
2	Shackle Straight, bolt type 210kN 20mm Gap – to drawing: D-DT-7018 Rev. 5	1
3	Plate, Yoke Triangle 250mm CRS 210kN 18mm Thick: Supplier drawing	1
4	Shackle Straight, bolt type 120kN 21.5mm Gap – to drawing: Supplier drawing	2
5	Turnbuckle, eye tongue 120kN: D-DT-7007 Rev. 4	2
6	Clevis/ball, bolt type, 16mm 16L 80CL 120kN – to drawing: D-DT-6059 Rev. 9	2
7	IEC 120; 132kV Composite strain insulator 120kN – to drawing: D-DT-7014 Rev. 9	2
8	Socket/tongue 16mm 120kN -to drawing: D-DT-6061 Rev. 8	2
4	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	2
9	Compression dead-end assembly; Aluminium; suitable for “Conductor Specific according to design BOM” – to drawing: D-DT-7000 Rev. 7	1

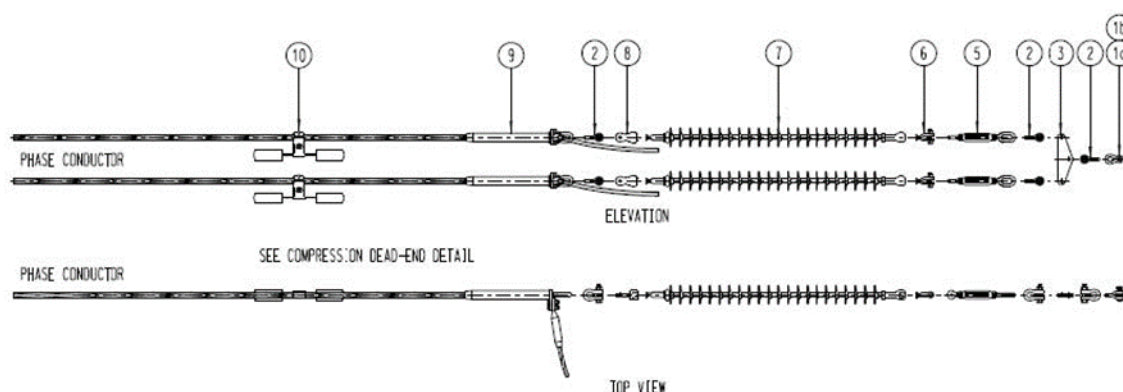


Figure 7: Phase Conductor Twin Strain Assembly for Twin “Conductor”

Required:-Specified in Design BOM

i) **Phase conductor single angle suspension assembly for single “Conductor” ACSR for angle suspension structures:**

Table 14: Phase Conductor Single Angle Suspension Assembly for Single “Conductor”

1	132kV Horizontal line post insulator 5.3kN Cast gain base– to drawing: D-DT-7013 Rev. 7
2	Angle Trunnion clamp; Aluminium alloy; suitable for “Conductor Specific according to design Bom” ACSR – to drawing: D-DT-7011 Rev. 3
3	Armor rod set; Aluminium alloy; suitable for “Conductor Specific according to design Bom” ACSR – to drawing: D-DT-7034 Rev. 2

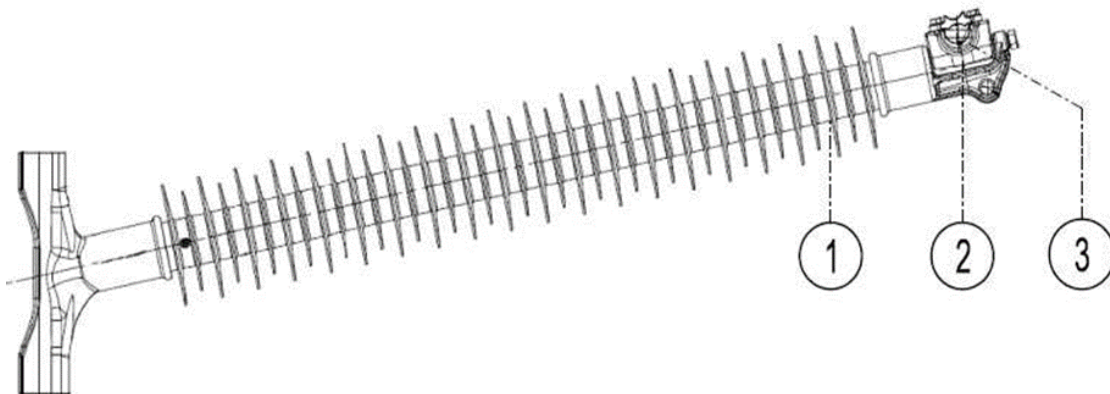


Figure 8: Phase Conductor Single Angle Suspension Assembly for Single “Conductor”

Required:-Specified in Design BOM.

j) **Phase conductor braced vertical suspension assembly for twin “Conductor” ACSR for twin conductor suspension structures:**

Table 15: Phase Conductor Braced Vertical Suspension Assembly for Twin “Conductor”

1	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	1
2	120kN Ball/Oval eye – to drawing: D-DT-7008 Rev. 4	1
3	IEC 120; 132kV Composite strain insulator 120kN – to drawing: D-DT-7014 Rev. 9	1
4	120kN Socket/tongue -to drawing: D-DT-6061 Rev. 8	1
5	Extension link 68mm 120kN incoming bolts nuts and split pins Supplier drawing	1
6	132kV Horizontal line post insulator 5.3kN D/E– to drawing: D-DT-7049 Rev. 1	
7	Shackle, twisted bolt type 120kN WITH 24mm Gap: Supplier drawing	2
8	Clamp suspension pivoted eye clevis attachment “Conductor Specific according to design BOM” Supplier drawing	1
9	Shackle Straight, bolt type 120kN 26mm Gap – to drawing: Supplier drawing	1
10	Pivoted suspension clamp; suitable “Conductor Specific according to design BOM” ACSR – to drawing: Supplier drawing	1
11	Armor rod set; Aluminium alloy; suitable for “Conductor Specific according to design Bom” ACSR – to drawing: D-DT-7034 Rev. 2	1

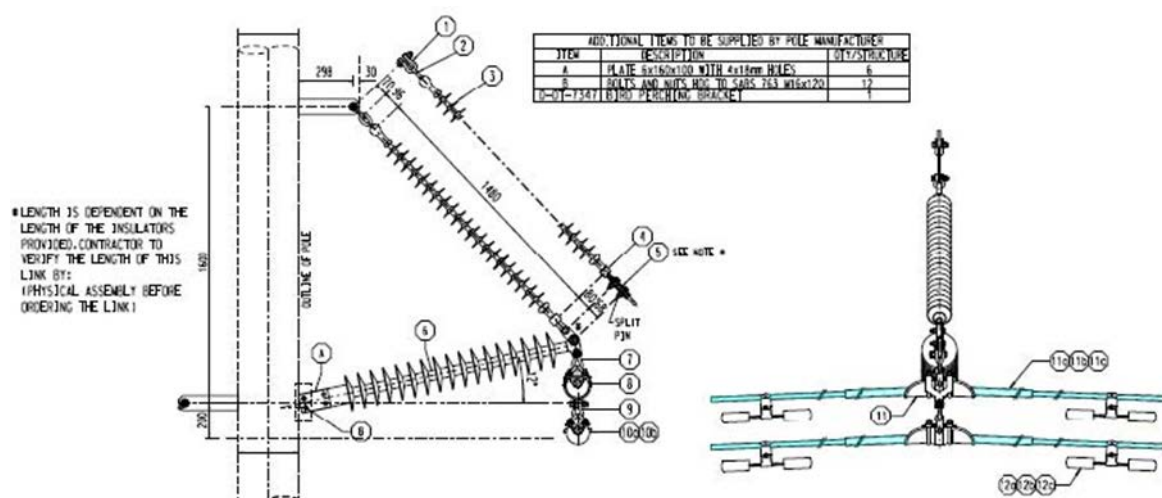


Figure 9: Phase Conductor Braced Vertical Suspension Assembly for Twin “Conductor”

Required:-Specified in Design BOM.

k) Phase conductor braced horizontal suspension assembly for twin “Conductor” ACSR for twin conductor suspension structures:

Table 16: Phase Conductor Braced Horizontal Suspension Assembly for Twin “Conductor”

	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	1
	120kN Ball/Oval eye – to drawing: D-DT-7008 Rev. 4	1
	IEC 120; 132kV Composite strain insulator 120kN – to drawing: D-DT-7014 Rev. 9	1
	120kN Socket/tongue -to drawing: D-DT-6061 Rev. 8	1
	Extension link Link 68mm 120kN incoming bolts nuts and split pins Supplier drawing	1
	132kV Horizontal line post insulator 5.3kN D/E – to drawing: D-DT-7049 Rev. 1	
	Shackle, twisted bolt type 120kN WITH 24mm Gap: Supplier drawing	1
	Shackle, twisted bolt type 120kN WITH 18mm Gap: D-DT-7019 Rev. 5	2
	Plate,Yoke Triang 260mm CRS 120kN 16mm Thick: : D-DT-7015 Rev. 7	1
	Pivoted suspension clamp; suitable "Conductor Specific according to design BOM" ACSR – to drawing: Supplier drawing	2
	Armor rod set; Aluminium alloy; suitable for "Conductor Specific according to design Bom" ACSR – to drawing: D-DT-7034 Rev. 2	1

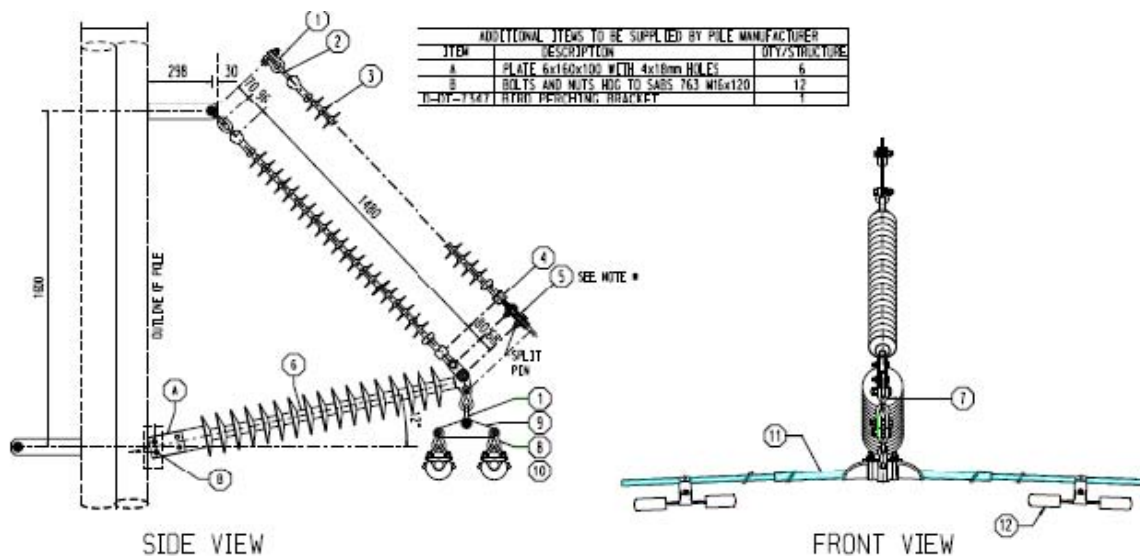


Figure 10: Phase Conductor Braced Horizontal Suspension Assembly for Twin “Conductor”

Required:-Specified in Design BOM.

I) Vertical phase conductor twin jumper assembly for twin “Conductor” ACSR for angle strain structures:

Table 17: Phase Conductor Braced Horizontal Suspension Assembly for Twin “Conductor”

1	132kV Horizontal line post insulator 5.3kN Cast gain base– to drawing: D-DT-7013 Rev. 7	1
1	132kV Horizontal line post insulator 5.3kN D/E– to drawing: D-DT-7049 Rev. 1	1
2	Shackle, twisted bolt type 120kN WITH 24mm Gap: Supplier drawing	1
3	Clamp suspension pivoted eye clevis attachment “Conductor Specific according to design BOM” Supplier drawing	1
4	Shackle Straight, bolt type 120kN 26mm Gap – to drawing: Supplier drawing	1
5	Pivoted suspension clamp; suitable “Conductor Specific according to design BOM” ACSR – to drawing: Supplier drawing	1
6	Spacer Rigit “Conductor Specific according to design Bom” Supplier drawing	1

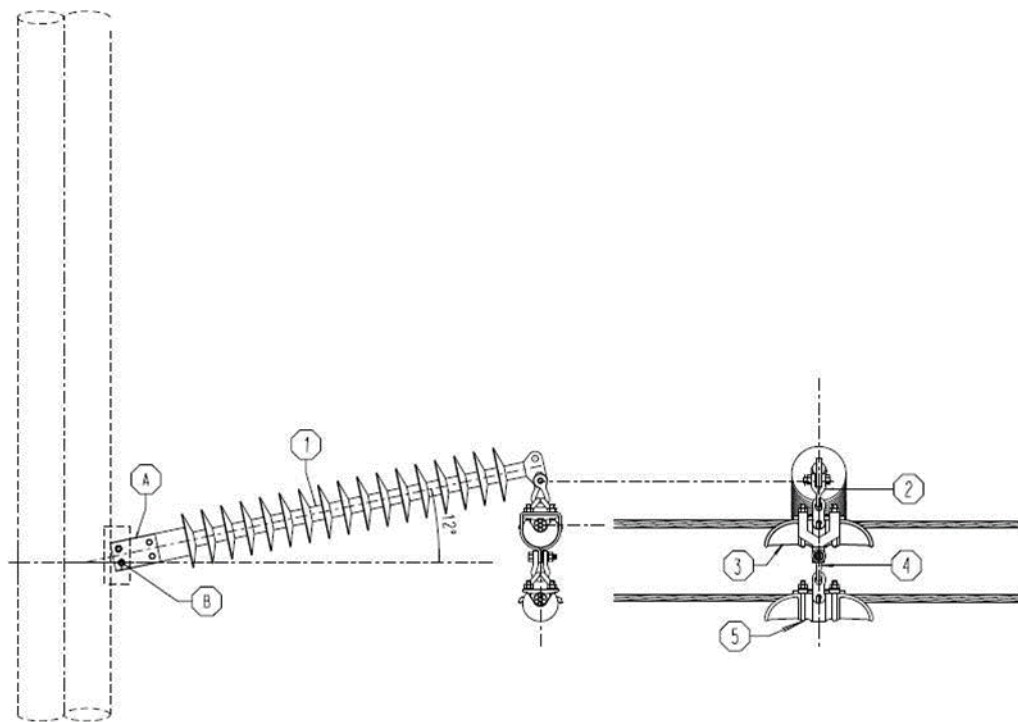


Figure 11: Phase Conductor Braced Horizontal Suspension Assembly for Twin “Conductor”

Required:-Specified in Design BOM.

**m) Horizontal phase conductor twin jumper assembly for twin “Conductor”
ACSR for angle strain structures:**

Table 18: Horizontal Phase Conductor Twin Jumper Assembly for Twin “Conductor”

1	132kV Horizontal line post insulator 5.3kN Cast gain base- to drawing: D-DT-7013 Rev. 7	1
1	132kV Horizontal line post insulator 5.3kN D/E- to drawing: D-DT-7049 Rev. 1	1
2	Shackle, twisted bolt type 120kN WITH 24mm Gap: Supplier drawing	1
3	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	1
4	Plate,Yoke Triang 260mm CRS 120kN 16mm Thick: : D-DT-7015 Rev. 7	1
5	Shackle, twisted bolt type 120kN WITH 18mm Gap: D-DT-7019 Rev. 5	2
6	Pivoted suspension clamp; suitable “Conductor Specific according to design BOM” ACSR – to drawing: Supplier drawing	2
7	Spacer Rigit “Conductor Specific according to design Bom” Supplier drawing	1

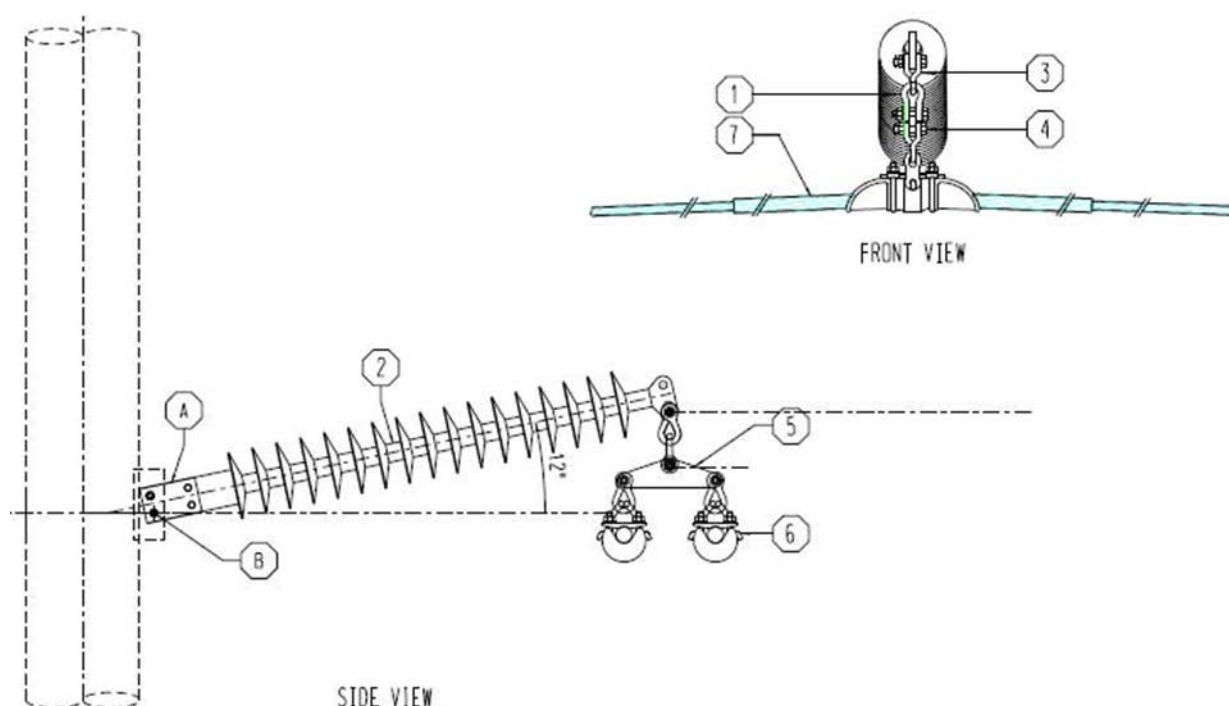


Figure 12: Horizontal Phase Conductor Twin Jumper Assembly for Twin “Conductor”

Required:-Specified in Design BOM.

n) Phase conductor single jumper support assembly for single “Conductor” ACSR for strain structures:

Table 19: Phase Conductor Single Jumper Support Assembly for Single “Conductor”

1	132kV Horizontal line post insulator 5.3kN Cast gain base– to drawing: D-DT-7013 Rev. 7	1
2	0°Trunnion suspension clamp; Aluminium alloy; suitable for “Conductor Specific according to design BOM” ACSR – to drawing: D-DT-7010 Rev. 2	1
3	A armor rod set; Aluminium alloy; suitable for “Conductor Specific according to design Bom” ACSR – to drawing: D-DT-7034 Rev. 2	1

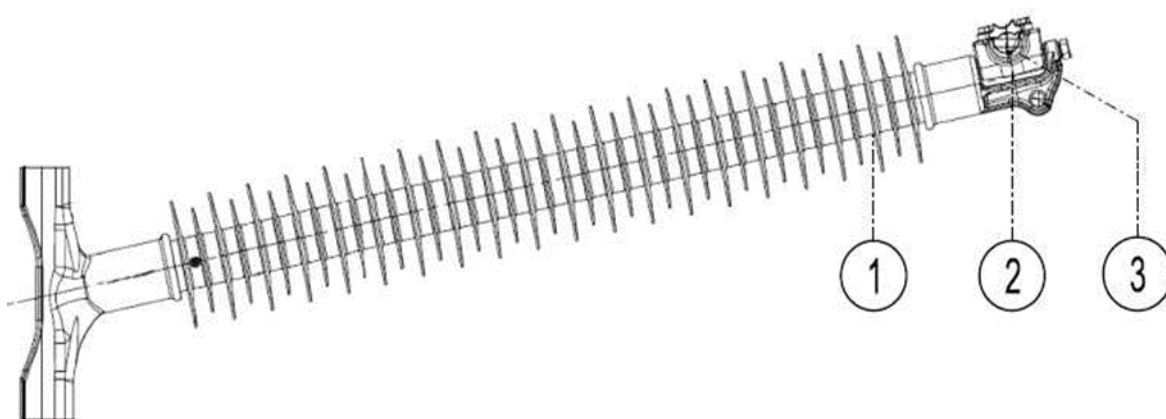


Figure 13: Phase Conductor Single Jumper Support Assembly for Single “Conductor”

Required:-Specified in Design BOM.

13.6. SHIELD WIRE ASSEMBLIES

a) (Insulated Option) Shield wire suspension assembly for single “7/3,35mm & 19/2.65” GS shield - wire for intermediate suspension structures:

Table 20: (Insulated Option) S/W Sus. Ass. for Single "7/3,35 mm & 19/2.65" GS Shield

1	Earth wire clamp; galvanized mild steel – to drawing: D-DT-7003 Rev. 11	1
2	Galvanized steel preformed armor rod set – to drawing: D-DT-7006 Rev. 2	1

Required:-Specified in Design BOM.

- b) **(Non-insulated Option) Shield wire suspension assembly for single “7/3,35mm & 19/2.65” GS shield wire for intermediate suspension structures:**

Table 21: (Non-insulated Option) S/W Sus. Ass. for Single “7/3,35mm & 19/2.65”

1	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	1
2	120kN Twisted tongue/oval eye – to McWade Productions (Pty) Ltd - Item no. B30572 or similar approved	1
3	Earth wire insulator, with arching horns – to drawing: D-DT-7012 Rev. 3	1
4	70kN Pistol grip strain clamp, 3-bolt type -to drawing: D-DT-7022 Rev. 14	1
5	Crosby clamp; suitable for 12mm wire rope – to drawing: D-DT-7032 Rev. 7	1

Required:-Specified in Design BOM.

- c) **(Insulated Option) Shield wire strain assembly for single “7/3,35mm & 19/2.65” GS shield wire for strain structures:**

Table 22: (Insulated Option) Shield Wire Strain Assembly for Single “7/3,35mm & 19/2.65”

1	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	1
2	120kN Twisted tongue/oval eye – to McWade Productions (Pty) Ltd - Item no. B30572 or similar approved	1
3	Earth wire insulator, with arching horns – to drawing: D-DT-7012 Rev. 3	1
4	70kN Pistol grip strain clamp, 3-bolt type - to drawing: D-DT-7022 Rev. 14	1
5	Crosby clamp; suitable for 12mm wire rope – to drawing: D-DT-7032 Rev. 7	1

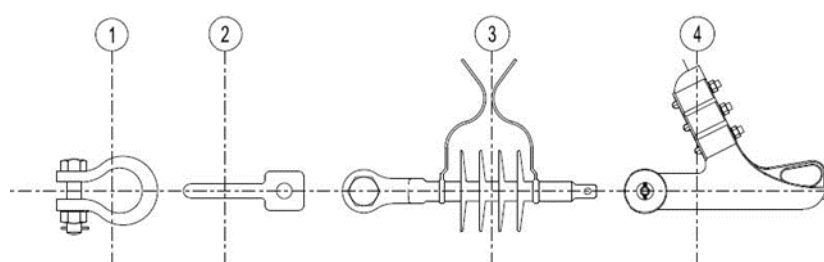


Figure 14: (Insulated Option) Shield Wire Strain Assembly for Single “7/3,35mm & 19/2.65”

Required:-Specified in Design BOM.

d) (Non-insulated Option) Shield wire strain assembly for single “7/3,35mm & 19/2.65” GS shield wire for strain structures:

Table 23: (Non-insulated Option) Shield Wire Strain Assembly for Single “7/3,35mm & 19/2.65”

1	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	1
2	Thimble; galvanized mild steel; 16mm wire rope – to drawing: D-DT-3026 Rev. 16	1
3	Galvanized steel preformed dead end – to drawing: D-DT-7035 Rev. 2	1
4	Shield clamp; double groove; galvanized mild steel – to drawing: D-DT-7004 Rev. 5	1

Required:-Specified in Design BOM

e) (Insulated Option) Shield wire strain assembly for single “7/3,35mm & 19/2.65” GS shield wire for terminal structures:

Table 24: (Insulated Option) Shield Wire Strain Assembly for Single “7/3,35mm & 19/2.65”

1	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	1
2	120kN Twisted tongue/oval eye – to McWade Productions (Pty) Ltd - Item no. B30572 or similar approved	1
3	Earth wire insulator, with arching horns – to drawing: D-DT-7012 Rev. 3	1
4	70kN Pistol grip strain clamp, 3-bolt type - to drawing: D-DT-7022 Rev. 14	1

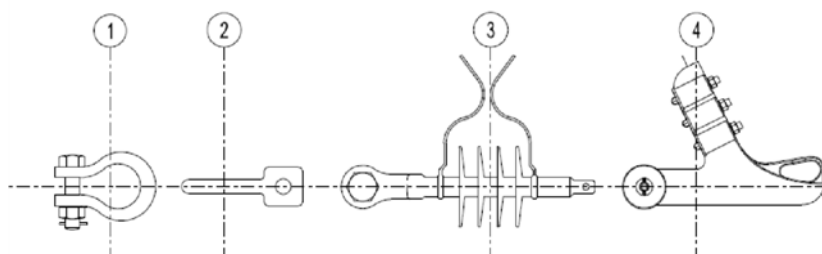


Figure 15: (Insulated Option) Shield wire strain assembly for single “7/3,35mm & 19/2.65”

Required:-Specified in Design BOM

f) (Insulated Option) Shield wire strain assembly for single “7/3,35mm & 19/2.65” GS shield wire for terminal structures:

Table 25: (Insulated Option) Shield Wire Strain Assembly for Single “7/3,35mm & 19/2.65”

1	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	1
2	120kN Twisted tongue/oval eye – to McWade Productions (Pty) Ltd - Item no. B30572 or similar approved	1
3	Earth wire insulator, with arching horns – to drawing: D-DT-7012 Rev. 3	1
4	70kN Pistol grip strain clamp, 3-bolt type - to drawing: D-DT-7022 Rev. 14	1
5	Crosby clamp; suitable for 12mm wire rope – to drawing: D-DT-7032 Rev. 7	1

Figure 16: (Insulated Option) Shield Wire Strain Assembly for Single “7/3,35mm & 19/2.65”

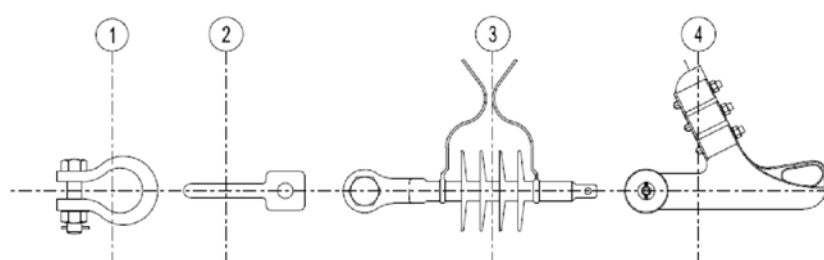


Figure 17: (Insulated Option) Shield Wire Strain Assembly for Single “7/3,35mm & 19/2.65”

Required:-Specified in Design BOM

14.5.1 (Non-Insulated Option) Shield wire strain assembly for single “conductor” ACSR shield wire High fault currents:

Table 26: (Non-Insulated Option) Shield Wire Strain Assembly for Single “Conductor”

1	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	2
2	Compression dead-end assembly; Aluminium; suitable for “Conductor Specific according to design BOM” – to drawing: D-DT-7000 Rev. 7	1
3	Turnbuckle, eye tongue 120kN: D-DT-7007 Rev. 4	1
5	Shield clamp; double groove; galvanized mild steel – “Conductor Specific” as per to drawing: D-DT-7004 Rev. 5	1

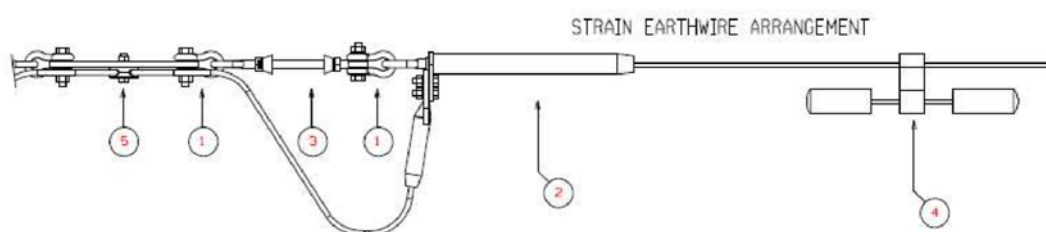


Figure 18: (Non-Insulated Option) Shield Wire Strain Assembly for Single “conductor”

Required:-Specified in Design BOM

g) (Insulated Option) Shield wire strain assembly for single “conductor” ACSR shield wire High fault currents:

Table 27: (Insulated Option) Shield Wire Strain Assembly for Single “Conductor”

1	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	3
2	Compression dead-end assembly; Aluminium; suitable for “Conductor Specific according to design BOM” – to drawing: D-DT-7000 Rev. 7	1
3	Turnbuckle, eye tongue 120kN: D-DT-7007 Rev. 4	1
5	Earth wire insulator, with arching horns – to drawing: D-DT-7012 Rev. 3	1

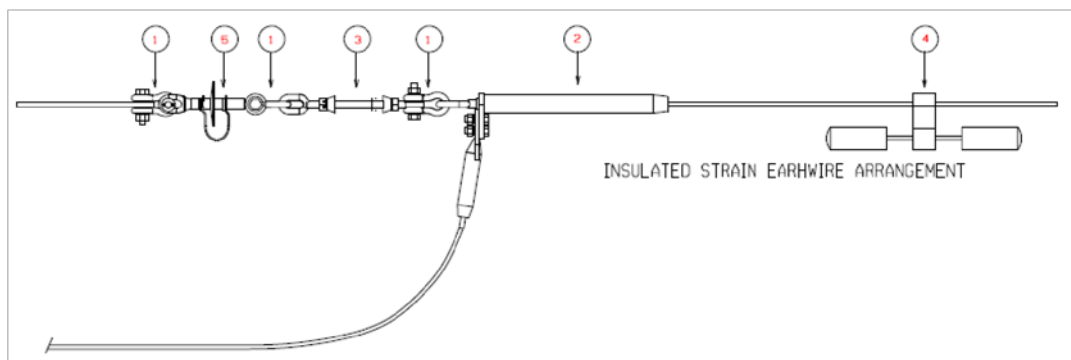


Figure 19: (Insulated Option) Shield Wire Strain Assembly for Single “Conductor”

Required:-Specified in Design BOM

h) (Non-Insulated Option) Shield wire suspension assembly for single “conductor” ACSR shield wire High fault currents:

Table 28: (Non-Insulated Option) Shield Wire Suspension Assembly for Single “Conductor”

1	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	2
2	Clevis/tongue, bolt type, to McWade Productions (Pty) Ltd - Item no. B30442 or similar approved	1
3	Clamp susp pivoted “Conductor Specific according to design BOM” ACSR – to drawing: D-DT-7009 Rev. 7	1
4	A armor rod set; Aluminium alloy; suitable for “Conductor Specific according to design BOM” ACSR – to drawing: D-DT-7034 Rev. 2	1
5	Parallel grooved clamp extruded: “Conductor Specific according to design BOM”	1
6	Shield clamp; double groove; galvanized mild steel – “Conductor Specific” as per to drawing: D-DT-7004 Rev. 5	1

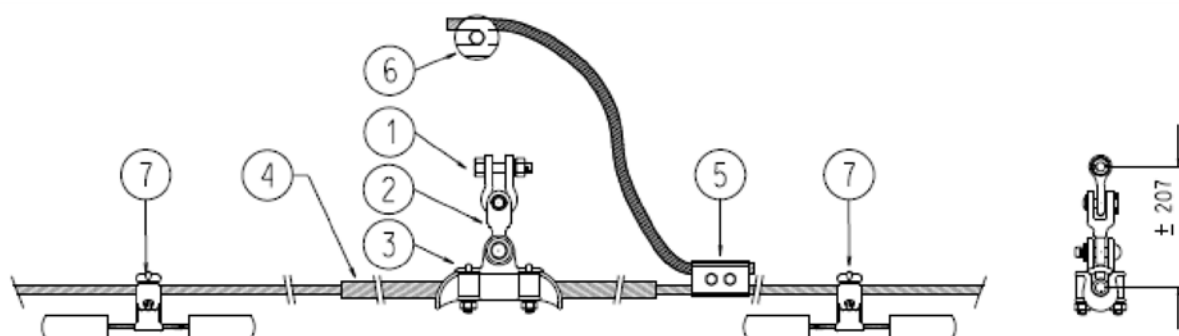


Figure 20: (Non-Insulated Option) Shield Wire Suspension Assembly for Single “Conductor”

- i) **(Insulated Option) Shield wire suspension assembly for single “conductor” ACSR shield wire High fault currents:**

Table 29: (Insulated Option) Shield Wire Suspension Assembly for Single “Conductor”:

1	120kN Straight shackle, bolt type – to drawing: D-DT-7017 Rev. 5	1
2	Earth wire insulator, with arching horns – to drawing: D-DT-7012 Rev. 3	1
3	Clamp susp pivoted “Conductor Specific according to design BOM” ACSR – to drawing: D-DT-7009 Rev. 7	1
4	Armor rod set; Aluminium alloy; suitable for “Conductor Specific according to design BOM” ACSR – to drawing: D-DT-7034 Rev. 2	3

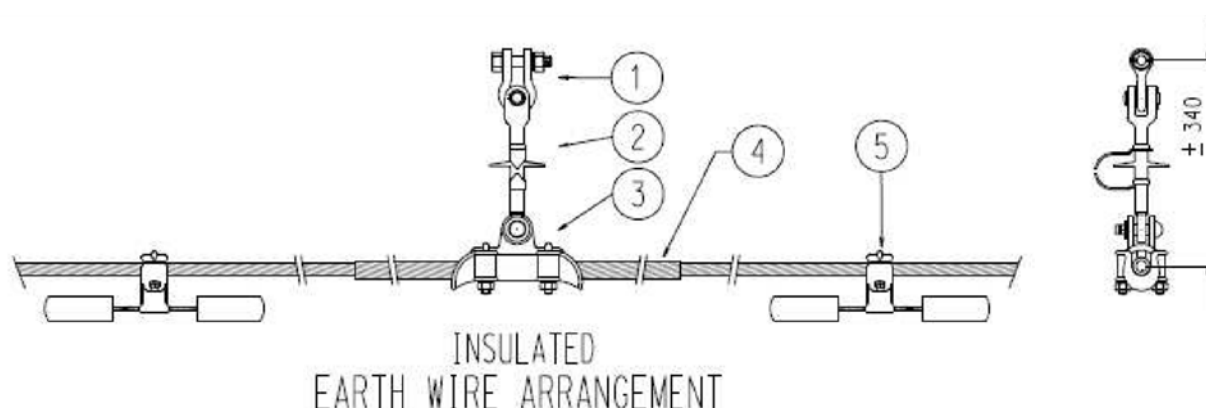


Figure 21: (Insulated Option) Shield Wire Suspension Assembly for Single “Conductor”

13.7. CRITERIA FOR INSULATORS AND APPROVED INSULATORS AND INSULATOR SUPPLIERS

- a) Horizontal line post insulators
- Specifications : DISASABL1; DSP 34-510; SCSAGAAR0
 - System voltage : 132kV (Peak -145kV);
 - IEC Power frequency wet flashover : 275kV;
 - IEC Basic insulation level : 650kV;
 - Minimum pollution creepage (Light) : 20mm/kV (Silicon rubber; EPDM)
 - Maximum safe working load (F.O.S.=2.5) : 5.3kN;
 - End fittings:
 - Live end (Galvanized malleable) : Trunnion with 1 hole drop tongue;
 - Base end (Galvanized malleable) : Standard Gain base (305mm hole centers);
 - Normal angle of inclination : 12°;
 - Connecting length between end fittings : 1 200mm;
 - Minimum horizontal distance (conductor to support) : 1 300mm;
 - Weather shed material (Alternating sheds preferred) : Silicon rubber; EPDM
- b) Composite suspension and strain insulators
- Specifications : DISASABL1; DSP 34-510; SCSAGAAR0
 - System voltage : 132kV (Peak -145kV);
 - IEC Power frequency wet flashover : 275kV;
 - IEC Basic insulation level : 650kV;
 - Minimum pollution creepage (Light) : 20mm/kV (Silicon; EPDM)

- Maximum safe working load (F.O.S.=2.5) : 120kN;
- End fittings:
 - Live end (Galvanized malleable) : IEC120 16mm Ball;
 - Earth end (Galvanized malleable) : IEC120 16mm Socket;
 - Connecting length between end fittings : 1 483mm (± 20 mm);
 - Weather shed material (Alternating sheds preferred) : Silicon rubber; EPDM

14. ACTIVITY STAGE 9

STRINGING ACTIVITIES

- a) All ACSR compression dead end type assemblies of phase conductors and earth wires must be tension tested.

14.1. TEST JOINTS

14.1.1. Compression joint sampling and testing

- a) The purpose of the test is to ensure that the assembly meets the required strength of 95% of the rated tensile strength of the conductor. By testing an assembly compressed on site with the compression machine to be used on the project and by the personnel appointed to perform the crimps, the entire system is proven.
- b) Before any stringing activities commences, the Eskom Clerk of Works shall randomly select two dead-end fittings and one joint from those on site supplied for the project. He shall check that they conform with buyers' guide drawings D-DT-7000 and DDT-7001, indelibly mark them with his signature and give them to the Contractor to compress.
- c) The Contractor shall compress, in the presence of the Eskom Clerk of Works, a sample phase conductor assembly. The assembly shall consist of two dead-end fittings and a mid-span joint.
- d) The crimping equipment used shall be that allocated for the project and the personnel performing the crimps shall be those appointed to do so. The length of conductor between the fittings shall not be less than 100 times the diameter of the conductor. This test assembly shall be labelled and sent to an approved test laboratory for tensile testing.
- e) The Contractor shall, at his expense, arrange for the samples to be mechanically tested, in the presence of himself and the Clerk of Works, at an approved laboratory.
- f) Test certificates to be provided as part of the Hand-Over Documentation.
- g) Should the Test Joint fail, the Contractor will re-test at his own cost.
- h) Compression assembly sample detail:
- i) An Example of information for the testing of compression fitting assemblies

14.1.2. Compression joint sampling and testing procedure

- a) The Contractor, using the following testing procedure, shall conduct a tensile test on the samples:

- A tensile load of about 50% of the breaking load of the conductor shall be applied and the conductor shall be marked in such a way that movement relative to the fitting can easily be detected;
- Without any subsequent adjustment of the fitting, the load shall be steadily increased to 95% of the breaking load and then reduced to 90% of the breaking load and maintained for 1 min;
- There shall be no movement of the conductor relative to the fitting due to slip during this period of 1 min. and no failure of the fitting;
- The conductor shall then be loaded to failure, and shall again withstand a minimum load of 95% of the minimum breaking strength of the conductor for it to be deemed acceptable. b) Compression joint test failures
- If the sample fails in any sense during the testing thereof, a further three (3) samples shall be tested and shall all be required to pass the above test procedure;
- If any one or more of these samples fail, no stringing shall commence until the Project Engineer has satisfied himself that the equipment is acceptable. c) Record keeping
- Four (4) copies of the test report shall be forwarded to the Project Engineer for his review and approval prior to stringing.

14.2. STRINGING

14.2.1. Transport of phase conductor and shield wire stringing hardware

- a) All compression and preformed joint fittings, as well as miscellaneous phase conductor and shield wire repair fittings shall be delivered to site by the Contractor.
- b) Refer to the BOM for summary of stringing material to be supplied by the Contractor.

14.3. SAFE STORAGE, HANDLING AND TRANSPORT OF PHASE CONDUCTOR AND SHIELD WIRE STRINGING HARDWARE

- a) The Contractor shall be responsible for the safe storage, handling and delivery to the construction site of all the phase conductors, shield wires supplied by the Employer.
- b) All compression type fittings shall be stored in an enclosed storage facility.
- c) The ACSR phase conductor as well as the Galvanized Steel or ACSR shield wire shall be supplied and delivered to the Contractor's construction yard site by the Employer.
- d) Refer to the Design BOM and order BOM of this document for the quantities of the phase conductor and shield wire supplied by the Employer for this project.
- e) The Contractor and Clerk of Works shall check and record all phase conductor and shield wire drum numbers delivered to site. Records shall be submitted to the Project Manager for acknowledgement.

14.4. SAFE HANDLING, TRANSPORT TO DRUM SITES AND COMPLETE STRINGING, REGULATING CLAMPING OF PHASE CONDUCTORS AND SHIELD WIRES

- a) The following Standards, Specifications, Guidelines and Drawings apply:
 - **TRMSCAAC1 Rev. 3 -Section 8** Transmission line tower and Line construction;
Project File Route Plan;
 - **Project File** PLSCADD design profile sheets;
 - **Project File** PLSCADD Stringing Sag & Tension Charts.
- b) The Project Engineer shall provide all PLSCADD generated Stringing sag and Tension Charts for the project to the Contractor. The Stringing Sag and Tension Charts shall be verified and accepted by the Contractor prior to the stringing and regulating activities. Any discrepancies with regards to the Stringing Sag and Tension Charts shall be immediately reported to the Project Engineer via the Clerk of Works.
- c) Sag & Tension loading criteria
 - The calculations of sag corrections for creep and clamping off sets, shall be the responsibility of the Contractor and will be based on the Stringing Sag and Tension Charts supplied by the Project Engineer.
 - Criteria for the calculations for the Stringing Sag and Tension Charts for the damped "ACSR" phase conductor must be based on a maximum final conductor loading after creep of: h) 70% UTS @ -5°C EDT 1050Pa wind load or C-value = 2450m for its "Ruling Condition". i) 70% UTS @ 15°C 1050Pa wind load or C-value = 1 800m for its "Ruling Condition".
 - Criteria for the calculations for the Stringing Sag and Tension Charts for the damped "ACSR and Galvanized Steel" shield wire must be based on a maximum final conductor loading of j) 70% UTS @ -5°C EDT under 1050Pa wind load or C-value = 2750m for its "Ruling Condition". k) 70% UTS @ 15°C 1050Pa wind load or C-value = 2100m for its "Ruling Condition"
 - The overhead shield wire will be sagged to follow the initial parabolic profile of the OPGW;
 - The initial tension criteria for the phase conductor at any temperature shall under no circumstances exceed 70% of the conductor specified UTS value under 1050Pa wind load.
 - The final tension criteria for the phase conductor at -5°C with 1050Pa wind loading shall under no circumstances exceed 70% of the conductor specified UTS value.
- d) Contractor's work comprise
 - Sampling and testing of all phase conductor and shield wire compression fittings, prior to the commencement and stringing activities.
 - The safe handling & transport to drum station, stringing, jointing, regulating and clamping of ACSR phase conductor.
 - The safe handling & transport to drum station, stringing, jointing, regulating and clamping of ACSR or Galvanized Steel shield wire.
- e) The phase conductor and shield wire drum numbers shall be recorded by the Contractor, when delivered to "Drum Sites" and verified by the Clerk of Works.
- f) Stringing method

- All phase conductors shall be tension strung over the entire length of the line, unless otherwise permitted by the Project Engineer;
- Non-tension stringing will be allowed for stringing of overhead shield wires, only if the Contractor can ensure that the shield wires will under no circumstances be dragged on the ground or be damaged in any degree during the stringing process;
- The equipment and methods used for stringing the phase conductors and shield wires shall be such that the phase conductors and/or shield wires will not be damaged. Particular care must be taken at all times to ensure that the phase conductors and shield wires do not become kinked, twisted or abraded in any matter.
- Vehicle traffic passing over phase conductors lying on the ground will not be permitted in any sense. The Contractor at his own cost will replace all damaged conductors caused by such incidents.
- The Contractor shall make suitable arrangements for temporary staying of structures and anchoring of conductors when necessary.
- Conductors may not be anchored to any portion of any structure, except strain towers and then only at the points designed for conductor attachment.
- Temporary anchoring to footings and guy anchors will not be permitted. Where temporary anchoring is required, suitable temporary anchors shall be provided. Installation and removal of temporary anchors will be the Contractor's responsibility.
- At no time shall the pulling tension in the conductors shall exceed the tensions shown on the stringing sag charts. Pulling of more than one drum length of conductor shall be subject to the Clerk of Works acceptance.
- Adequate protection shall be provided where there is danger of conductors being damaged by vehicles or other equipment and objects. Conductors shall not be left in contact with the ground, vegetable matter or any conducting or semi-conducting material. Wood lagging or similar material shall be used to protect the conductor when working at ground level.
- Radio communications shall be used to relay information and instructions between the conductor tensioning station, intermediate check points, mobile stations and the pulling station at all times during a stringing-tensioning operation. An outage of radio communications at any station will require immediate cessation of conductor pulling operations.
- The placement of tensioning and pulling equipment shall be such that the vertical angle of pull on a cross-arm during stringing operations shall not be more than 20°. Conductors shall not be pulled around angles that exceed 20°.
- During stringing operations and before regulating, if it becomes necessary to leave the conductor in the blocks for longer than eighteen hours, the conductor shall be left at reduced tension, and the Clerk of Works immediately notified. The percentage of sag, spans involved, time interval, and correction for creep shall be noted, and records forwarded to the Clerk of Works. In no case shall conductors be left with less than the following clearances:
 - Cultivated or open country : 6,0m,
 - Roads and trails : 8,0m,
 - Railway tracks : 9,0m.
- Stringing shall be done in "Daylight-hours" only.
- n) Stringing shall not be allowed to commence in abnormal windy conditions.

- The use of phase conductor and shield wire are to be optimized to avoid excessive waste. All off-cuts and surplus phase conductor and shield wire shall be returned to the Employer upon completion of the project.
- Matched conductor drums, marked with the same number followed by the suffix A, B, C etc., shall be used for each pull of multiple conductors per phase to ensure even sag characteristics and a minimum number of joints. The Contractor shall select the most suitable sets of matched conductor drums for each stringing position to minimize wastage of conductor. The Contractor shall keep an accurate record of the phase conductor and shield wire drum numbers and their position in the line. On completion a copy of these records shall be submitted to the Project Manager.

14.4.1. Stringing equipment

- a) Calibration and test certificates for all dynamometers and stringing equipment shall be submitted to the Clerk of Works for evaluation and approval, well in advance of the commencement of any stringing activities.
- b) Swivels shall be used to attach the pulling line and conductors to the running board. Swivels shall be small enough to pass through the blocks without damage to either, and shall have ball bearings and be free turning under load.
- c) The sheaves shall conform to the conductor manufacturer's recommendation as to diameter, and to size and shape of groove for the size of conductor used. Sheaves shall have a minimum diameter of fifteen times the conductor diameter at the base of the groove.
- d) Block surfaces that will be in contact with the conductor shall be coated with neoprene or rubber. This covering shall be kept clean and free of materials that might damage the conductor surface.
- e) The conductor sheaves shall have a separate groove for the pulling line. The pulling line shall not run on the rubber covered conductor grooves. The sheaves shall be inspected for damage or contamination before each usage.
- f) The Contractor shall not use any sheaves rejected by the Clerk of Works due to damage or excessive wear. The Contractor shall immediately remove such sheaves from the site.

14.4.2. Stringing program

- a) The Contractor shall submit a complete stringing program to the Project Manager at least 50 days in advance of the stringing activities. The Project Manager will then arrange all crossing permits with the relevant Service Owners from this stringing program;
- b) All existing overhead services for example, Telkom lines, Railway lines, Power lines and Proclaimed Roads, etc. are indicated on the profile drawings. All crossing notices and permits will be obtained and coordinated by the Clerk of Works;
- c) The Contractor shall notify the Clerk of Works at least 35 days in advance, of the time he intends to make a crossing over any existing overhead services;
- d) All crossings over existing services shall be done in accordance with TRMSCAAC 1 Section 8.2.1.

14.4.3. Crossings

- a) No crossing over above mentioned services will commence without proof of the official Eskom Land Development application for these services crossings, as well as the written acceptance and approval from the relevant service authorities.
- b) Special scaffolding to be erected at Spoornet Railway line crossings to ensure the safe passing of trains at all times during the stringing activities. Special scaffolding only to be removed on completion of the regulating and clamping of the phase conductors and shield wires.
- c) Special scaffolding to be erected at National road crossings to ensure the safe passing of traffic at all times during the stringing activities. Special scaffolding only to be removed on completion of the regulating and clamping of the phase conductors and shield wires.
- d) Temporary "Goal post" type structures to be erected at all service crossings to ensure safe clearances over these crossing at all times during the stringing activities. Temporary structures to be removed on completion of the regulating and clamping of the phase conductors and shield wires, only.

NOTE: Minimum design clearances are measured at:

- 70°C conductor temperature for over-crossings;
- -5°C conductor **temperature for under-crossings**

14.4.4. Insulation of overhead shield wire

- a) The following Standards, Specifications, Guidelines and Drawings apply:
 - **SCSASABF9 Section 4.9** Sub-transmission line Earthing Specification;
 - **Project** File PLSCADD design profile sheets;
 - **Project File** PLSCADD design staking table.
- b) The shield wire insulators shall be 120kN units in accordance with D-DT-7012. Where shield wire insulators are fitted with adjustable spark-gaps, the gap shall be set to 8mm for all cases.
- c) Except for the structures listed, all other structures on the entire line shall not be equipped with shield wire insulators:

14.5. MAKING OFF AND REGULATION

14.5.1. Regulate of phase conductors and shield wires

- a) The Contractor shall string all phase conductors and shield wires to the appropriate sags and tensions as determined from the conditions specified in above. The calculation of sag corrections for creep and clamping offsets shall be the responsibility of the Contractor, based on charts supplied by the Project Engineer. Such calculations shall be submitted to, and accepted by the Project Engineer prior to regulating.
- b) Phase conductors and shield wires shall be strung to the appropriate sag determined for the actual span length, and the equivalent span of the strain section involved.
- c) The appropriate conductor temperature to be used for sagging shall be determined by means of a Celsius-thermometer inserted in the end of a suitable length of phase conductor or shield wire from which a 150mm length has been removed

from the centre strand, or other accepted method. The wire with the thermometer inserted shall be hung at cross-arm level for at least two hours before the temperature is read.

- d) The length of a section of phase conductors and shield wires to be regulated at any one time shall be limited to that length that will assure attainment of correct sag based upon terrain and obstructions.
- e) Where there are a large number of suspension towers between strain towers, regulating of phase conductors and shield wires shall be done at intervals of 3 to 5 spans. In hilly country the conductors may require to be temporarily anchored one span away from the spans being regulated. The sag spans chosen shall be near each end of the section pulled for single conductor lengths, and near each end and at the middle for double conductor lengths. In addition, the sags shall be checked in all spans over 500m. In unusual situations, the Clerk of Works may require additional checks.
- f) The Contractor shall provide, and maintain in good condition, suitable dynamometers, sag boards or other accepted apparatus for the proper checking of the work. Dynamometers shall read in Newton and shall be tested and re-calibrated at regular intervals, at least for every major line project. The Contractor shall keep dynamometer calibration certificates at the site office.
- g) The Contractor shall notify the Clerk of Works at least twenty-four hours prior to any planned regulating operation. No regulating shall be done except in his presence, unless otherwise authorized. The Contractor shall furnish labour and equipment, for signalling and climbing purposes as requested by the Clerk of Works, to facilitate his inspection of the sag.
- h) In pulling up the conductor, caution shall be used to avoid pulling the conductor above sag.
- i) The maximum elapsed time from the beginning of the pulling operation to the completion of the regulating operation shall not exceed seventy two hours, nor shall the maximum elapsed time between the completion of the regulating operation and the completion of the clamping operation exceed seventy two hours. Conductor remaining in the blocks longer than the established limits shall be subject to inspection and, if damaged, replaced. The Contractor shall furnish labour and equipment as requested by the Clerk of Works for this purpose, as well as for inspection in the event of sudden windstorms.
- j) No minus regulating tolerance will be allowed. A plus regulating tolerance of 0,01 times the theoretical sag, but not exceeding 150mm will be allowed, provided all conductors in the regulating span assume the same relative position to true sag. Sags of conductors in the same bundle shall not vary more than 35mm relative to one another. Sag variances between phases shall not be apparent to the naked eye.
- k) When finally adjusting the sags of the phase conductors and shield wires, the sag shall be checked with sag boards, or other accepted methods in spans where the levels of the two structures are approximately the same, and the span length is approximately equal to the equivalent span length of the strain section. Upon completion of this regulating operation, as many successive spans as can be observed from the sag board position shall be checked for uniformity of sag.
- l) All conductors, except for conductors in sag sections over flat terrain, shall be plumb-marked at each structure for the complete section regulated, before clamping-in or dead-ending of the conductor is begun. Conductors shall be marked with paint crayon or wax pencil -not with metal objects.

- m) Insulator strings on three suspension towers adjacent to a new section to be regulated must be clamped to the conductor before temporary anchors are removed and regulating of the new section begins. These insulators shall remain in the plumb position upon completion of regulating of the new section and during plumb-marking.
- n) Regulating operations shall be conducted during daylight hours only. Regulating operations shall be suspended at any time, when in the opinion of the Clerk of Works, wind or other adverse weather conditions would prevent satisfactory regulating.
- o) Records of temperature sag and tension for each section regulated shall be kept by the Contractor, and a copy submitted to the Project Manager.
- p) On completion of regulating of a section of the line, the Contractor shall measure and record all clearances over roads, power lines, communication lines, railways etc. along the route. A copy of these records is to be submitted to the Project Manager. The Clerk of Works is to be notified immediately of any discrepancy found between the actual clearance and that shown on the profiles.

14.6. MIDSPAN JOINTS

14.6.1. Jointing general

- a) As far as possible, complete drum lengths of phase conductor and earth wire shall be used to reduce the number of joints;
- b) Joints shall not be closer than 15,0m from the nearest suspension structure and 30,0m from the nearest strain structure;
- c) Joints shall not be installed in spans crossing Railway lines, Proclaimed roads, Power lines, major communication lines and rivers;
- d) In no case shall more than one joint be installed in any given span, nor shall a joint be installed in a span dead-ended at both ends;
- e) The minimum distance between joints on the same phase shall be 300m.
- f) Whenever joints or dead-ends are made, auxiliary erection clamps and hauling devices shall not be placed closer than 8,0m to the point of joint or dead-end. The auxiliary erection clamps shall not allow relative movement of strands or layers of wire, and shall not birdcage, over tension or deform individual wires.
- g) The conductor shall be cut with a ratchet or guillotine cutter to produce a clean cut, retaining the normal strand lay and producing minimum burrs. The Aluminium strands shall then be stripped from the steel core by using an acceptable stripper. Under no circumstances shall high tensile hacksaw blades be used to cut conductor.
- h) The conductor shall be laid out for a distance of 15,0m and straightened at the ends before preparation for installation of joints or dead-ends. Compression jointing shall be carried out on a clean tarpaulin or jointing trailer. The lay of wires shall be tightened before the first compression is made. The conductor strands shall be cleaned by wire brushing and an accepted non-oxidizing paste applied.
- i) Compression shall be carefully made so that the completed joint or dead-end is as straight as possible. To minimize distortion, the joint should be rotated 180° between each compression operation, the joint and conductor being fully supported in the same plane as the compression jaws.

- j) If, in the opinion of the Clerk of Works, the completed joint or dead-end requires straightening, it shall be straightened on a wooden block by use of a sledgehammer and shaper or wooden mallet.
- k) If, in the opinion of the Clerk of Works, the joint or dead-end has not been satisfactorily straightened or has been damaged in the process, the Contractor shall replace it at his own cost.
- l) After compression has been completed, all corners, sharp projections and indentations resulting from compression shall be carefully rounded. All other edges and corners of the fitting that have been damaged shall be carefully rounded to their original radius. Nicked or abraded surfaces shall be carefully smoothed. Tape, tape residue and filler paste shall be removed from fittings and conductors.
- m) Sufficient notification must be given to Clerk of Works prior to the installation of compression fittings. Unless previously agreed all joints and dead-ends shall be installed in the presence of the Clerk of Works.
- n) Under no circumstances shall compression joint be allowed to pass through the travellers (stringing pulleys).
- o) During the progress of the stringing, the Contractor shall keep an accurate record of the spans in which conductor and earth conductor joints are made, the date of assembly onto the conductor. A copy of these records shall be supplied to the Project Manager.
- p) Only coded jointers authorized by the Project Manager shall carry out compression joints on the phase conductors & shield wires.
- q) Each coded jointer shall be issued with his own unique identification number or sign, which he shall use to punch completed joints as a register of his acceptance.
- r) All current carrying connections, contact surfaces, clamps, conductor and terminals shall be prepared as follows:
 - s) Wipe the mating surfaces free from grease and dirt (except the bores of compression sleeves);
 - t) Apply 1mm thick coating of approved jointing compound to the surfaces using a non-metallic spatula or similar tool;
 - u) Scrub all the coated surfaces thoroughly with a wire brush which is new or which has been used solely for this purpose;
 - v) Wipe off the jointing compound;
 - w) Apply a fresh 1mm thick coating of compound; and
 - x) After a period of not more than one minute make the connection in the normal manner and remove excess extruded compound.
- y) NOTE: No compound squeezed out by clamping pressure shall be used in making further joints. The Contractor shall apply such compound as necessary for making the connections by the method outlined above. On bolted connections care shall be taken during the tightening to avoid overstressing the bolts or components of the clamps. A torque wrench shall be used for tightening each bolt to the required torque.
 - Tighten all bolts and U-bolts to their specified torque.
 - Leave clamps for **24 hours** to allow Aluminium conductor to expand and contract.
 - Check all bolts to ensure that they are still at the required torque.

14.7. REPAIR SLEEVES

14.7.1. Conductor repairs

- a) Damage caused by the Contractor shall be repaired in a manner determined by the Clerk of Works.
 - Damage is any deformity on the surface of the conductor that can be detected by eye or by feel.
 - Damage includes, but is not limited to nicks, scratches, abrasions, kinks, bird caging, and popped out and broken strands.
- b) Depending upon the severity of the damage and the length of damaged section, the repair shall be made by careful smoothing with extra fine sandpaper, covering with preformed repair rods, installing a compression-type repair sleeve, or by cutting and splicing.
- c) Kinked, bird caged or severely damaged sections of conductor shall be cut out. When there is repeated damage in the same span, or in consecutive spans, the entire conductor in such spans shall be replaced.
- d) All damage caused by auxiliary erection clamps or other gripping devices shall be repaired or cut out, as instructed by the Supervisor, before the conductor is sagged.
- e) Preformed repair rods shall be installed if no more than one strand is broken, or nicked deeper than one third of the strand diameter, or when a number of strands are reduced in area not exceeding the area of one strand. Not more than two sets of preformed repair rods shall be installed on any one conductor in any given span.
- f) A compression-type repair sleeve shall be installed, if not more than one third of the outer strands of the conductor are damaged over a length of not more than 100mm, or not more than two strands are broken in the outer layer of conductor and the area of any other damaged strands is not reduced by more than 25%.
- g) Compression-type repair sleeves shall not be installed on one conductor in a given span if it already contains a conductor splice, conductor dead-end or another compression-type repair sleeve.
- h) Damage to the steel strands or aluminium strands, exceeding the stated limits for repair sleeves, shall be cut out and spliced by means of a compression type mid-span joint.
- i) Any foreign matter such as pitch, paint and grease placed on the conductor and fittings by the Contractor shall be removed by methods approved by the Supervisor prior to regulating.

14.8. CLAMPING IN

14.8.1. Clamp of phase conductors and shield wires

- a) The phase conductors and shield wires shall be clamped-in by the Contractor after the Clerk of Works has accepted the regulating operation as being in full compliance with the specifications and stringing data. Where offsets are required, the conductors shall be accurately adjusted in accordance with the offset clamping information developed by the Contractor.
- b) All conductors in a sag section shall normally be clamped-in, beginning at the second structure from the forward end of the pull, and shall progress structure by structure, until the conductors at all structures are clamped-in.

- c) The Contractor shall exercise extreme care in moving the phase conductors and shield wires from the stringing blocks to the suspension clamps.
- d) Where armour rods or conductor clamps incorporating armor rods are called for, they shall be installed in strict accordance with the manufacturer's recommendations. Armor rods shall be centered in each suspension clamp in such a manner that the clamp is not more than 50mm from the center of the rods. Variations between the ends of the individual rods shall not exceed 12mm.
- e) Aluminium rods shall be handled with the same care as the phase conductor.
- f) Properly calibrated torque wrenches shall be used to tighten suspension clamp and dead-end bolts to the Manufacturer's specified torque values. U-bolts shall be drawn up evenly to torque values.
- g) Bolts shall not be tightened excessively. Proof of calibration must be submitted to the Clerk of Works.
- h) All phase conductor support assemblies shall be installed such that the insulator string will hang in a vertical plane through points of insulator string attachment to structure, with the structure properly aligned.

14.9. VIBRATION DAMPERS

14.9.1. Installation of vibration control devices

- a) All work to be done in strict accordance with specification DST 34-1204
- b) Except for terminal structures at the closings span sides, all other structures on the entire line shall be equipped phase conductor and shield wire vibration dampers.
- c) The number of vibration dampers to be installed per span shall be as recommended by the manufacturer. The spacing from the mouth of the strain clamp or the centre of the suspension clamp shall be in accordance with the manufacturer's recommendations.
- d) If the use of armour rods makes it impossible to meet this spacing, the first damper shall be positioned at the end of the armour rods, and any additional dampers shall then be spaced from the first damper. Dampers shall be located within 25mm of their correct position.
- e) Vibration dampers shall be installed when clamping the conductor, but only after the conductor has been securely fastened in the conductor support assembly.
- f) Multi frequency Stockbridge type vibration dampers shall be installed so that they hang directly under the conductor.
- g) The installation of vibration dampers shall be in accordance with the manufacturer's recommendations.
- h) Vibration dampers shall be installed within 72 hours after clamping of the phase conductors and shield wires.
- i) All vibration control devices supplied by the Contractor for the project shall be technically approved by the Project Engineer prior to the installation thereof.

14.9.2. Phase conductor vibration damper positioning

- a) Helically attached "Multi frequency Stockbridge or Dog-bone type" vibration dampers are to be installed on ACSR type phase conductor;
- b) The dampers must be installed in strict accordance with the Manufacturer's specifications;

- c) The number of multi frequency vibration dampers per span shall be:
 - Spans up to 350m : 2 (2 Subsets of 1);
 - Spans 351m to 550m : 4 (2 Subsets of 2);
 - Spans 551m to 730m : 6 (2 Subsets of 3);
 - Multi frequency vibration damper positioning is specific conductor related and specified per project.
- d) Min. 50mm bare conductor between armour rod ends to be maintained at all times;
- e) No damper must be positioned with the overlapping of the amour rods of any clamp.
- f) No damper must be positioned, overlapping the amour rods of any clamp and/or the next damper.
- g) Vibration dampers shall comply with D-DT 7005; bolted attachments are prohibited.

Note: The attachment clamp used to connect the damper to the conductor has traditionally been a bolted type of clamp. This type of clamping is not an acceptable clamping technology for distribution lines. A good clamping technology is helically formed rods. Clamping with helically formed rods ensures consistency and effectiveness of attachment.

The Dogbone vibration damper is used on larger conductors especially Rail. It has a damping efficiency as high as 70% in the 12-40 Hz range as compared to 40% efficiency in the range 11-13 Hz accepted for the traditional damper.

No tool is required for the installation. Installation or removal can be carried out without shut-down of the line by using hot stick application. There is a neoprene pad between damper and conductor which offers conductor protection from abrasion at the point of attachment. No concentrated radial stresses are set up under the clamp and the design completely eliminates any moisture build up and corrosion.

14.9.3. GS shield wire vibration damper positioning

- a) "PVC Spiral" type vibration dampers are to be installed on the overhead GS shield-wire;
- b) The dampers must be installed in strict accordance with the Manufacturer's specifications;
- c) The number of spiral type vibration dampers per span shall be:
 - Spans up to 250m : 2 (2 Subsets of 1);
 - Spans 251m to 500m : 4 (2 Subsets of 2);
 - Spans 551m to 750m : 6 (2 Subsets of 3);
- d) Positioning of earth conductor dampers to be one hand's width from the mouth of the strain clamp or end of the suspension clamp armour rods and also one hand's width apart for cases where more than one damper are to be installed;
- e) No damper must be positioned with the overlapping of the amour rods of any clamp
- f) Positioning of the shield wire dampers to be one hand's width from the mouth of the strain clamp or end of the suspension clamp armour rods and also one hand's width apart for cases where more than one damper are to be installed. No damper must be positioned, overlapping the amour rod of any clamp and/or the next damper.

14.9.4. Installation of jumper assemblies

- a) The Contractor will be responsible for the safe storage, handling and transport of all jumper assembly fittings to the specified structures and the complete installation thereof.
- b) The phase conductor jumpers shall be formed to provide the maximum amount of clearance from earthed hardware and structure steelwork. The positioning of phase conductor jumpers shall comply with the clearances stated under the specified displacements.
- c) All phase to earth jumper clearances at phase conductor jumpers shall be measured by the Contractor in the presence of and as instructed by the Clerk of Works and records shall be submitted to the Project Engineer for acceptance.
- d) Jumper clearances not meeting the requirements shall be removed and replaced at the Contractor's own cost.
- e) Compression type jumper terminals shall be installed at all phase conductor jumper ends.
- f) Phase conductor jumpers around all mono-pole strain structures shall be supported with jumper insulator support assemblies.
- g) The shield wire jumpers shall be solid connected to all steel pole structures, except in cases where shield wire insulators are installed and at structures where it is specified that the overhead shield wire shall be omitted.

14.10. BIRD FLIGHT DIVERTERS

14.10.1. Installation of bird flight diverters

- a) The following Standards, Specifications, Guidelines and Drawings apply:
 - SCSASABF9 Section 4.9 Sub-transmission line Earthing Specification;
 - Project File
 - PLSCADD design profile sheets;
 - Project File PLSCADD design staking table;
 - Environmental **Management Plan Project File.**
- b) The "Bird diverters" for this project shall be supplied and installed by the Contractor.
- c) The Environmental Management Plan for the project will specify the bird flight routes and bird sensitive areas for the installation of "Bird diverters".
- d) "Bird diverters" shall be installed on 70% of the indicated spans, spread equally over mid span and 7,0m-10,0m apart with alternating colours GREY and WHITE.
- e) "Bird diverters" will be technically approved by the Employer's Environmental Manager prior to the purchasing and installation thereof.
- f) The "Tyco Flight Diverter" -Buyers guide reference D-DT-3107 is recommended for installation on this project.

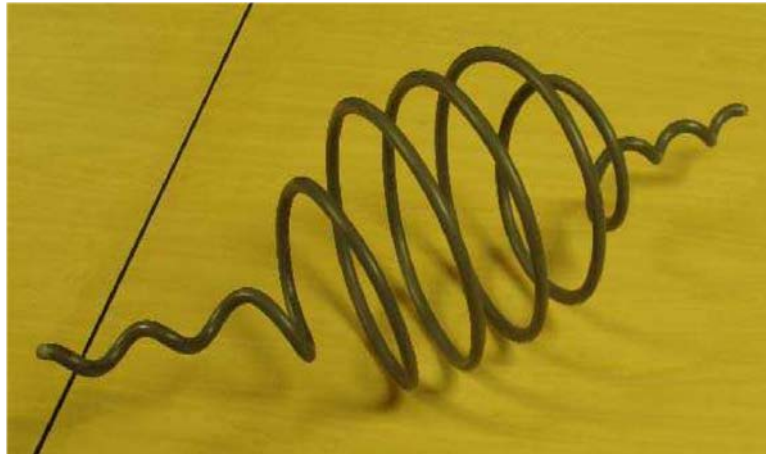


Figure 22: Tyco Flight Diverter

- g) The "Tyco Flight Diverter" has been used successfully in many places around the world and has been installed on a line in the former North Western Region in conjunction with EWT and proved very successful as a mitigating device.

14.11. AIRCRAFT WARNING DEVICES

14.11.1. Installation of aircraft warning devices

- a) Aircraft warning devices required for this project shall be supplied and installed by the Contractor.
- b) The following Standards, Specifications, Guidelines and Drawings apply:
 - DSP 34-1681 Standard for aircraft warning devices used on overhead transmission, sub-transmission and distribution lines;
 - DST 34-2052 Aviation requirements for power lines, buildings, towers, wind turbines and related structures;
 - DSP_34-254 Manufacturing specification for distribution equipment labels
 - Civil Aviation Act no. 13 of 2009 South African Civil Aviation Authority Act no. 40 of 1998 ICAO Annex 14 Volume 1 - Chapter 6 Visual aids for denoting obstacles;
 - Project File - PLSCADD design profile sheets.
- c) Aircraft warning sphere specifications
 - Maximum diameter = 600mm;
 - Maximum weight/unit = 5kg.
 - The two standard colours for the aircraft warning devices, as listed in SANS 1091, shall be:
 - Cloud White (SANS.G80, NCS 0704-G38Y, Nearest NCS 0505-G20Y); -
 - International Orange (SANS.A15, NCS 1777-Y72R, Nearest NCS 2075-Y70R).
- d) Aircraft warning sphere installation
 - AWS shall be installed by alternating the colours;
 - On a single overhead shield wire AWS shall be installed max. 30,0m apart;
 - On two overhead shield wires shall be installed alternating max. 30,0m apart (Max. 60,0m apart on the same shield wire);
 - In both single and/or double overhead shield wires the aircraft warning spheres shall be equally spread on either side of mid span.

- e) The centre mount "Aircraft Warning Sphere" manufactured by "Inotec Innovative Technologies (Pty) Ltd" or similar approved is preferred for application on this project.



Figure 23: Aircraft Warning Sphere

15. ACTIVITY STAGE 10

POWER LINE LABELLING ACTIVITIES

15.1. SUPPLY AND TRANSPORT TO SITE OF LINE AND STRUCTURE IDENTIFICATION LABELS AND ACCESSORIES

- a) The following Standards, Specifications, Guidelines and Drawings apply:
- TRMSCAAC1 Rev. 3 -Section 7.7.4 Transmission line tower and Line construction;
 - 34-1439 Eskom's Labelling Standard;
 - DISASZAA2 Section 2 Application standard for Distribution Equipment Labels;
 - Project File Project File Route Plan;
 - Project File Label manufacturing detail drawings;
 - Project File PLSCADD design profile sheets.
- b) The power line labels as well as all material required for the installation power line labels shall be supplied and delivered to site by the Contractor.
- c) Prior to the purchasing of power line labels written confirmation of the structure identification label codes shall be obtained from the Gauteng Operation Unit Network Planning Manager.
- d) The labels to be supplied by the Contractor:
- Line designation labels:
 - Label 1:-"Line Label Name" to be installed at the terminal structure at Substation Name.
 - Label 2:-"Line Label Name" to be installed at the line terminal structure at Substation Name.
 - Label 3:-"Line Label Name" to be installed at the Substation Name to Substation Name T-off structure.
 - The labels shall be manufactured to specification: DSP_34254.
 - The 122mm x 1,0mm thick (Length of label will vary to suit relevant line designation) "Line Designation"
 - Structure identification labels:
 - The new "Line Name" codes shall be as follow:
 - " Line Label Name " starting at Substation Name up to the Substation Name

- The labels shall be manufactured to specification: DSP_34254 Latest Revision.
 - 122mm x 1,0mm thick (Length of label will vary to suit relevant line code) "Structure identification".
 - Phase colour disc labels:
 - The labels shall be manufactured to drawing: D-DT-5047s3.
 - Dia 230mm x 1,0mm thick "Phase Colour Disc" labels (RED, WHITE, BLUE).
 - Line crossing labels:
 - 406 x 900mm x 1,0mm thick "Line crossing" labels must be manufactured to specification: DSP_34254 and supported by a 15mm x 15mm x 1,6mm Aluminium square tube frame.
- Each label shall be properly strapped to the pole or structure with 4 x 12mm x 1,7mm thick heavy duty bandit strapping.

15.2. SAFE STORAGE, HANDLING AND TRANSPORT TO PEG OF LINE AND STRUCTURE IDENTIFICATION LABELS AND ACCESSORIES

- a) The Contractor will be responsible for safe storage of all power line labels and accessories.
- b) Labels shall be stored on a flat surface not to cause any bend and cracks to the finished label surfaces.
- c) Special care shall be taken in handling and transport of line labels not to cause any surface damage to the line labels.

15.3. SAFE HANDLING AND COMPLETE INSTALLATION OF POWER LINE AND STRUCTURE IDENTIFICATION LABELS

- a) The labels shall be installed by the Contractor:
 - Line designation labels:
 - Labels shall be fitted vertically below the bottom phase conductor attachment at the specified structures.
 - The line designation label shall face towards the substation where it must be installed.
 - Each label shall be properly strapped to the pole structure with 4 x 12mm x 1,7mm thick heavy-duty bandit strapping.
 - Structure identification labels:
 - Labels shall be fitted vertically midway between the lowest conductor attachment and ground level on every structure on the line.
 - The label shall face towards the substation first mentioned on the label code.
 - Each label shall be strapped to the pole structure with 3 x 12mm x 1,7mm thick heavy-duty bandit strapping.
 - Phase colour disc labels:
 - The line phases shall be identified by means of phase colour disc labels installed at the beginning and end of the line, as well as any other position on the line specified by the Project Engineer
 - The labels shall be fitted at the phases in the correct orientation at the Substation Name substation line terminal structure, and at the Substation Name substation line terminal structure.
 - Each label shall be strapped to the pole structure with 1 x 12mm x 1,7mm thick heavy-duty bandit strapping.

- Line crossing labels:
 - Line crossing labels must be installed at all major line crossings, unless otherwise specified by the Project Engineer.
 - The first, second and third structures away from an intersection point in all directions must be provided with line crossing labels.
 - At mono-pole structures the label shall be installed at the top of the structure, below the shield wire attachment and facing away from the point of intersection, or
 - At lattice steel towers the label shall be installed the transverse face of the cross-arm, facing away from the point of intersection.
 - Each label shall be properly strapped to the pole or structure with 4 x 12mm x 1,7mm thick heavy duty bandit strapping.

16. ACTIVITY STAGE 11

DISMANTLING AND REMOVAL OF THE EXISTING NAME LINE

16.1. DECOMMISSIONING EXISTING LINE AND DISCONNECT LINE SECTIONS

- a) The existing Name line section between Name to be decommissioned and disconnected as specified in the design document.

16.2. DISMANTLE, CUT, BUNDLE, TRANSPORT AND STOCKPILE OF PHASE CONDUCTOR, SHIELD WIRE, STAY ASSEMBLIES, INSULATORS & HARDWARE

- a) The phase conductors and/or shield wires shall not be cut under ruling tension conditions. The phase conductors and shield wires must be carefully slacken-out and dropped from the structures.
- b) Special care shall be taken to prevent any unsafe conditions and/or damages to services such as Railway lines, proclaimed roads, Telkom lines and power lines, etc. crossing under the existing line.
- c) ACSR phase conductor, shield wire and stay wires shall be cut, bundled and transported and stockpiled at a pre-allocated storage site for further disposal by the Employer, unless otherwise requested by the Employer's Asset Disposal Manager.
- d) Copper phase conductor shall be cut and bundled by the Contractor, only. All further handling and removal from site shall be done by an Eskom accredited scrap dealer. The Eskom Clerk of Works shall arrange and supervise such removal.
- e) All Copper phase conductor loads shall be weighed and recorded in the presence of the Eskom Clerk of Works, prior to removal from site by the Eskom accredited scrap dealer.
- f) All dismantled, insulators, line hardware, stay assemblies shall be removed from site by the Contractor, transported and stockpiled at a pre-allocated storage-site for further disposal by the Employer, unless otherwise requested and/or specified by the Employer's Asset Disposal Manager.

16.3. MINIMUM EXCAVATIONS AROUND STRUCTURE LEGS AND UNDERGROUND STAY ASSEMBLIES

- a) All existing steel pole structure legs shall be completely removed. Minimum excavations shall be done around structure legs to the various planted depths, for the complete removal thereof.
- b) In veld and rocky areas underground stay assemblies can be cut min. 1,0m below natural ground level.
- c) In other areas such as cultivated lands, town developments, etc. underground stay assemblies shall be completely removed.

16.4. COMPLETE DISMANTLING AND REMOVAL OF EXISTING POWER LINE STRUCTURES

- a) All steel structure legs shall be completely removed from the ground. No part of any structure shall be cut off and/or left in the ground.
- b) Steel structures shall be dismantled into manageable parts.
- c) All dismantled structure members and legs shall be removed from site by the Contractor, transported and stockpiled at a pre-allocated storage-site for further disposal by the Employer, unless otherwise requested and/or specified by the Employer's Asset Disposal Manager.

16.5. RE-INSTATE ALL EXISTING STRUCTURE SITES

- a) All work to be done in accordance with the Environmental Management Plan for this project.
- b) All excavations left from structure legs and underground stay assemblies shall be properly backfilled with in-situ excavated material and thoroughly compacted.
- c) Where additional backfill material is required, the Contractor shall import any suitable topsoil to complete the backfilling.
- d) All dismantled structure sites shall be properly reinstated to prevent any possible erosion that might originate from these sites.
- e) All damaged and deep vehicle tracks caused to the veld and environment on the dismantled line route shall be properly covered with suitable top soil and re-instated by the Contractor.

17. ACTIVITY STAGE 12

TAKING OVER OF THE WORKS AND CLEARANCE OF SITE

17.1. RE-INSTATE ENTIRE CONSTRUCTION SITE AND ROADS

17.1.1. Re-instate entire construction site

- a) The Contractor shall clear the entire construction site. All construction waists, cement bags, conductor strand off-cuts, shall be removed from site and disposed as prescribed in the Environmental Management Plan.

- b) Closing of construction access roads and providing of the necessary erosion protection measures on all construction areas, as specified in TRMSCAAC1 Clause 4.5 and 4.6 and to the relevant Landowner's satisfaction.
- c) Any position along the line route showing signs of possible soil erosion caused by construction activities shall be properly re-instated by the Contractor.
- d) Arrangements shall be made by the Contractor to rip and re-instate all cultivated lands compacted due to construction activities.
- e) Landowners shall be compensated by the Employer for any crop damages caused inside the servitude due to construction activities. Any damages caused to crops outside the servitude by the Contractor during construction activities shall be compensated by the Contractor.

17.2. CLOSURE OF CONSTRUCTION ROADS

- a) Upon completion, only roads as indicated by the Clerk of Works shall be closed, unless otherwise specified by the Employer and/or Landowner.
- b) In areas where no cut or fill has been made, barriers of earth, rocks or other suitable material shall affect closure.
- c) In areas 30 % slope and less, the fill of the road shall be placed back into the roadway using equipment that does not work outside the road-cut (e.g. back-hoe). In areas of greater than 30 % slope, the equipment shall break the road shoulder down so that the slope nearly approximates to the original slope of the ground. The cut banks shall be pushed down into the road, and a near normal side slope shall be re-established and re-vegetated.
- d) Replacement of earth shall be at slopes less than the normal angle of repose for the soil type involved.
- e) Construction of water diversion berms
 - Water diversion berms shall be installed as specified in this document
 - Borrow pits:
 - The **Contractor's** decision as to the location of borrow pits, shall be at the **Clerk of Works** acceptance;
 - The **Contractor** shall be responsible for the rehabilitation and re-vegetation of the borrow pits.
 - It is the **Contractor's** responsibility to negotiate the royalties for borrow pits with the relevant **Landowners**.

17.3. FINAL INSPECTION OF THE LINE

- a) The pre-commissioning final inspection on the line shall be carried out in accordance with the relevant Eskom Specifications and Standards, Design Profile Drawings and Route Plan, as well as the "Installation Records" of the line and the "Contract Documentation" for the project.
- b) A pre-arranged final inspection on the entire line shall be held, at least 10 days prior to the commissioning of the new line.
- c) The compulsory final inspection shall be accompanied by the following individuals:
 - The Contractor;
 - The Project Manager;
 - The Clerk of Works; d) The Project Engineer;
 - The Environmental Control Officer and the Employers Environmental Official;

- The Field Services and Plant Officials responsible for the line.
- d) The final quality inspection shall be held "Pole-to-Pole" covering all aspects of the new installation.
- e) All quality related defects from the "Defects List" compiled during the final inspection shall be rectified by the Contractor, prior to the commissioning of the line.

17.4. HANDING OVER, TEST & COMMISSIONING

- a) Indemnity forms shall be signed by all relevant Landowners in the presence of the Clerk of Works, expressing their satisfaction or dissatisfaction with the Contractors performance and behaviour on his/her property, prior to the handing-over of the project to the Field Services Manager.
- b) All jumper clearances shall be measured and submitted for handing-over by the Contractor.
- c) The Contractor shall assist the Employer in commissioning the new power line.

17.5. SUBMISSION OF "AS BUILT" INFORMATION

- a) The Contractor in conjunction with the Clerk of Works will be responsible for the compilation of the "As Built" information on the newly constructed power line.
- b) Four copies of a complete "Line Inventory" of the total line shall be submitted to the Employer on completion of all the work on site.
- c) The following information to be included in the "Line Inventory":
 - Copies of the "Introduction Agreements" and "Indemnity Agreements" between the Employer, the Contractor and all the Landowners on the power line;
 - "As Built" Line route data (Gate installation/refurbishment; Bush clearing; Herbicides application and Access road data);
 - Structure and structure label data;
 - Structure foundation type data;
 - Structure footing resistance data;
 - Insulator assembly and hardware data;
 - Phase conductor & shield wire drum data;
 - "As Built" Sag & tension data;
 - Mid span joint and conductor repair data;
 - Crossing clearances data;
 - Jumper clearances data;
 - Stringing equipment calibration certificates;
 - Compression joint test certificates;
 - "As Built" drawings.

17.6. SITE CLEARANCE

- a) In the event of the Contractor not pricing the items of the Taking over of the Works and Clearing of site Activities in sufficient detail, the Employer reserves the right to exercise its own discretion in the apportionment to individual items of the total

Taking over of the Works and Clearing of site Activity prices within the contract documents.

- b) The Contractor will be responsible for the proper clearance of the construction as well as camp sites:
- Removal of all temporary established items by the Contractor, see Activity Stage 1;
 - Clearing of construction camp sites from all rubble, waste and rubbish resulting from construction activities and re-instatement of these terrains.
 - Removal of all excess material supplied by the Employer (Hardware, insulators, copper, etc.) from site and returning of such material to the nearest Identified Site.

18. CONSTRUCTION GUIDELINES

18.1. GENERAL INFORMATION

18.1.1. Information Tables

Table 30: Conductor Properties

Conductor Type	Stranding & wire diameter (mm)	Overall diameter (mm)	Al area (mm ²)	Steel area (mm ²)	Total area (mm ²)	Weight Mass (kg/m)	N/m	UTS (kN)
MAGPIE	3/4/2.118	6.35			24.71	0.1397	1.3705	18.57
SQUIRREL	6/1/2.11	6.33			24.48	0.0852	0.8358	8.02
FOX	6/1/2.79	8.37	36.68	6.11	42.80	0.1490	1.4617	13.10
MINK	6/1/3.66	10.98	63.13	10.52	73.65	0.2570	2.5212	21.90
HARE	6/1/4.72	14.16	104.98	17.50	122.48	0.4270	4.1889	36.00
WOLF	30/7/2.59	18.13	158.06	36.88	194.94	0.7300	7.1613	69.20
CHICKADEE	18/1/3.77	18.87	200.93	11.16	212.09	0.6430	6.3078	44.90
LYNX	30/7/2.79	19.53	183.4	42.77	226.20	0.8460	8.2993	79.30
PANTHER	30/7/3.00	21.00	212.06	49.48	261.54	0.9700	9.5157	90.80
PELICAN	18/1/4.21	20.70	242.31	13.46	255.77	0.7750	7.6028	53.80
BEAR	30/7/3.35	23.45	264.42	61.70	326.12	1.2200	11.9682	112.00
GOAT	30/7/3.71	25.97	324.31	75.67	399.98	1.5000	14.7150	136.00
KINGBIRD	18/1/4.78	23.88	323.01	17.95	340.20	1.0280	10.0847	69.80
TERN	45/3.38+7/2.25	27.00	403.77	27.83	431.60	1.3400	13.1454	98.70

ZEBRA	54/7/3.18	28.62	428.88	55.60	484.48	1.6300	15.9903	133.00
BERSFORT	48/4.27+7/3.32	35.58			747.96	2.369	23.24	177.65
Steel 19/2.65	19/2.65	13.25			104.8	0.826	8.1	113
Steel 7/3.35	7/3.35	10.50		61.70	61.70	0.4850	4.7579	67.45
Steel 3/3.35	3/3.35	7.35		26.44	26.44	0.2150	2.1092	29.10

Table 31: Standard Electrical Clearances

System Nominal Voltage (kV)	System Highest Voltage (kV)	Minimum clearance (mm)		Working clearance (m)	
		Phase to Earth	Phase to Phase	Vertical	Horizontal
3.3	3.6	80	110	2.5	1.2
6.6	7.2	150	200	2.6	1.2
11	12	200	270	2.7	1.3
15	17.5	230	310	2.7	1.3
22	24	320	430	2.8	1.4
33	36	430	580	2.9	1.5
44	48	540	730	3	1.6
66	72	770	1050	3.2	1.8
88	100	840	1150	3.3	1.9
132	145	1200	1650	3.7	2.3
220	245	1850	2300	4.3	2.9
275	300	2350	2950	4.8	3.4
330	362	2900	3600	5.4	4
400	420	3200	4000	5.7	4.3

Table 32: Power Line Servitudes and Building Restrictions

Line Voltage (kV)	Building Restriction	Separation	Timber Restriction
	From Line Centre	Parallel Lines	Forestry Area
22 and below	11	12	-
33 (H-pole)	15.5	14	-
66	15.5	14	33
88 (Horizontal)	15.5	21	33.5
88 (Delta)	15.5	15	33.5
132 (Mono pole)	15.5	15	36
132 (Horizontal)	15.5	21	36
132 (Double circuit)	15.5	32	36
275	23.5	32	38.5
400	23.5	35	38.5
765	40	60	-

Table 33: Standard Insulation Levels and Creepage Distances

System Nominal Voltage (kV)	System Highest Voltage (kV)	BIL at sea level (kV)	60 sec power Hz withstand test (kV)	Creepage distance over external insulation		
				Normal (mm)	Special (mm)	Extreme (mm)
3.3	3.6	45	16	70	70	125
6.6	7.2	75	22	140	140	180
11	12	95	28	240	240	300
15	17.5	110	38	350	350	440
22	24	150	50	480	480	600
33	36	200	70	720	720	900
44	48	250	95	960	960	1200
66	72	350	140	1400	1400	1800
88	100	380	150	2000	2000	2500
132	145	550	230	2900	2900	3600
220	245	825	360	3700	4900	6100
275	300	1050	460	4500	6000	7500
330	362	1300	570	5500	7300	9000
400	420	1425	630	6300	8400	10500

Table 34: Minimum Vertical Clearances of Power Lines at Maximum Sag and Swing

Description		Note	Data/Minimum Clearance									
System Nominal Voltage (kV)			6.6	11	22	33	44	66	88	132	275	400
Highest System Voltage (kV)			7.2	12	24	36	48	72	100	145	300	420
Minimum Safety Clearances												
Phase to Ground (m)			0.15	0.20	0.32	0.43	0.54	0.77	1.00	1.45	2.35	3.20
Phase to Phase (m)			0.20	0.30	0.40	0.60	0.70	1.00	1.20	1.70	3.00	4.00
Minimum Vertical Clearances												
Above ground outside townships (m)		1	5.0	5.1	5.2	5.3	5.4	5.7	5.9	6.3	7.2	8.1
Above ground inside townships (m)		1	5.5	5.5	5.5	5.5	5.5	5.7	5.9	6.3	7.2	8.1
Above roads in townships (m)		7	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8.4	9.3
Above proclaimed roads outside townships (m)		7	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8.4	9.3
To building, poles and structures not part of the power line (m)			3.0	3.0	3.0	3.0	3.0	3.2	3.4	3.8	4.4	5.6
To other power lines (m)		2	0.7	0.8	0.9	1.0	1.1	1.4	1.6	2.0	2.9	3.8
To telephone lines - Angle of crossing from right angle			45°	45°	30°	30°	30°	30°	30°	30°	30°	30°
To TELKOM telephone lines (m)		3	1.8	1.8	1.8	1.8	1.8	1.8	1.8	2.0	2.9	3.8
To SPOORNET telephone lines (m)		3	1.4	1.4	1.5	1.7	1.8	2.0	2.2	2.7	3.6	4.5
To SPOORNET railways non-electrified (m)		4 & 5	9.6	9.7	9.8	9.9	10.0	10.2	10.4	10.9	11.8	12.7
To SPOORNET railways non-electrified (m)		6	11.2	11.3	11.4	11.5	1.6	11.8	12.0	12.4	13.3	14.2
To SPOORNET electrification structures (m)			3.0	3.0	3.0	3.0	3.0	3.2	3.4	3.8	4.8	5.5
To SPOORNET electrification live wires & track earth wires (m)			2.0	2.1	2.2	2.3	2.4	2.5	2.8	3.3	4.2	5.0
To SPOORNET earth wires (Power Lines) (m)			0.7	0.8	0.9	1.0	1.1	1.4	1.6	2.1	2.9	3.8
To SPOORNET other power lines (m)		2	1.4	1.4	1.5	1.7	1.8	2.0	2.2	2.4	3.5	4.5
EXPLOSIVE MAGAZINES			QUARRIES			ROADS (From road reserve)			Parallel to roads		Crossings roads	
Spans	Clearance	Only single shot blasting is permitted within 457m of a power line	National roads			60m to structure			20m to structure			
Under 30m	15.2m		Important main roads			32m to line centre			16m to structure			
30 - 167m	31.3m	AERODROMES & RIFLE RANGES			Less important main roads			32m to line centre			16m to structure	
Over 167m	30.5m	See Land Survey Manual Vol. 1			Low traffic dust roads (from centre)			40m to line centre			16m to structure	
NOTES:		4.Single power lines not at station yard						7.For abnormal load route = 7.5m				
1. +0.6m on major line templating		5. Where electrification is not foreseen (See Land Survey Manual Vol. 1)										
2. Higher conductor at 50°C, Lower conductor at -5°C												
3. Min. clearance as per letter Distribution Engineering Manager (A.Y.Poulton)		6.Multiple crossings & single power lines at station yard										

19. CONCRETE MIX GUIDELINES

19.1. BACKGROUND

- a) A tower is only as stable as its foundation. Therefore the strength of the concrete/reinforcing, that constitutes the foundation, is of utmost importance.

19.2. BATCH MIX

This is the preferred method of mixing to be used as it guarantees the required strength.

- b) Concrete strength is normally specified as a certain strength after 28 days. The 28 days create a problem as Construction cannot afford to wait this long before commencing with erection work. To overcome the problem, a stronger strength concrete must be ordered, as concrete reaches 60% of its 28 day strength after 7 days.

		Concrete Ordered (MPa)	
		42	50
7 Day strength (MPa)	20	25	30

NOTES:

- Never add any additional water if the concrete has been batch-mixed, as this weakens the concrete considerably.
- Order 13mm stone concrete for foundations with steel reinforcing.
- Records must be kept (delivery notes) of all batch mix deliveries.
- Take a random sample from such deliveries periodically and allow sample to cure for 28 days. Then get it tested at a reputable laboratory.

20. CONCRETE HAND MIX

- a) Hand-mixed concrete should be avoided as far as possible as it is difficult to control the mixing ratios.
- b) However, if concrete must be hand-mixed, the following precautions should be taken:
- Order 13mm stone.
 - Adhere to the given ratios.
 - Do a slump test to prove your mix.
 - Do not over vibrate!


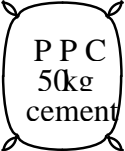
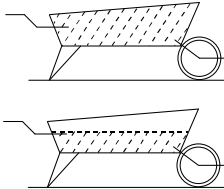
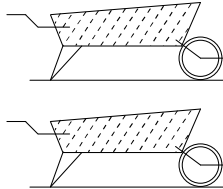
20.1. RATIOS

- | | | | | |
|-----------------|---|-----------|---|------|
| • 1 Bag Cement | = | 33 litre | = | 50kg |
| • 1 Wheelbarrow | = | 65 litre | | |
| • 1kg Sand | = | 0,8 litre | | |


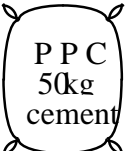
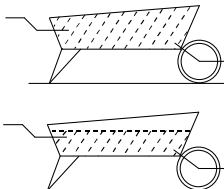
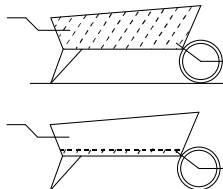
- 1kg Stone (19mm) = 0,75 litre
- 1kg Stone (13mm) = 0,73 Liter

20.2. HAND MIX 20MPa CONCRETE MECHANICALLY VIBRATED


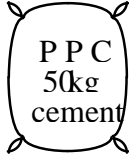
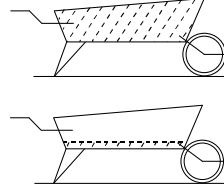
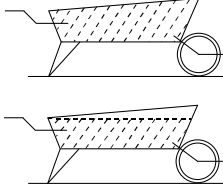
- 19mm Stone: 20MPa
- 1m³ Concrete = 10 Bags cement + 0.7m³ Sand + 0.92m³ Stone

Water	Cement	Sand	Stone 19mm
			
24 litres	1 bag	1 + 1/2 wheelbarrows	2 wheelbarrows
24 litres	33 litres	95 litres	125 litres
		12 + 6 shovels	12 + 12 shovels

- 9.5mm to 13.2mm Stone: 20MPa
- 1m³ Concrete = 10 Bags cement + 0.77m³ Sand + 0.6m³ Stone

Water	Cement	Sand	Stone 9.5mm to 13.2mm
			
23.5 litres	1 bag	1.6 wheelbarrows	1.2 wheelbarrows
23.5 litres	33 litres	105 litres	80 litres
		12 + 7 shovels	12 + 2 shovels

- 19mm Stone: 25MPa
- 1m^3 Concrete = 10 Bags cement + 0.6m^3 Sand + 0.81m^3 Stone

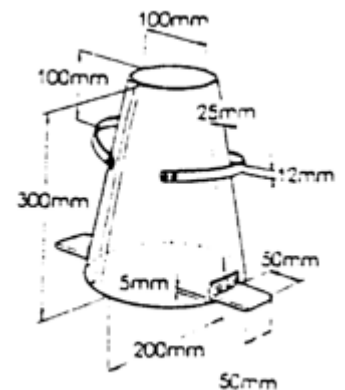
Water	Cement	Sand	Stone 19mm
			
21.5 litres	1 bag	1.2 wheelbarrows	1.7 wheelbarrows
21.5 litres	33 litres	80 litres	110 litres
		12 + 2 shovels	12 + 8 shovels

- 9.5 to 13.2mm Stone: 25Mpa
- 1m^3 Concrete = 10 Bags cement + 0.66m^3 Sand + 0.6m^3 Stone

20.3. TESTS ON CONCRETE: SLUMP TEST

20.3.1. Materials and Tools

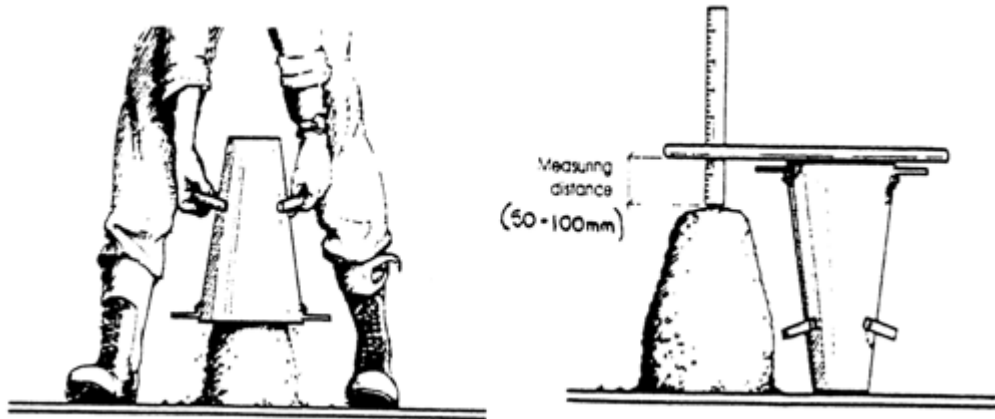
- A wheelbarrow and shovel
- A sample of freshly mixed concrete (about half a wheelbar)
- row full)
- A flat steel plate about 600 x 600mm by 3mm thick
- A metric rule or tape measure
- A scoop
- A steel tamping rod, 16mm in diameter by 600mm long
- with one end rounded
- A small trowel (gauging trowel)
- A standard slump cone



20.3.2. How to measure the slump

- Mix the concrete in the wheelbarrow.
- Wipe all the tools with a damp cloth.
- Put the steel plate down on a level place so that it is firm, and then put the slump cone in the foot pieces.
- Fill the slump cone in four layers of about 75mm. Tamp through each layer 25 times with the rounded end of the tamping rod.
- The last layer should more than fill the cone. After tamping the last layer, use the trowel to smooth off the top of the concrete so that it is level with the top of the cone.
- Hold the cone by the handles to keep it steady while you step off the foot pieces.
- Slowly lift the slump cone straight up and off.

- h) Turn the slump cone upside down and place it on the plate, next to the concrete.



21. BASIC STRINGING PROCEDURE

21.1. INTRODUCTION

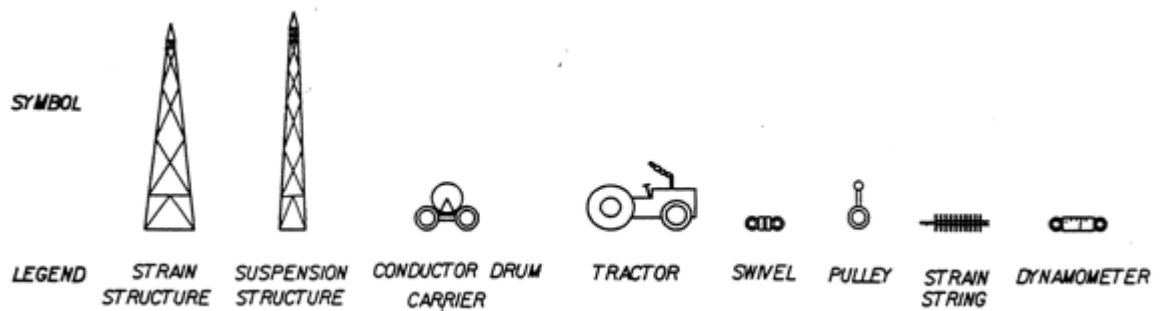
- With the phasing out of the glass disc insulators and the introduction of the long rod polymer type insulators, new stringing precautions must be taken.
- The new type long rod insulators have some disadvantages. The rubber-like appearance gives one the idea that they cannot break and that they cannot take any cantilever or torsion loads
- Care should thus be taken whenever one does stringing with this type of insulators.
- Tension stringing is the recommended stringing technique but if it is not possible the alternative stringing procedure as described below must be used.

21.2. STRINGING EQUIPMENT PER PHASE

21.2.1. Equipment:

- Conductor drum carrier : 1;
- Swivels : 2;
- Dynamometer (Calibrated not longer than 6 months ago) : 1;
- Running out pulleys : X amount to suit no. off suspension structures in strain
- section;
- Come along : 1;
- Tractor : 1.

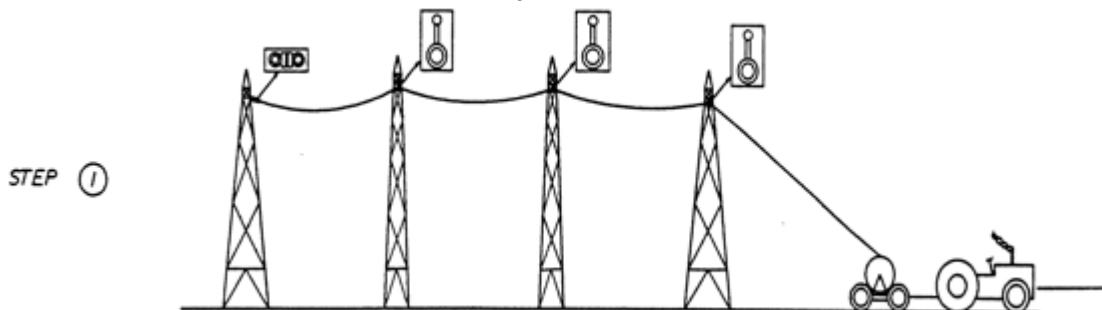
21.3. SYMBOLS:



21.4. STRINGING PROCEDURE

21.4.1. STEP 1: Running out of the conductor

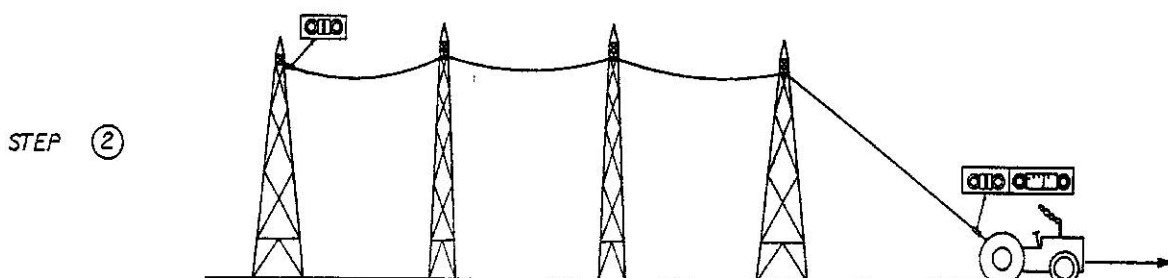
- Secure swivel onto the strain structure (anchor end).
- Terminate the conductor with the compression dead-end onto the swivel.
- Use a conductor drum carrier to run out the conductor along the line and lock the conductor onto the running blocks.
- All unnecessary slack shall be eliminated to prevent conductor friction during tensioning.
- The conductor must never be dragged on the ground, if it is not possible to achieve this, the conductor must be protected with wooden planks form damaging.
- Under no circumstances shall any vehicle be allowed to drive over conductors.



21.4.2. STEP 2: Unwinding of the conductor

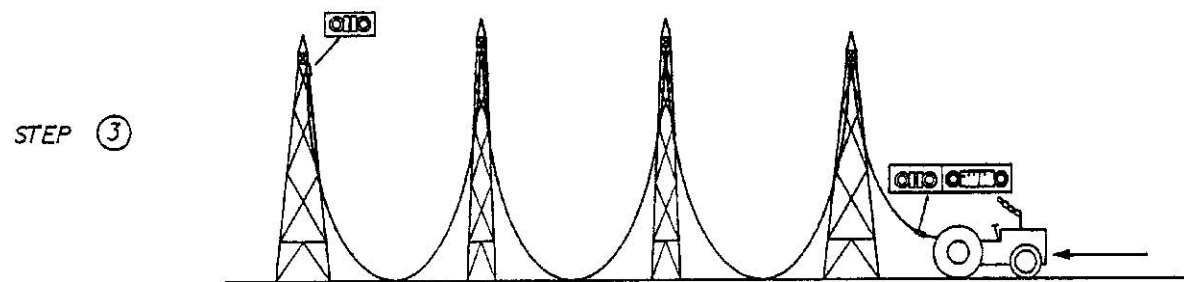
- Cut the conductor.
- Install a swivel and dynamometer at the pulling end.
- Tighten conductor slightly and give the conductor time to unwind.

NOTE: The conductor shall not be tensioned more than 27,68kN for “Wolf”; 17,96kN for “Chickadee”; 28,53kN for “Kingbird”; 36,32kN for “Panther” and 44,8kN for “Bear”.



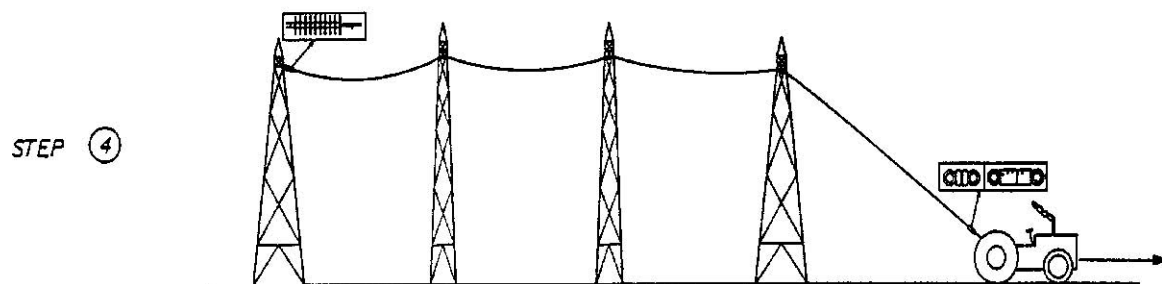
21.4.3. STEP 3: Slacking of conductor

- a) Conductor to be slacked after it has unwound.



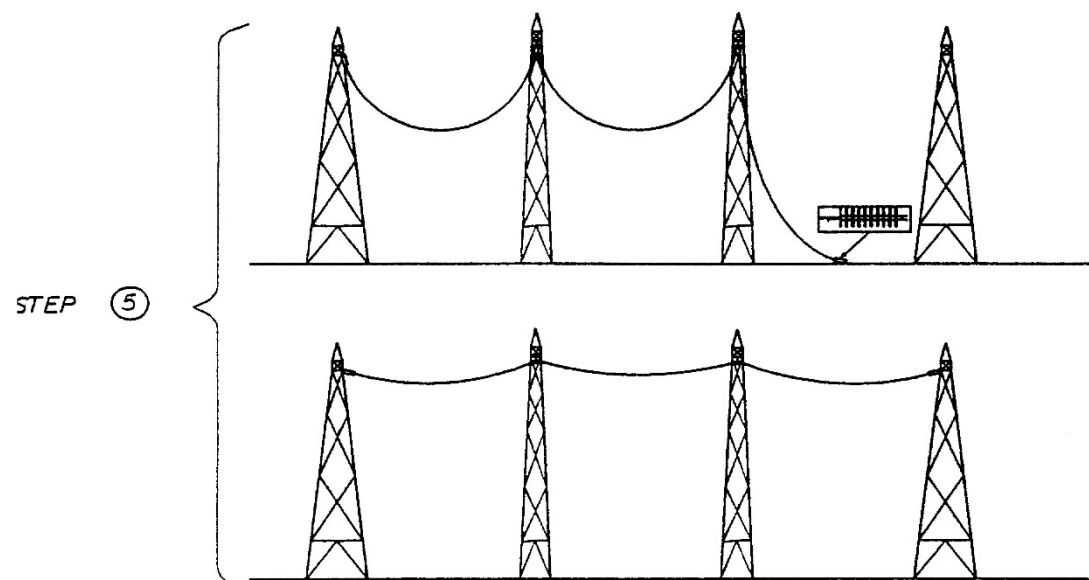
21.4.4. STEP 4: Sagging

- a) Remove the swivel at the anchor end.
b) Install the strain insulator.
c) Sag conductor according to the provided Sag and Tension Chart.
d) Ensure that conductor has not snagged on any of the running blocks.

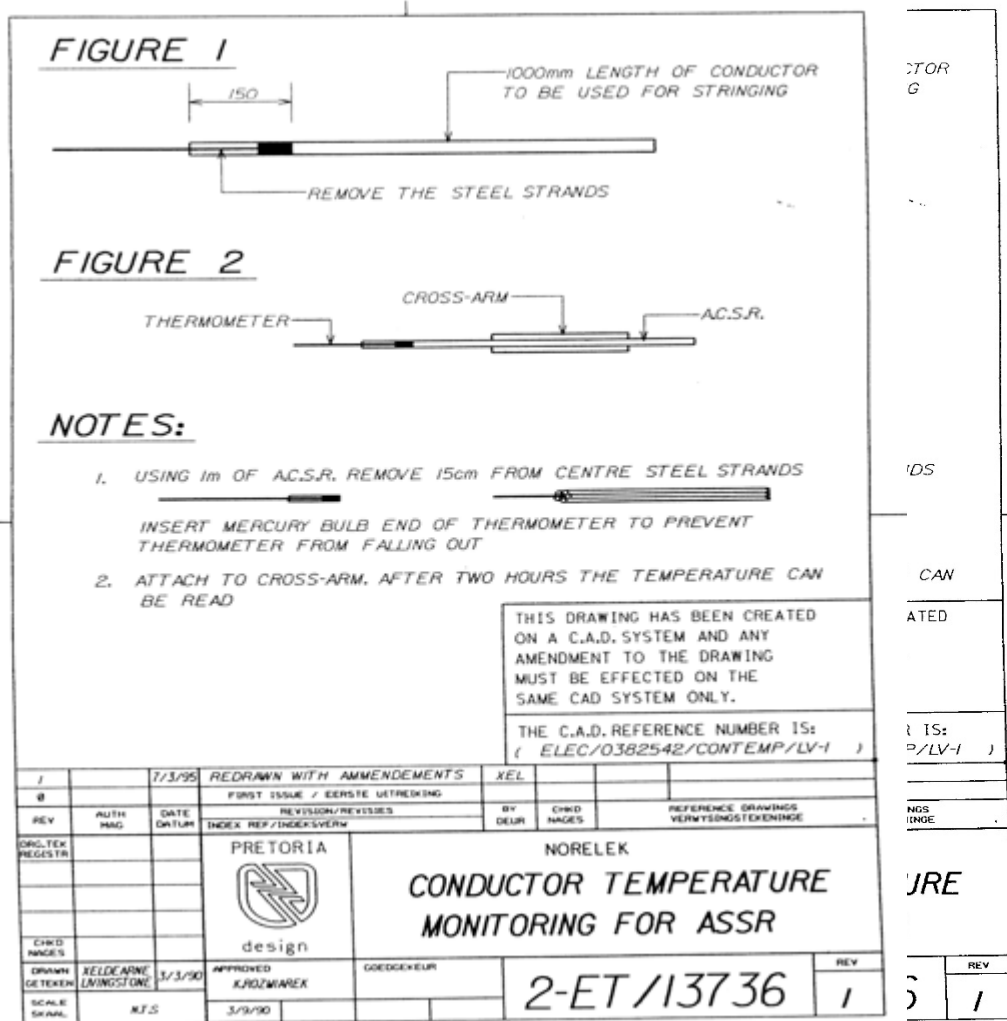


21.4.5. STEP 5: Regulation

- a) Install the strain insulator at the pulling end.
b) Hook conductor into position.
c) Do regulation (fine tuning) with the turn buckle.
d) Remove the running blocks and secure the conductor with the suspension clamps.



22. AMBIENT TEMPERATURE MEASURING TECHNIQUE



23. FOOTING RESISTANCE MEASUREMENT GUIDELINE

- a) This guideline provides the minimum requirements for the measuring of the footing resistance of steel poles

23.1. METHOD

23.1.1. Short fall-of-potential

- The short version fall-of-potential method can be used by the contractor. The drawings show the equipment layout and how the measurements must be taken.
- Three resistance values are measured, namely R1, R2 and R3. If the three values agree reasonably, the average can be calculated for the final resistance value. If not, the 61,8% method must be used.

23.1.2. 61.8% Method

Figure 1: connections for earth electrodes resistance measurement -61.8% method

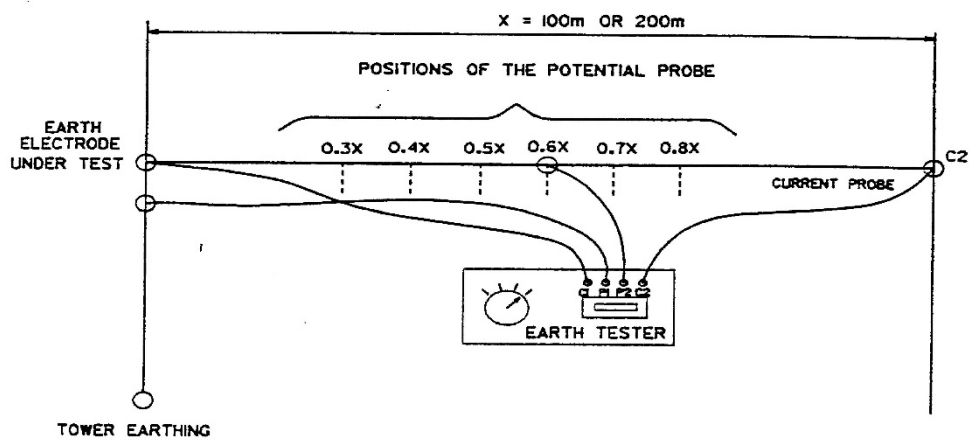


Table 35: Earth Electrode Resistance -61.8% Method Measurement Results

DEFINITION	POSITION	DISTANCE (m)	RESISTANCE (Ohm)
R1	0.2X		
R2	0.4X		
R3	0.5X		
R4	0.6X		
R5	0.8X		

Table 36: Earth Electrode Resistance -61.8% Method Calculated Results 2. Steel Poles

$R = -0,1187R1 - 0,4667R2 + 1,9816R4 - 0,3961R6 =$	_____Ω
$R = -2,6108R2 + 4,0508R3 - 0,1626R4 - 0,2774R6 =$	_____Ω
$R = -1,8871R2 + 1,1148R3 + 3,6837R4 - 1,9114R5 =$	_____Ω
$-6,5225R3 + 13,6816R4 - 6,8803 R5 + 0,7210R6$	_____Ω
$R =$	_____Ω
TOTAL	_____Ω
AVERAGE	_____Ω

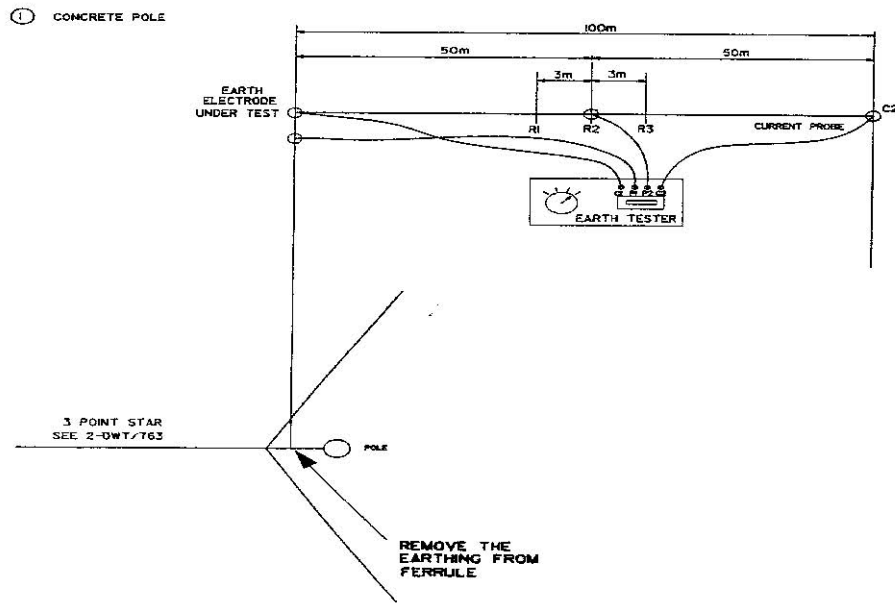


Figure 24: Connections for Earth Electrode Resistance Measurements Fall-Of-Potential Method

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GSE14 – GENERAL SPECIFICATION ELECTRICAL

INSPECTION, TESTING AND HANDOVER

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1. MANUALS AND DATA RECORDS

All data pamphlets packed with equipment and other pamphlets, handbooks of equipment, operating instructions of equipment, drawings, etc., shall be kept in safe storage by the Contractor during the Contract period.

The Contractor shall also keep accurate records of all tests carried out on equipment and cables and of the test results achieved.

Records shall be kept of setting values of instrumentation and all readings taken during testing and commissioning, as well as records of all final adjustment readings or changed settings done during the maintenance period.

A comprehensive operational and maintenance hard copy manual shall be built up by the Contractor, using the data mentioned well as other data and descriptions as specified herein.

All drawings and diagrams shall be done in AUTOCAD 2010 (or later) format and all text shall be submitted on the latest edition of Microsoft Word format. All tabular data shall be submitted on the latest edition of Microsoft Excel format. All pamphlet and brochure data shall be submitted in PDF format.

DXF files of other CAD programs can also be submitted, if these are suitable for conversion to AutoCAD format, without scrambling of text or graphics upon conversion.

The number of copies as scheduled in the Pricing Schedules or Bill of Quantities, of the manuals described herein, shall be made up by the Contractor. The quantity of copies required is normally not less than five (5).

The manuals shall be presented to the Engineer on the first day of "wet commissioning", if handover of the Works takes place on that day. The manuals shall be neatly housed in lever arch files and shall be in typewritten and/or printed format, properly indexed, with appropriate 2 or 3-layer card dividers between each section to facilitate ready reference.

A main index shall be placed in the beginning of each manual. The project name and project description shall appear at the top on the main index of the manual. Coloured dividers shall preferably be used.

The manuals and drawings shall cover all installation, operation, and maintenance schedule aspects of each item of equipment and all circuitry provided under this Contract, as specified.

The manuals, if approved, will be handed to the Employer or the representative of the Employer, so that the Works can be operated correctly and safely.

Any changes which may be necessary to the contents of the manual after the commissioning of the Works shall be done by the Contractor and sufficient copies of the altered data shall again be submitted to the Engineer for binding into the manuals. This process shall be repeated for the duration of the maintenance period or until the final certificate is issued by the Engineer for the project.

A "Practical Completion Certificate" and subsequent "Certificate of Commissioning" / "Handing over Certificate" will only be issued on receipt of accurate and final "as-built"

drawings and documentation to the approval of the Engineer. Such documentation shall be presented to the Engineer on the first day of commissioning of the works. Any certification of "Practical Completion", "Commissioning" or "Handing Over" of the works is subject to final approval of such documents and drawings by the Engineer.

Wherever manufacturer's manuals refer to types of equipment other than the exact type as installed, the exact type shall be highlighted throughout such manuals.

2. DOCUMENTATION AND DRAWINGS

All documentation and drawings as specified in the general or equipment specification shall apply to this contract.

3. GENERAL REQUIREMENTS

A stringent requirement of a Contract is to have "as built" data when a contract is complete to ensure that:

- a) The Employer knows where all the equipment and materials are installed
- b) Fault finding in the system can be done in future
- c) Alterations and additions can be undertaken in future by referring to the drawings to determine the built in capacity of the system without having to determine this data on site.

It is therefore imperative for the Contractor to produce acceptable manufacturing drawings at the onset of a project so that equipment can be manufactured and ordered. Drawings such as layout drawings, single line diagrams, block diagrams, typical control diagrams, etc. are normally issued by the Engineer together with documents for tender purposes.

If no drawings or limited drawings are issued by the Engineer at tender stage or thereafter, the Contractor shall arrange a technical meeting or meetings with the Engineer to determine the exact scope of the work and shall then prepare the necessary drawings to enable him to manufacture the specified equipment. This shall include "shop" drawings, diagrams and/or constructional detail drawings.

The drawing or drawings prepared by the Contractor shall obviously make provision or include the drawings or standards normally used by the Contractor to produce acceptable quality of work. The Contractor shall further keep all drawings and diagrams prepared during the course of production and installation of the Works and shall present this to the Engineer on completion of the Contract. Such drawing shall at least consist of all the drawings the Contractor used for construction and installation work as well as all data of final positions and final settings of equipment.

All cable positions on the site of the Works shall be shown on layout drawings, together with dimensions taken on site from fixed points to show exact location of underground cables. Any diagrams (standards or specific) issued by the Engineer shall not be used by the Contractor for making up his own design drawings by adding data or wiring and terminal numbers to such diagrams.

The Contractor shall draw up and submit his own diagrams and general arrangement drawings in the formats and quantities as required by the Engineer. Hand drawn drawings

will not be acceptable, except in the case where formal site layout plans are not available to mark-up equipment and cable positions. Drawings shall preferably be done in A3 booklet format and on the standard border and title block sheets of the Employer or the Engineer, unless permission is granted in writing by the Engineer for other formats of title blocks.

All drawings shall be properly numbered with the numbering system required by the Employer or the Engineer and the number of the particular sheet and the total number of sheets shall be shown on each drawing.

The Contractor may use his own reference number in a separate block if the Engineer requires a special drawing numbering system. Standard drawing sheets in electronic format can be obtained from the Engineer, if available.

Electronic copies (soft copy), of all "as built" drawings prepared by the Contractor during the course of the Contract, as well as all electronic copies of software and descriptions of equipment, handbooks or sales data shall also be handed to the Engineer, together with the hard copy "as built" drawings and manuals, in quantities and formats as specified in the Project Specifications

4. DRAWINGS FOR APPROVAL

A set of three (3) prints of the shop drawings for all equipment shall be submitted for approval before any of the aforementioned are manufactured.

3D Survey drawings of the existing infrastructure is available in .dwg format for this project. These drawings shall be made available to the contractor on which detail designs are to be populate for approval by the Engineer.

The following information shall be presented:

- a) Single line diagrams for electrical, electronic and power circuits, showing rating of wiring, cables, switchgear, power supplies, current rating of all circuit breakers and fuses, VA rating of all power supplies, sizes, specifications and quantities of cables and cable cores with:
 - the rating, type number, catalogue number, ratio, class, etc. next to each component with the abbreviated reference number
 - the functions of each control circuit or section of control circuit, above each control group of components
 - the functions of each component on control diagrams below the component
 - wire and cable numbers for all control and power wiring together with the colours of all wires.
- b) A general arrangement block diagram of the whole of the Works.
 - Overall dimensions together with material type and thickness used for the framework, doors and covers as well as the type and colour of finish of the material;
 - Front elevations and sections for all the panels and devices;
 - Positions of door locks, hinges, handles, vermin proofing, ventilation facilities, seals on doors and covers, etc.;
 - The IP ratings;
 - Placement positions of all front panel components on panels;

- All labelling information for each component shall be shown in tabulated form on general arrangement drawings.

All drawings shall be done using NRS symbols and the applicable SANS standards for drawings plus any further requirements for drawings which may be bound into this document and which may be required by the end user of the equipment.

The approval of drawings shall not relieve the Contractor of his responsibility to supply the works in according to the requirements of this specification and/or Project Specifications.

5. FINAL DRAWINGS AND INFORMATION

At least three (3) complete sets of "as built" drawings of all panels shall be submitted to the Engineer prior to the installation being handed over to the Employer.

A professional portfolio consisting of still images and details of the entire installation in operation shall be submitted.

A professional overview narrated video shall be submitted in editable soft copy format for marketing purposes

The drawings submitted shall preferably be in A3 format (in hard copy and on CD) and shall also be bound into the "Operational and Maintenance Manuals" as specified herein.

The following information shall be presented:

- a) All the information as described in the section "Drawings for Approval", hereinbefore.
- b) The final, updated drawings and diagrams specified showing the latest revisions after commissioning of the Works.
- c) All final terminal strip numbers, numbers and colours of conductors connected to the terminal strips and numbers and colours of the conductors utilized for the internal wiring.
- d) A separate schedule of all equipment with the name, manufacture, type, model-catalogue number of equipment, as well as the name, address and telephone number of the supplier of each component.
- e) All site and building layout drawings, showing sizes and positions of cables and equipment.
- f) The site layout drawings showing cables shall be dimensioned using fixed points on site such as buildings, beacons, boundary walls, canals, poles, sumps, etc.

6. OPERATIONAL AND MAINTENANCE MANUALS

A minimum of three (3) complete sets (or as scheduled in the Schedules of Quantities) of operational and maintenance manuals for all specified Works.

Also refer to the section "Final Drawings" herein, regarding binding in of "as built" drawings into the required manuals.

7. DETAILED OPERATIONAL AND DESCRIPTIVE MANUAL

This manual shall contain the detailed descriptions of all equipment i.e. all proprietary assemblies, shall be provided to assist the user personnel of the Employer with advanced

knowledge of the equipment for short, medium and long term maintenance and operations of Works.

The descriptions must be complete in all respects and the Contractor shall also ensure that these manuals are prepared in such a manner that, in the opinion of the Engineer, a competent and qualified technician can trace any fault, identify any defective component, replace it with the correct spare part and follow, without difficulty, the exact function of every component.

To this end, care must be exercised to correlate the text with the circuit diagrams, to relate the diagrams one with another and to provide a simple method of diagnosis and test to be used wherever breakdowns occur. The manuals shall also include block diagrams giving the layout of equipment as well as a description of the function and operation of every unit in the system.

The manuals shall be neatly prepared, in typewritten and/or printed format, indexed, with appropriate dividers between each section to facilitate ready reference. All documentation shall be presented in the English language.

The description shall, as a minimum requirement, include:

Operational and maintenance data, details of all assemblies or components of electrical and electronic equipment installed in the Works. Copies of operational manuals of manufacturers can be inserted in these descriptions. In the case of insufficient descriptions in manuals of manufacturers, the Contractor shall provide additional descriptions to enable maintenance of the equipment.

The descriptions shall include:

- a) Technical details of all equipment installed
- b) A complete description of the operation of all equipment.
- c) A parts and spares list of every item of equipment together with a description of the item, the name, address and telephone number of the original supplier or wholesaler of the equipment. Brochures may be added as additional information but must not replace the data required.
- d) Complete equipment schematics
- e) All manufacturers' handbooks having reference to the equipment
- f) Installation test and alignment procedures
- g) All circuit diagrams
- h) All interconnection and inter cabling diagrams
- i) Complete trouble shooting procedures and any other information deemed necessary to permit rapid and efficient maintenance of any part of the equipment by a qualified technician.
- j) Concrete Strength Test Result (7 & 28 days)
- k) Commissioning Reports for LV Network.
- l) Aiming Certificate.
- m) Survey of illumination levels.

The operating procedures contained in the manuals shall contain the following detailed features in fully descriptive format:

- a) Operating Procedures
 - Pre power-up checks of all equipment
 - Routine running attention

- Shutting down the works or parts thereof
 - Prolonged shut-down of the works
 - Re-commissioning of the works after repairs, maintenance or prolonged shut-down.
- b) Maintenance
- Routine maintenance procedures
 - Description
 - Schedule
 - Preventative maintenance
- c) Fault Finding Procedures
- Power supply faults
 - Control faults
 - Investigation procedure for detection of faults and remedies:
 - Symptom
 - Probable fault
 - Remedy
- d) Safety Precautions
- The nature of each hazard
 - The level of seriousness
 - How to avoid the hazard
 - The possible consequences of not avoiding the hazard

In the case of sealed assemblies or advanced assemblies of equipment that cannot be opened or maintained or repaired onsite, the Contractor shall provide sufficient data and instructions for the replacement of the assembly and shall further describe the measures which the user or operator of the works can follow to operate the Works in an emergency and, if necessary, operate the works manually, to overcome total shut-down or non-operation of the Works until a new replacement can be installed.

The descriptions for operational measures shall be of sufficient nature to enable safe operating conditions of the works and shall further not be of a nature which shall cause damage to other parts or sections of the Works:

- a) A schedule of every item of equipment in the Works or panels together with a description of the item, part number, catalogue number, etc., as well as the name, address and telephone number of the original supplier or wholesaler of the equipment. Brochures may be added as additional information but must not replace the data required.
- b) All as-built record drawings, including AC and/or DC schematic and wiring diagram drawings for the equipment. The wiring diagrams shall contain all the terminal numbers and wire numbers of all wiring in the Works. Also refer to "C3.3.16.5 FINAL DRAWINGS" hereof. A4 drawings may be used in manuals but all text must be clearly legible. A3 drawing sizes are preferred.
- c) Technical brochures and pamphlets of equipment as additional information.
- d) Routine and type test certificates issued by factories.
- e) All calibration and setting data of electronics and instrumentation. This data shall also contain all the embedded software, on disc or CD, issued together with the instruments as part and parcel of the selling price of instruments where the instruments cannot be purchased without the embedded software.

8. PHYSICAL INSPECTION PROCEDURE

Once the Contractor has completed the installation, written notice shall be given to the Engineer in order that a mutually acceptable date can be arranged for a joint inspection.

During the course of the inspection, the representative of the Engineer will compile a list of items (if any) requiring further attention. A copy of this list will be provided to the Contractor who will have a period of 7 days in which to rectify the offending items of the installation.

The Contractor shall then provide written notice that he is ready for an inspection of the remedial work to the offending items.

This procedure will continue until the entire installation has been completed to the satisfaction of the Engineer.

9. TESTING AND TEST EQUIPMENT

All materials and workmanship shall be of the respective kinds described in the Contract and in accordance with the Engineer's instructions and shall be subjected from time to time to such tests and by such persons as the Engineer may direct at the place of manufacture or fabrication or on the site or at all or any of such places.

Except as otherwise provided in the Specification the Contractor shall supply such assistance, accommodation, instruments, machines, labour and materials as are normally required for examining, measuring and testing of any work and the quality, mass or quantity of any materials used and shall supply samples of materials before incorporation in the works for testing as may be selected and required by the Engineer.

All samples shall be supplied by the Contractor at his own cost if the supply thereof is clearly intended by or provided for in the Specification but if not, then at the cost of the Employer. The cost of performing any test shall be borne by the Contractor if such test is clearly intended by or provided for in the Specification and (in the case of a test under load or a test to ascertain whether the design of any finished or partly finished work is appropriate for the purposes which it was intended to full fill if such is particularised in the Specification in sufficient detail to enable the Contractor to price or allow for the same in his Contract Price.

If any test is ordered by the Engineer which is either -

- a) not so intended by or provided for; or
- b) not so particularised; or
- c) though so intended by or provided for is ordered by the Engineer to be carried out by an independent person or body at any other place than the site or the place of manufacture or fabrication of the materials or equipment tested;
- d) Then the cost of such test shall be borne by the Contractor if the test shows the workmanship or materials not to be in accordance with the provisions of the Contract or the Engineer's instructions, but otherwise by the Employer.

The Contractor shall keep records of all the data of tests and shall submit this data to the Engineer upon completion of all tests. Tests carried out in the factory of the manufacturer or at a testing facility shall be done in accordance with the prescribed standards for such tests.

The applicable standards for such tests shall be SANS, BSI, IEC, DIN, NEMA or such acceptable standard as may be applicable to the product or equipment or assembly.

The Engineer will have the right to obtain a quotation from the Contractor for any special tests which are required by him and to instruct the Contractor to carry out such tests.

If equipment should fail a standard or prescribed standard test by a testing authority, the cost thereof shall be for the account of the Contractor.

10. SITE TESTS AND INSPECTIONS

The tenderer will also be responsible for arranging Site Acceptance Testing (SAT) on site, which will be attended by the Maintenance Personnel of the Employer and the Engineers Representative.

The inspections of the Engineer of any part of an installation or Works on site does not exempt the Contractor from his responsibilities in terms of the Contract. The Engineer will only accept the completed installation work after having received all test results, commissioning results and certificates of compliance or test certificates on completion of the whole of the Works.

Any abnormal condition, beyond the control of the Contractor, which may come to the attention of the Contractor during any preliminary or final tests or commissioning procedures shall immediately be reported to the Engineer.

The Contractor shall not allow equipment of other contractors to stay connected to, or operate with electric power from his installation if any equipment of other contractors do not operate normally or within the limits laid down by the manufacturer of equipment for other contractors.

11. COMMISSIONING

Commissioning on site shall include the following actions and shall be done with the Engineer present and shall require the presence of the Contractor for as long as it is necessary to carry out all the actions hereunder or as may be further required by the Engineer or the Client.

- a) The system shall be connected to the power supplies and shall operate and communicate as specified in the Project Specification.
- b) Power protection equipment shall be set by the Contractor in the presence of the Engineer. All the settings shall be recorded by the Contractor for handing over to the Engineer after commissioning.
- c) All earthing installation work must be completed.
- d) Communication signals and/or remote control signals shall be tested to ensure that Works are integrated as a complete system and functioning correctly. The communication of signals between the site Works and a remote control room or station shall be verified.
- e) All safety checks and tests of power equipment must be completed.
- f) The number of required maintenance and operational manuals (complete in all respects) shall be handed over to the Engineer.
- g) The spares and tools (if applicable), shall be on site together with inventory sheets, ready for signature of the recipient party.
- h) All panels and electronic equipment shall be clean and neat and wiring shall be neat and strapped. No loose hanging wiring will be acceptable.
- i) All labelling shall be complete.

- j) All cable trunking lids or covers shall be in place and all draw box covers and lids shall be screwed down.
- k) A Certificate of Compliance for all 230V work shall have been handed to the power supply authority with a copy on site for the Engineer.
- l) The Contractor shall hand all the test results of equipment which was logged by him together with the settings of such equipment to the Engineer. This information shall be made available on properly structured test sheets and log sheets and shall be dated and signed by the Contractor.
- m) Any small items such as alterations to labels, faulty electronic equipment, etc. shall be recorded for repairs.
- n) The Contractor shall then proceed with training of the operating personnel of the Employer as may be required in the Project Specification.

No last minute repairs or installation work shall be done by the Contractor on the day of commissioning of the Works:

The successful completion of all the above shall be regarded as the "first hand over day" of the Works to the User or Owner of the installation. The retention period of the Works normally starts on that day, unless abnormal conditions prevent the handing over of the Works to the Client.

An abnormal occurrence preventing handing over will not be seen as failure of the Contractor in this respect. If the commissioning should have to be stopped or abandoned due to the failure of the Contractor to complete the Works and have the Works ready for inspection or as stated above, then the further costs for re-commissioning later will be for the Contractor's account. Such costs will include all the travelling, accommodation and time rate costs of the Engineer or the Client.

The Works will not be regarded as being commissioned if all of the above requirements are not met on the day of commissioning of the Works.

The Contractor shall only apply for inspection by the Engineer once the Contractor have completed his own inspections and rectified snags identified. For Site Acceptance testing should the works or equipment not be in a ready state to be commissioned the Engineers cost for all re-inspections shall be for the Contractors account according to the latest gazetted fee scales as provided by the Engineering Council of South Africa.

12. TRAINING OF PERSONNEL

The training of personnel of the Employer or User of the Works shall only be applicable to the Contract.

Training provided by the Contractor and OEM shall be directly applicable to the actual equipment to be used at the installation. Training shall be carried out on site and at the OEM's works. The priced unit rates in the bill of quantities shall allow for all travel, accommodation and living expenses.

All of the training shall be presented by the OEM and allowed for by the contractor in the bill of quantity's unit rates.

Operators of the installed equipment shall be trained by The Contractor to safely and successfully operate the equipment and controls.

This training course shall include the training of technical personnel of the Employer during the installation period and commissioning stages of equipment on site to make the technical staff and or skilled operators completely conversant with the installed equipment and the use thereof.

The Employer thus reserves the right to appoint certain staff to the Contractor's team during the installation and commissioning phase of the work for training as described in the previous paragraph. The Employer will bear the cost of salaries, accommodation and other allowances and traveling expenses of its personnel, but all other expenses to allow the personnel to attend the said training on site shall be borne by the Contractor.

The Employer may also decide to request the Contractor to make use of the ability of the staff of the Employer to assist with physical installation and commissioning work, and in such instance the Engineer will instruct the Contractor accordingly.

The Contractor shall provide all course material including manuals and training data in this case, and shall present well prepared lectures of the courses in locations which suite the Employer.

Advanced training courses shall proceed within one month after date of first hand-over of the particular section of the Works.

The Contractor shall price the items allowed for training in the Bill of Quantities of the tender document.

At conclusion of any training period, either for the operation and maintenance of equipment, or for advanced software and programming, the Contractor shall issue the necessary certificates at the end of the course and/or a signed statement to the effect that these training sessions were adequate.

The tenderer shall also be responsible for arranging formal training by the agency, distributor or accredited supplier for all specified equipment offsite as well as on site, which will be attended by the Maintenance Personnel of the Employer and the Engineers Representatives. The offsite training shall be held at a premise of the supplier. The number of delegates will be as specified in the BoQ.

Training shall be provided in a class room environment, the OEM shall provide relays or equipment for each delegate attending the training session which will allow for practical interaction with various control, monitoring and measuring equipment. Training material shall include the necessary equipment manuals and software.

Training content shall be approved by the original equipment supplier if the supplier is not the original equipment manufacturer.

Training shall as a minimum have the following objectives.

- Enable the trainee to operate the equipment with confidence.
- Ensure that equipment shall be correctly maintained.

Training shall be provided for the following equipment:

- All IED's in the substation
- All measuring equipment used in the substation

INSPECTION, TESTING AND HANDOVER

- All switchgear and operation sequences

The tenderer shall also arrange training and testing in the relevant ORHVS modules required to operate and maintain HV Voltage equipment. The ORHVS training shall be done at an accredited institution and an ORHVS Authorisation Certificate shall be issued to the successful delegates. Training shall be in accordance with all parts of NRS 040.

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GSE18 – GENERAL SPECIFICATION ELECTRICAL

POWER TRANSFORMERS RATED FOR
1.25 MVA AND ABOVE AND WITH
HIGHEST VOLTAGE OF 2.2 KV OR ABOVE.

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1. GENERAL

This general specification covers the general requirements for Power Transformers rated for 1.25 MVA and above and with highest voltage of 2.2 kV or above.

2. NORMATIVE REFERENCES

The following documents contain provisions that constitute requirements of this specification. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

Table 1: SANS specifications

Document	Rev./issue	Title and Publisher
SANS 107	Latest	Standard Transformer Bushings.
SANS 1091	Latest	National colour standard
SANS 9001	Latest	Requirements For Quality Management Systems
SANS 14001	Latest	Environmental Management Manual International Standards – EMS
SANS 60034	Latest	Rotating electrical machines.
SANS 60076	Latest	Power Transformers. All parts
SANS 60137	Latest	Insulated bushings for alternating voltages above 1000 V.
IEC 60085	Latest	Thermal evaluation and classification of electrical insulation.
IEC60156	Latest	Insulating liquids – Determination of the breakdown voltage at power frequency.
IEC 60214	Latest	On-load tap-changers.

In addition, the following Eskom specifications shall constitute requirements of this specification. All Eskom standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

Table 2: Eskom specifications

Document	Rev./issue	Title and Publisher
240-68973110	1	Specification for Power Transformers rated for 1.25 MVA and above and with highest voltage of 2.2 kV or above.

3. PHYSICAL ARRANGEMENT

The power transformer's maximum dimensions, including the bushings, cooler banks and conservator shall be:

Height: < 3.1 m (plinth to tank cover)
 < 5 m (top of bushing stem)

POWER TRANSFORMER LARGER THAN 1.25 MVA

Length:	< 5.5 m (conservator tank top)
	< 4.4 m (tank footprint)
	< 6.5 m (overall)
Width:	< 1.5m (tank footprint)
	< 5 m (overall)

NOTE: The conservator spatial orientation, with reference to the transformer main tank, must be adjustable to ensure the minimum safe working clearances are satisfied.

The power transformer's physical arrangement shall conform to the layout as per the sketch below.

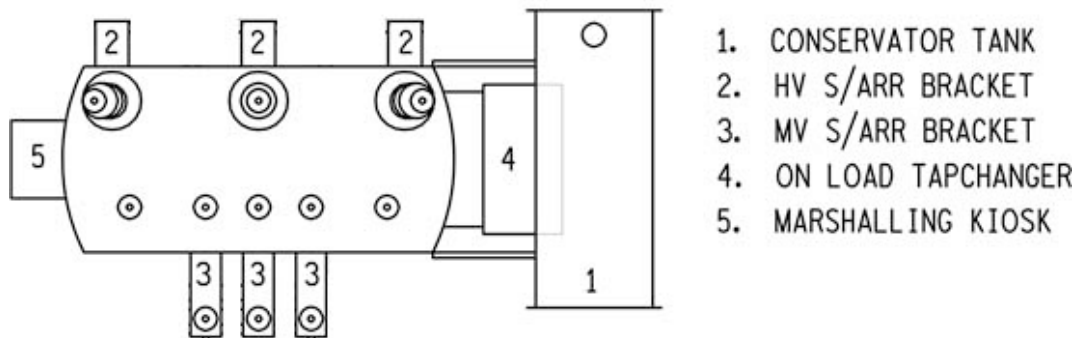


Figure 1: Transformer arrangement

Tenderers shall note that the transformer radiators / cooling fins shall be attached to the transformer main tank only and shall not destabilise the transformer to such an extent that radiator supports are required.

The use of radiator supports shall only be approved where the radiators are installed in a remote location for special applications such as indoor transformers with remote cooling banks and vents.

4. BUSHINGS

The following shall apply to the transformer bushings:

1. The HV Bushing shall be symmetrically arranged about the overall transverse Centre line of the transformer.
2. All neutral bushings shall be fitted in line with the MV bushings.
3. Despite the actual operating voltage, the transformer bushings shall have an insulation level corresponding to a nominal system voltage of 33 kV. These bushings shall be equipped with a terminal stem of **38 mm diameter** for secondary side, **26 mm diameter** for primary side and **125 mm length**, have a minimum centre-to-centre spacing of not less than **400 mm for MV side**.
4. The MV bushings shall be of the capacitance graded type.
5. The minimum distance from the transformer base (plinth) to the bushing flange base shall be 2.5 m.
6. The bushing creepage distance shall be 31 mm/kV (MV: at 33 kV).

5. TAP CHANGER

The tap changer shall be of the vacuum type. The on-load tap changer shall operate in the range of +5% to -15% of the HV voltage in 16 equal steps of 1.25% each.

The tap changer shall be subject to the following testing:

1. 8 Complete Cycles – not energized
2. 1 Complete operation cycle – 85% of rated voltage applied
3. 1 Complete Cycle energized at rated voltage and frequency (no-load)
4. 10 Tap changes within +/- 2 steps of the principle tap

Care shall be taken to match the tap voltages to the voltage range of other transformers.

6. CORE

There shall be no sparking that may upset Dissolved Gas Analysis (DGA) monitoring of the transformer, between bolted mechanical members during inrush or other transient conditions. This requirement shall apply even if DGA is not included at this stage.

The core shall be earthed to the core clamping structure at one point only, through a removable external link suitably situated and protected, to allow testing after installation of the transformer. The core earthing connection shall be larger than 80mm².

Lifting lugs shall be provided for lifting the core and windings.

7. WINDINGS

The paper used in the winding insulation shall be thermally upgraded paper. The bracing of the windings and connections shall be such that these parts shall safely withstand the cumulative effects of stresses that may occur during handling, transportation, installation and service, including line-to-line and line-to-ground faults

8. AUXILIARIES

All contacts providing an alarm output shall be rated to carry 30 A for 200ms at 250 V_{D.C.} and continuously carry 2 A at 250V_{D.C.} All secondary wiring shall be 2.5mm² with 30 strands (660/100 V as per SANS 1507-2). The auxiliary wiring shall be neatly fitted into a cable tray or compartment onto the transformer.

A 400/230V_{A.C.}, 3ph, 4 wire, 50Hz auxiliary power supply shall be provided.

The marshalling box shall have a certified rating of min. IP55. The marshalling box shall preferably be free standing. All gauges such as oil and winding temperature indications shall be equipped within the marshalling box.

9. TANK

The transformer tank cover shall be bolted.

The interior surfaces of the tank, the cover and the cooling equipment shall be cleaned and dried immediately prior to filling the transformer with oil. Interior surfaces (other than those

POWER TRANSFORMER LARGER THAN 1.25 MVA

of cooling tubes and headers) above a line that lies at least 50 mm below the oil level that corresponds to an oil temperature of 20 °C, shall be corrosion-protected by varnishing, priming or painting, using materials that are not affected by, or will not adversely affect, the electrical or chemical properties of the insulating oil.

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.

The under base shall be suitable for the movement of the transformer in any direction, by sliding on greased rails, and 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 with not less than 100 mm working clearance above them.

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 offloaded on site.

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 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.

Centre of gravity shall be clearly visible and indicated on all sides of the transformer tank.

The transformer primary will be solidly earthed without any Neutral Earthing Resistor. The OEM shall therefore take circulating currents into consideration when the tank wall thickness is calculated to prevent any interior or exterior corrosion.

Provision shall be made for earthing the transformer and associated apparatus as follows:

1. Transformer tank earthing
2. Transformer neutral(s) earthing (direct)
3. Transformer surge arrester earthing (line and neutral surge arresters)
4. All tank attached apparatus, including cable marshalling boxes, tap-changer operating gear and mechanism boxes, and fan and pump motors shall be bonded to their supporting structures.
5. Earthing pads 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.
6. No copper shall be used as connections for the purpose of earthing.

10. INSULATION

The transformer bushing insulation level shall be 10% above the values given in the table below:

Table 3: Insulation level

U _m (kV _{rms})	U _n (kV _{rms})	Fault level (kA)	Lightning - BIL (kV peak)		Power Frequency 60s 50Hz		Bushings					Tap changer		
							Line		Neutral		Creepage (31mm/kV)			
			Line Terminal	Neutral Terminal	Separate source	Induced	BIL	60s 50Hz (kV _{rms})	BIL (kV peak)	60s 50Hz (kV _{rms})			U _n (kV _{rms})	BIL (kV peak)
12	11	25	95	95	28	22	200	70	200	70	375	11	95	28
100	88	25	380	250x	95x	150	550	230	350	140	3100	44	250	95
145	132	40	550	250x	95x	230	650	275	350	140	4500	44	250	95

x - The HV insulation level shall be 48kV RMS without exceeding 165kV Peak for partially graded transformers.

11. TRANSFORMER OIL

The transformer main tank oil insulation level shall be 70kV per 2.5mm for virgin oil prior to filling and 60kV per 2.5mm at time of taking over.

12. TESTS

The transformer shall be subject to the following test at the cost of the OEM to be witnessed by the Authority and Engineering representative:

1. Voltage Ratio and Phase displacement
2. Winding D.C. Resistance
3. Insulation Resistance to Earth
4. Insulation Characteristics and bushing dielectric loss
5. Separate source voltage withstand
6. Induced Over-voltage withstand
7. Partial Discharge Measurement
8. Lightning impulse Withstand
9. Switching Impulse Withstand
10. Insulation resistance to earth
11. Short circuit AC tests (Partial Discharge)
12. No load loss, magnetizing current and impedance voltage
13. Short Circuit Impedance and load loss
14. Zero Sequence Impedance
15. On load tap changing
16. Temperature rise & overload
17. Overpressure – Leakage Test
18. Oil DGA

19. Determining of Sound Levels / acoustic noise
20. Frequency Response analysis (Factory & Site)
21. Paint thickness & quality
22. Auxiliary wiring functionality & pressure test (Factory)
23. Impact Recorders during transport, loading and offloading
24. Short circuit withstand calculations for the transformer shall be provided.

13. OIL SEPARATION AND HOLDING FACILITIES

The transformer bay shall be equipped with oil drainage, water separation and oil holding facilities. The system shall be automated with system healthy and system in operation indications to the SCADA systems. All ancillaries such as float levels, sump pumps etc. shall be included by the bidder in the bill of quantities' rates.

14. TRANSFORMER OFFLOADING

Loading and offloading of the transformers shall be done by means of rigging on skids. The transformer mounted on the low bed vehicle will be brought into position adjacent to the transformer bay. The transformer must be lifted with jacks to install railway rails underneath the transformer. By means of a system of packers and jacks, the tank is then lowered onto a pair of greased railway rails along which it can be slid to its position over the plinth. The required position of the tank on the plinth must be accurately marked. When the tank is correctly positioned on the plinth, it must then be carefully examined for any signs of damage or any other indication that it might have been abused during transport.

The impact recorder that has been fitted for transport shall now be read or downloaded and then switched off and removed. Any additional clamping that has been applied to the core and windings for transport must now be removed according to the instruction manual. The coolers, pipework, bushing, turrets, etc. which were removed for transport, will now be fitted and connected, requiring the removal of blanking plates giving access to the tank.

Such opening of the tank must be kept to a minimum time to reduce the possibility of moisture entering the tank. If the transformer has been transported with the tank full of nitrogen, it is necessary to perch this fully with dry air.

When all bushings have been fitted, access covers replaced, conservator and Buchholtz pipe work erected as well as associated pipe work installed and connected to the radiators, preparation can begin with the filling of the transformer with oil.

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GSE20 – GENERAL SPECIFICATION ELECTRICAL

COMBINED THREE-PHASE NEUTRAL
ELECTRO-MAGNETIC COUPLERS WITH
NEUTRAL EARTHING RESISTORS AND
AUXILIARY TRANSFORMERS (NECRT's)"

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1. GENERAL

This general specification covers the general requirements for Power Transformers rated for 1.25 MVA and above and with highest voltage of 2.2 kV or above.

2. NORMATIVE REFERENCES

The following documents contain provisions that constitute requirements of this specification. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

Table 1: SANS specifications

Document	Rev./issue	Title and Publisher
SANS 107	Latest	Standard Transformer Bushings.
SANS 1091	Latest	National colour standard
SANS 2093	Latest	Electroplated coatings of tin - Specification and test methods.
SANS 9001	Latest	Quality Management Systems.
SANS 60076	Latest	Power Transformers. All parts.
SANS 60137	Latest	Insulated bushings for alternating voltages above 1000 V.
SANS 60270	Latest	High-voltage test techniques - Partial discharge measurements.
SANS 60815	Latest	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions.
NRS 079-1	Latest	Mineral insulating oils (uninhibited) Part 1: Purchase, management, maintenance and testing.
IEC 60071	Latest	Insulation co-ordination.
IEC 60085	Latest	Thermal evaluation and classification of electrical insulation.
IEC 60156	Latest	Insulating liquids – Determination of the breakdown voltage at power frequency.
IEC 60185	Latest	Current transformers.
IEC 60216-2	Latest	Guide for the determination of thermal endurance properties of electrical insulating materials.
IEC 60233	Latest	Tests on hollow insulators for use in electrical equipment.
IEC 60505	Latest	Guide for the evaluation of insulation systems of electrical equipment.
IEC 60507	Latest	Artificial pollution tests on high voltage insulators to be used on ac. systems.

In addition, the following Eskom specifications shall constitute requirements of this specification. All Eskom standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

Table 2: Eskom specifications

Document	Rev./issue	Title and Publisher
240-57648848	1	Specification For Combined Three-Phase Neutral Electro-Magnetic Couplers With Neutral Earthing Resistors And Auxiliary Transformers (Necrt's)".

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GSE48 – GENERAL SPECIFICATION ELECTRICAL

OPTICAL GROUND WIRE (OPGW)

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1. GENERAL

This general specification covers the general requirements for Optical Ground Wire (OPGW).

Optical Ground Wire (OPGW) serves as a medium for protection, SCADA and general communication as well as the conventional purpose of a shield i.e. lightning overage and earth wire.

2. NORMATIVE REFERENCES

The following documents contain provisions that constitute requirements of this specification. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

Table 1: SANS specifications

Document	Rev./issue	Title and Publisher
NRS 061	Latest	Specification for overhead ground wire with optical fibre:
NRS 061-1	Latest	Product specification
NRS 061-2	Latest	Installation guidelines
NRS 081	Latest	Single-Mode Non-Dispersion Shifted Optical Fibres
SANS 10280-1	Latest	Overhead Power Lines for conditions prevailing in South Africa.
SANS 60815	Latest	Guide for the selection of insulators in respect of polluted conditions.
SANS 60793-2	Latest	Optical fibres. Part 2: Product specifications – General.
SANS 60794-4-1	Latest	Optical fibre cables. Part 4: Sectional specification – Aerial optical cables along electrical power lines.
SANS 60793-2-30	Latest	Optical fibres Part 2-30: Product specifications - Sectional specification for category A3 multimode fibres.

2.1. GENERAL REQUIREMENTS

- The general requirements for OPGW are specified below, where conflicting requirements with NRS 061-1 occur, this specification shall take precedence.
- The OPGW shall have the necessary protective outer layer to prevent damage to the fibre due to mechanical elongation, bending, twisting and crushing forces.
- The stranded bare conductor shall consist of the same electrical and mechanical characteristics as a conventional overhead ground wire.

- d) Full details of the construction of the fibre cable offered shall be provided, as well as the measures taken to minimize hydrogen absorption in the fibres.
- e) Each fibre shall be measured for continuity and length, while the cable is on a drum, prior to delivery.
- f) Sample tests shall be performed to ensure that the material used and the manufacturing processes are without defect.
- g) Type test certificates shall be provided and routine tests shall be carried out in accordance with NRS061-1.
- h) Each fibre shall be uniquely identified in an approved manner.
- i) There shall be no fibre splices in any individual drum length of OPGW.
- j) The fibre carrier design shall be such that no moisture shall be able to penetrate and come in contact with the fibres and no grease shall be applied on the conductor.
- k) The wires shall be stranded in such a manner that, when the complete conductor is cut, the individual layers can easily be regrouped.

2.1.1. OPGW TYPES

Dependant on the power line detail design one of the following 24 Core or 48 Core OPGW types shall be selected as stated in the project specification, Bill of Quantities or project drawings.

OPGW types shall be either 12, 24 or 48 Core (G.652.D) in accordance with NRS081 and shall comply with the general requirement as tabled below. The Ultimate Tensile Strength stipulated is the expected extremity between manufacturers and the short circuit current rating stipulated is a minimum value.

Table 2: General Requirements

ITEM	DIAMETER (mm)	UTS (kN)	CURRENT RATING (1s)
5kA	10.8	66kN	5.66kA
10kA	13.3	69.7kN	10kA
12kA	14.9	113.4kN	12kA
16kA	16.6	104.5kN	16.5kA
18kA	17.7	118.3kN	18.68kA
21kA	19.3	141.5kN	22.34kA

For all of the above OPGW types the relevant PLS CADD seed /wire file shall be submitted by the Contractor to the Engineer, as supplied by the Original Equipment Manufacturer (OEM). No material shall be ordered by the Contractor prior to written approval by the Engineer that the OPGW type was successfully integrated into and tested as part of the PLS CADD power line design.

For high fault levels or double circuit power lines the Engineer may opt to combine the use of OPGW with steel or ACSR wires. The use of single strand ACSR conductor shall be prohibited to prevent unnecessary fatigue failure due to vibration. Contractors shall provide the Engineer with the OPGW's DC resistance in order to confirm fault current

sharing provisions. The Contractor shall note that with the use of ACSR as a second shield wire reduced tensions in the shield wire and thus also in phase conductors will be required to retain adequate lightning coverage and compliance with relevant standards.

3. SERVICE CONDITIONS

The OPGW shall be designed for use under the following typical in-land service conditions:

- a) Pollution level : very heavy
- b) Maximum temperature : 50 °C
- c) Minimum temperature : -10 °C
- d) Route altitude : 1 000m - 2 000m (Above sea level)

The conductor tension limits for un-damped conductors (after creep) shall be 1425m. The sag for earth / shield wires shall be limited to 90% of the conductor sag.

Tension limits for damped conductors shall comply with the table below:

Table 3: Damped conductor tension limits (SANS10280-1)

1	2	3
Conductor condition	Phase conductor	Earthwire
After creep condition at -5 °C	C limit: 2 450 m	C limit: 2 750 m
After creep at EDT	C limit: 1 800 m	C limit: 2 100 m
Ultimate wind/Ice load	70 % of UTS	

4. DESIGN DETAILS

4.1. FIBRE OPTIC

- a) These shall be **SINGLE MODE** fibres as in accordance with, IEC 60793-1 and IEC 60793-2. The number of cores shall be 12, 24 or 48.

4.2. ARMOUR

- a) The OPGW armour shall be designed to provide similar mechanical and electrical characteristics as a conventional shield wire, and meet short-circuit current requirement.
- b) The construction of the armour shall comprise bare metallic wires of combined metals stranded in one or more layer(s).
- c) The direction of lay shall be reversed in successive layers.

4.3. CRUSH RESISTANCE

During stringing, the conductor is subjected to side compression when it passes over metal pulleys or when clamps are installed. To endure these stresses, the fibre shall have a high anti-crushing resistance. When tested there shall be no measurable permanent changes in optical attenuation coefficient at 1310 nm and 1550 nm (nanometer), while any temporary change in attenuation shall be less than 0,1 dB (decibels).

Note: *Attenuation is the reduction of signal strength during transmission.*

4.4. TENSILE PERFORMANCE

The conductor shall be designed in such a manner that it can withstand a specified tensile load without damaging influence on the optical fibres. The tensile performance shall comply with NRS 061-1 clause 4.2.7.

4.5. CABLE DEFORMATION

During installation the cable shall be subjected to passing, under tension, over several metal pulleys. The cable deformation shall comply with NRS 061-1 clause 4.2.8.

4.6. STRESS-STRAIN

There shall be no visual change to the cable strands. The stress-strain shall comply with NRS 061-1 clause 4.2.9. The stress-strain curve, creep and UTS shall be an exact match to the typical galvanized steel wires utilized namely 3/4.00, 7/3.35 or 19/2.65 unless otherwise specified in documentation presiding over this general specification.

4.7. IMPACT

The impact shall comply with NRS 061-1 clause 4.2.10.

4.8. AEOLIAN VIBRATION

The optical attenuation increase shall be less than 0,05 dB/km at 1550 nm. The Aeolian vibration shall comply with NRS 061-1 clause 4.2.11.

4.9. CONDUCTOR CREEP

The manufacturer shall submit records of a long term (>1 000 h) elongation test, with extrapolation to 15 years of a conductor sample tensioned at 20 % RTS.

4.10. TEMPERATURE CYCLE

The temperature cycle shall comply with NRS 061-1 clause 4.2.13.

4.11. SHORT - CIRCUIT CURRENT

The short-circuit current shall comply with NRS 061-1 clause 4.2.14.

4.12. LIGHTNING

The lightning shall comply with NRS 061-1 clause 4.2.15.

4.13. MACRO-BEND RESISTANCE

The macro-bend resistance shall comply with NRS 061-1 clause 4.2.5 for G.652 fibres respectively.

5. INSTALLATION

All requirements as per NRS061-2 shall be met and provided for. Before initiation the installation process the Contractor shall provide the Engineer with his quality check list for approval. Stringing shall not start until the Contractors quality checklist is approved by the Engineer.

6. TESTS

The OPGW type tests; routine test and sample test set out in NRS 061-1 shall apply to this specification. OTDR tests shall be conducted as routine tests.

7. MARKING, LABELLING, PACKAGING

Marking, labelling and packaging shall comply with the requirements of NRS 061-1.

8. DOCUMENTATION

- a) PLS CADD seed / wire file
- b) Technical product catalogue and manuals shall be provided.
- c) Full detailed dimensions drawings shall be provided (including all splice boxer and attachment method).
- d) All splice position relating to the station lengths of the line shall be submitted for approval before orders for material are placed.
- e) A copy of all type test certificates and routine test reports in English shall be provided.
- f) A copy of the proposed routine test certificates in English shall be provided.

9. TRAINING

A necessary certified training course shall be offered to relevant local authority staff. The training shall include, amongst other things, the handling, storage and installation of the OPGW.

The associated costs for a certified training course shall be given per person and shall be fixed for the period of the contract.

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EMALAHLENI LOCAL MUNICIPALITY

**40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION
OF A 11,5 KM, 132 KV OVERHEAD LINE.**

CONTRACT NUMBER: ELM 07/2021 (READVERT)



THE CONTRACT PART 3: SCOPE OF THE WORK

C4: SITE INFORMATION

EMALAHLENI LOCAL MUNICIPALITY

40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION OF A 11,5 KM, 132 KV OVERHEAD LINE.

CONTRACT NUMBER: ELM 07/2021 (READVERT)

C4. SITE INFORMATION

The site falls within the jurisdiction of Emalahleni Local Municipality.

The Contractor shall cater for his own water, electricity and sanitation requirements.

The onus will be on the Contractor to acquaint himself with the site conditions before the tender closing date.

It is recorded that the Contractor has, before signature of this Contract, carried out a site inspection in order to acquaint itself with the site conditions, access and all other matters relating to the site.

The contractor acknowledges that it has allowed for all conditions on site and agrees that extra claims arising from difficult site conditions in respect of transport, handling, loading, off-loading, labour, housing and any other matter relating to the site will not be entertained.

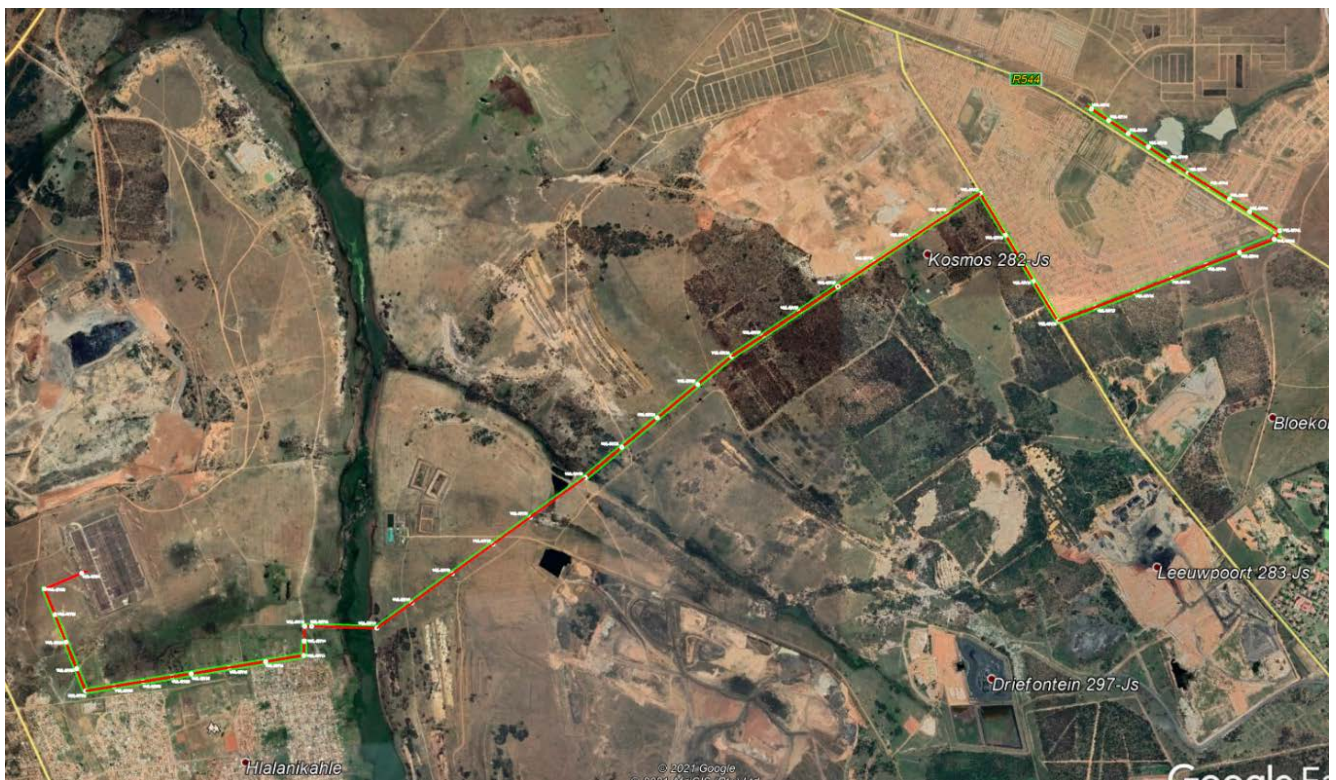


Figure 7: Locality

EMALAHLENI LOCAL MUNICIPALITY

40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION
OF A 11,5 KM, 132 KV OVERHEAD LINE.

CONTRACT NUMBER: ELM 07/2021 (READVERT)

Table 12: Site information

Overhead line Information	
Item	Description
Start: Co-ordinates (Lat.)	LAT: 25° 49' 48.72"S
Start: Co-ordinates (Long.)	LONG: 29° 06' 30.90"E
End: Co-ordinates (Lat.)	LAT: 25° 48' 14.5"S
End: Co-ordinates (Long.)	LONG: 29° 10' 16.28"E
Line Length	11.5 km
Number of lines	One (1)
Number of circuits	Single
Number of conductors per circuit	One (1)
Line System Voltages	132 kV
Structure type	Steel
Terminal Structures	4 %
Strain Structures	35 %
Intermediate (Suspension) Structures	62 %
Conductor type	Chickadee
Shield wire Type	OPGW (48 core)
Average span length	218 m
Altitude	between 1 450 m and 1544 m
Ambient Temp Max. °C	28 °C
Ambient Temp Min. °C	7 °C
Lightning Density	12 flashes to ground/km ² /year
Rain Fall	966 mm
Thunder days/year (mean)	38
Snow days/year (mean)	0
Max. Wind m/sec	10 m/s

SIGNED AT ON BEHALF OF THE FIRM

ON THIS DAY OF 20....

NAME:

SIGNATURE:

CAPACITY:

EMALAHLENI LOCAL MUNICIPALITY

**40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION
OF A 11,5 KM, 132 KV OVERHEAD LINE.**

CONTRACT NUMBER: ELM 07/2021 (READVERT)



THE CONTRACT PART 3: SCOPE OF THE WORK

C5: ANNEXURES AND DRAWINGS

EMALAHLENI LOCAL MUNICIPALITY

**40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION
OF A 11,5 KM, 132 KV OVERHEAD LINE.**

CONTRACT NUMBER: ELM 07/2021 (READVERT)

ANNEXURE 1: EMPLOYER H & S SPECIFICATION

EMALAHLENI LOCAL MUNICIPALITY

**40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION
OF A 11,5 KM, 132 KV OVERHEAD LINE.**

CONTRACT NUMBER: ELM 07/2021 (READVERT)

ANNEXURE 2: EMPLOYER ENVIRONMENTAL SPECIFICATION

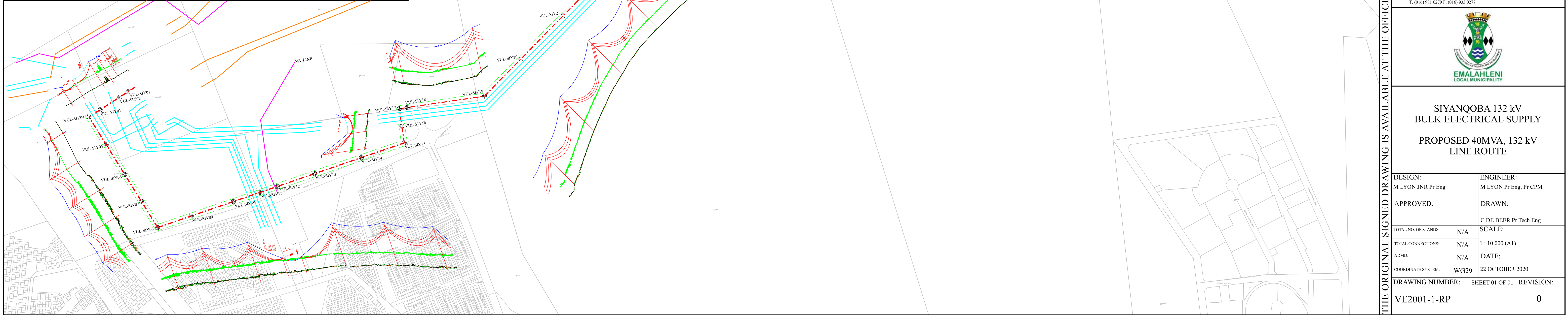
EMALAHLENI LOCAL MUNICIPALITY

**40 MVA/132/11 KV, SIYANQOBA SUBSTATION PHASE 5 - CONSTRUCTION
OF A 11,5 KM, 132 KV OVERHEAD LINE.**

CONTRACT NUMBER: ELM 07/2021 (READVERT)

ANNEXURE 3: DRAWINGS

NO.	POLE LABEL	DESCRIPTION	POLE LENGTH (m)	EMBEDDED (m)	STATION (m)	AHEAD SPAN (m)	CAH				CROSSING LABEL	SW	STAYS	COMMENT
							SW	T	M	B				
1	VUL-SIY00	Gantry-12m beam 106			6	39	14.83	10.6	10.6	10.6	N	Non Insulated		Existing Gantry Beam
2	VUL-SIY01	Str_4pole_in_line_15m_17m.pole	3 x 15m 1 x 17m	2.3m	44	51	14.7	12.5	12.5	12.5	N	Non Insulated	8	4 Poles
3	VUL-SIY02	Str_4pole_in_line_15m_16m.pole	3 x 15m 1 x 16m	2.3m 2.4m	96	122	13.6	12.5	12.5	12.5	N	Non Insulated	8	4 Poles
4	VUL-SIY03	Str_4pole_in_line_10m_11m.pole	3 x 10m 1 x 11m	1.8m 1.7m	218	70	9.3	8	8	8	N	Non Insulated	8	4 Poles
5	VUL-SIY04	Str_4pole_90deg_10m_12m.pole	3 x 10m 1 x 12m	1.8m 1.8m	288	172	10.2	8	8	8	N	Non Insulated	8	4 Poles
6	VUL-SIY05	Str_mono_in_line_20m.pole	20m	2	460	184	18	16.6	14.8	13	Y	Non Insulated	7	
7	VUL-SIY06	Int_mono_SC_22m.pole	22	2.8	644	165	19.2	17	15.9	14.8	Y	Non Insulated		
8	VUL-SIY07	Int_mono_SC_22m.pole	22	2.8	809	163	19.2	17	15.9	14.8	2 x Y	Non Insulated		
9	VUL-SIY08	Str_mono_SC_7615d_r2_20m.pole	20m	2	972	187	18	16.6	14.8	13	Y	Non Insulated	7	
10	VUL-SIY09	Int_mono_SC_22m.pole	22	2.8	1159	234	19.2	17	15.9	14.8	Y	Non Insulated		
11	VUL-SIY10	Int_mono_SC_22m.pole	22	2.8	1393	148	19.2	17	15.9	14.8	N	Non Insulated		
12	VUL-SIY11	Str_4pole_in_line_10m.pole	4 x 10m	1.8m	1540	97	8.2	8	8	8	Y	Non Insulated	8	4 Poles
13	VUL-SIY12	Str_4pole_in_line_11m.pole	4 x 11m	1.9m	1637	208	9.1	8.9	8.9	8.9	Y	Non Insulated	8	4 Poles
14	VUL-SIY13	Int_mono_SC_24m_FM.pole	1 x 24m	flange mounted	1845	259	24	21.8	20.7	19.6	Y	Non Insulated		Flange Mounted
15	VUL-SIY14	Int_mono_SC_24m_FM.pole	1 x 24m	flange mounted	2104	239	24	21.8	20.7	19.6	Y	Insulated		Flange Mounted
16	VUL-SIY15	Str_mono_SC_23.2m_FMS.pole	1 x 23.2m	flange mounted	2342	89	23.2	21.8	20	18.2	Y	Insulated		
17	VUL-SIY16	Str_4pole_in_line_10m_12m.pole	3 x 10m 1 x 12m	1.8m 1.7m	2431	92	10.2	8	8	8	N	Insulated	8	4 Poles
18	VUL-SIY17	Str_4pole_90deg_10m_12m.pole	3 x 10m 1 x 12m	1.8m 1.8m	2524	42	10.2	8	8	8	N	Insulated	8	4 Poles
19	VUL-SIY18	Str_mono_SC_23.2m_FMS.pole	1 x 23.2m	flange mounted	2566	410	23.2	21.8	20	18.2	Y	Insulated	N/A	
20	VUL-SIY19	Str_mono_SC_23.2m_FMS.pole	1 x 23.2m	flange mounted	2977	273	23.2	21.8	20	18.2	Y	Insulated	N/A	
21	VUL-SIY20	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	3250	317	25.3	23.1	22	20.9	Y	Insulated		Flange Mounted
22	VUL-SIY21	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	3567	305	25.3	23.1	22	20.9	Y	Insulated		Flange Mounted
23	VUL-SIY22	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	3872	297	25.3	23.1	22	20.9	Y	Insulated		Flange Mounted
24	VUL-SIY23	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	4169	423	25.3	23.1	22	20.9	Y	Non Insulated		Flange Mounted
25	VUL-SIY24	Str_3pole_in_line_12m.pole	3 x 12m	flange mounted	4592	297	32	30.5	30.5	30.5	Y	Non Insulated	7	Tied at top
26	VUL-SIY25	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	4890	289	25.3	23.1	22	20.9	Y	Non Insulated		Flange Mounted
27	VUL-SIY26	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	5179	326	25.3	23.1	22	20.9	Y	Non Insulated		Flange Mounted
28	VUL-SIY27	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	5505	273	25.3	23.1	22	20.9	Y	Non Insulated		Flange Mounted
29	VUL-SIY28	Str_mono_in_line_20m.pole	20m	2	5779	231	18	16.6	14.8	13	Y	Non Insulated	6	Based on 7615
30	VUL-SIY29	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	6010	275	25.3	23.1	22	20.9	Y	Non Insulated		Flange Mounted
31	VUL-SIY30	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	6285	281	25.3	23.1	22	20.9	Y	Non Insulated		Flange Mounted
32	VUL-SIY31	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	6566	276	25.3	23.1	22	20.9	Y	Non Insulated		Flange Mounted
33	VUL-SIY32	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	6843	260	25.3	23.1	22	20.9	Y	Non Insulated		Flange Mounted
34	VUL-SIY33	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	7103	281	25.3	23.1	22	20.9	Y	Non Insulated		Flange Mounted
35	VUL-SIY34	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	7384	240	25.3	23.1	22	20.9	Y	Non Insulated		Flange Mounted
36	VUL-SIY35	Str_mono_SC_7615d_r2_24.pole	24m	2	7624	303	22	20.6	18.8	17	N	Non Insulated	7	
37	VUL-SIY36	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	7927	333	25.3	23.1	22	20.9	Y	Non Insulated		Flange Mounted
38	VUL-SIY37	Int_mono_SC_25.3m_FM.pole	25.3m	flange mounted	8260	290	25.3	23.1	22	20.9	Y	Non Insulated		Flange Mounted
39	VUL-SIY38	Str_mono_SC_7615d_r2_24.pole	24m	2	8551	251	22	20.6	18.8	17	N	Non Insulated		
40	VUL-SIY39	Int_mono_DCHVdcvm_24m_FM.pole	1 x 24m	flange mounted	8802	260	24	21.8	20.7	19.6	N	Non Insulated		Flange Mounted
41	VUL-SIY40	Int_mono_DCHVdcvm_24m_FM.pole	1 x 24m	flange mounted	9061	251	24	21.8	20.7	19.6	N	Non Insulated		Flange Mounted
42	VUL-SIY41	Int_mono_DCHVdcvm_24m_FM.pole	1 x 24m	flange mounted	9312	236	24	21.8	20.7	19.6	N	Non Insulated		Flange Mounted
43	VUL-SIY42	Int_mono_DCHVdcvm_24m_FM.pole	1 x 24m	flange mounted	9548	224	24	21.8	20.7	19.6	N	Non Insulated		Flange Mounted
44	VUL-SIY43	Int_mono_DCHVdcvm_24m_FM.pole	1 x 24m	flange mounted	9772	235	24	21.8	20.7	19.6	N	Non Insulated		Flange Mounted
45	VUL-SIY44	Str_mono_SC_7615d_r2_24.pole	24m	2	10007	68	22	20.6	18.8	17	N	Non Insulated	7	
46	VUL-SIY45	Str_2pole_2xSC_23.2mcah-MV_FM.pole	2 x 23.2m	flange mounted	10075	71	23.2	21.8	20	18.2	N	Non Insulated		
47	VUL-SIY46	Int_mono_DCHVdcvm_24m_FM.pole	1 x 24m	flange mounted	10145	150	24	21.8	20.7	19.6	N	Non Insulated		Flange Mounted with MV
48	VUL-SIY47	Int_mono_DCHVdcvm_24m_FM.pole	1 x 24m	flange mounted	10295	150	24	21.8	20.7	19.6	N	Non Insulated		Flange Mounted with MV
49	VUL-SIY48	Int_mono_DCHVdcvm_24m_FM.pole	1 x 24m	flange mounted	10445	150	24	21.8	20.7	19.6	N	Non Insulated		Flange Mounted with MV
50	VUL-SIY49	Int_mono_DCHVdcvm_24m_FM.pole	1 x 24m	flange mounted	10595	150	24	21.8	20.7	19.6	N	Non Insulated		Flange Mounted with MV
51	VUL-SIY50	Str_2pole_2xSC_23.2mcah-MV_FM.pole	2 x 23.2m	flange mounted	10745	149	23.2	21.8	20	18.2	N	Non Insulated		
52	VUL-SIY51	Int_mono_DCHVdcvm_24m_FM.pole	1 x 24m	flange mounted	10894	152	24	21.8	20.7	19.6	N	Non Insulated		Flange Mounted with MV
53	VUL-SIY52	Int_mono_DCHVdcvm_24m_FM.pole	1 x 24m	flange mounted	11046	149	24	21.8	20.7	19.6	N	Non Insulated		Flange Mounted with MV
54	VUL-SIY53	Int_mono_DCHVdcvm_24m_FM.pole	1 x 24m	flange mounted	11195	150	24	21.8	20.7	19.6	N	Non Insulated		Flange Mounted with MV
55	VUL-SIY54	Int_mono_DCHVdcvm_24m_FM.pole	1 x 24m	flange mounted	11345	135	24	21.8	20.7	19.6	N	Non Insulated		Flange Mounted with MV
56	VUL-SIY55	Str_2pole_2xSC_19mcah-MV_FM.pole	1 x 19m	flange mounted	11480	37	19	17.6	15.8	14	N	Non Insulated	7	
57	VUL-SIY56	132kv-12m beam-double 106			11516	0	14.83	10.6	10.6	10.6	N	Non Insulated		Existing Gantry Beam



2021-05-11	PROFILE ADDED	CDB	F
2021-06-15	DRAWING WAS VERIFIED-LIAISON-FINAL	CDB	E
2021-02-28	ROAD CROSSING REVISED	CDB	D
2020-12-10	ALTERNATIVE ROUTES ADDED	CDB	C
2020-12-02	ALTERNATIVE ROUTES ADDED	CDB	B
DATE:	REVISIONS	DRAWN	REVISION NO

TENDER		
ISSUED FOR TENDER PURPOSES ONLY		
As-Built	DATE:	
Construction	DATE:	
Tender	DATE:	2021-06-10
Approval	DATE:	
Information	DATE:	
Planning	DATE:	
ISSUED FOR:		
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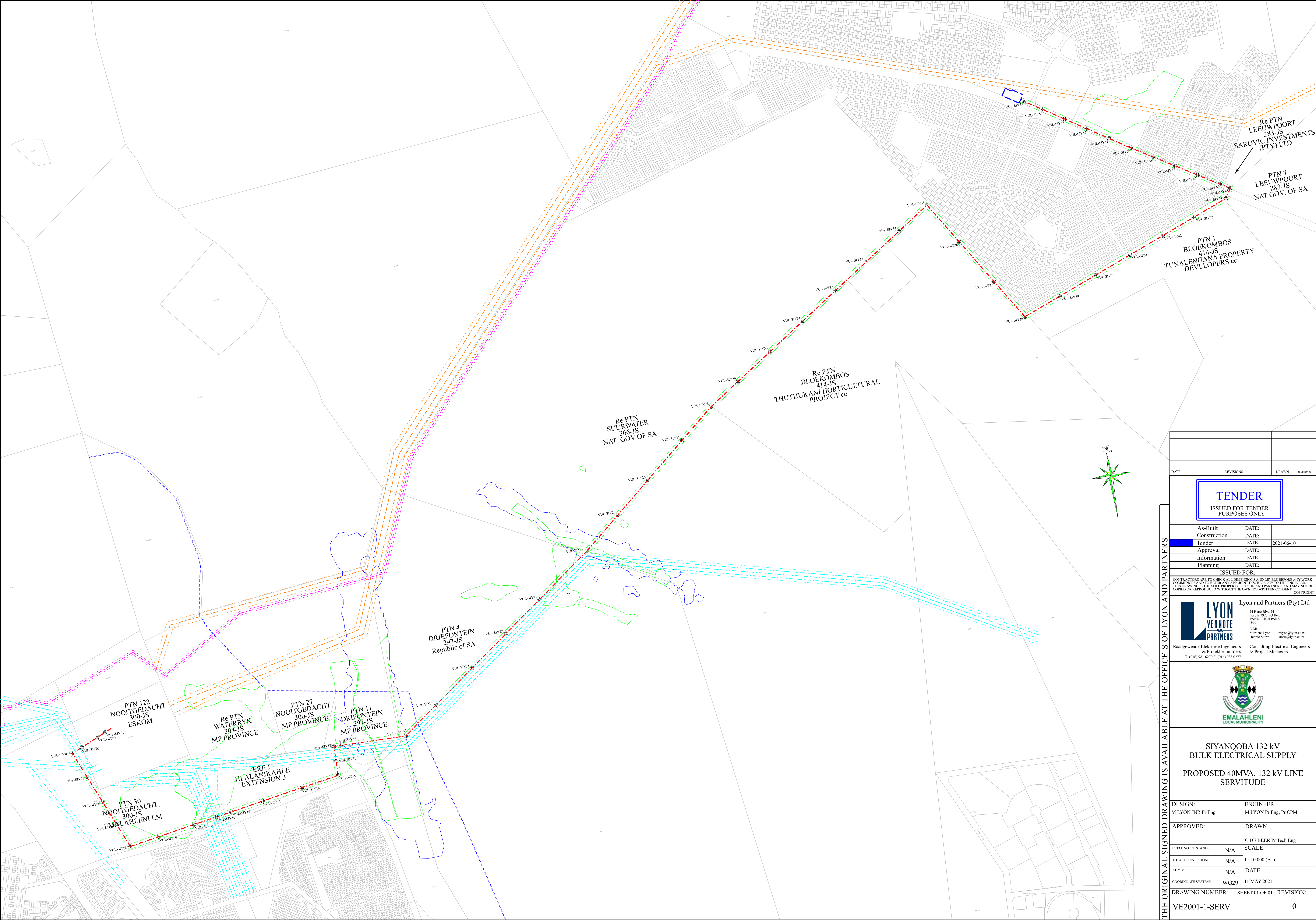
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& Projekbestuurders
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**SIYANQOBA 132 kV
BULK ELECTRICAL SUPPLY**

**PROPOSED 40MVA, 132 kV
LINE ROUTE**

DESIGN:	M LYON JNR Pr Eng	ENGINEER:	M LYON Pr Eng, Pr CPM
APPROVED:		DRAWN:	C DE BEER Pr Tech Eng
TOTAL NO. OF STANDS:	N/A	SCALE:	1 : 10 000 (A1)
TOTAL CONNECTIONS:	N/A	DATE:	22 OCTOBER 2020
ADMD:	N/A	DRAWING NUMBER:	SHEET 01 OF 01
COORDINATE SYSTEM:	WG29	REVISION:	0
VE2001-1-RP			



DATE:	REVISIONS	DRAWN	REVISION NO

TENDER		
ISSUED FOR TENDER PURPOSES ONLY		
As-Built	DATE:	
Construction	DATE:	
Tender	DATE:	2021-06-10
Approval	DATE:	
Information	DATE:	
Planning	DATE:	

ISSUED FOR:
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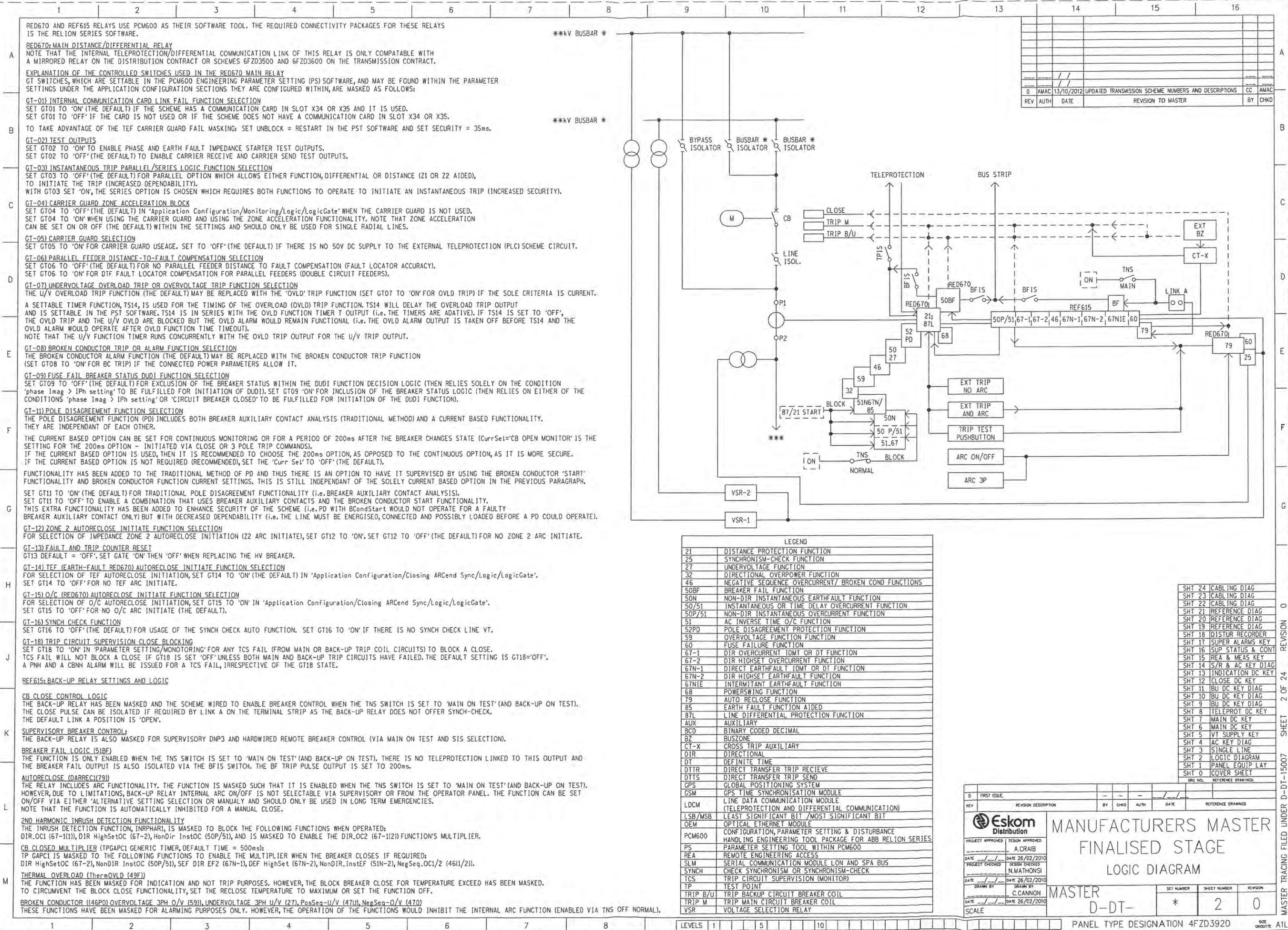
**LYON
VENNOTE
PARTNERS**

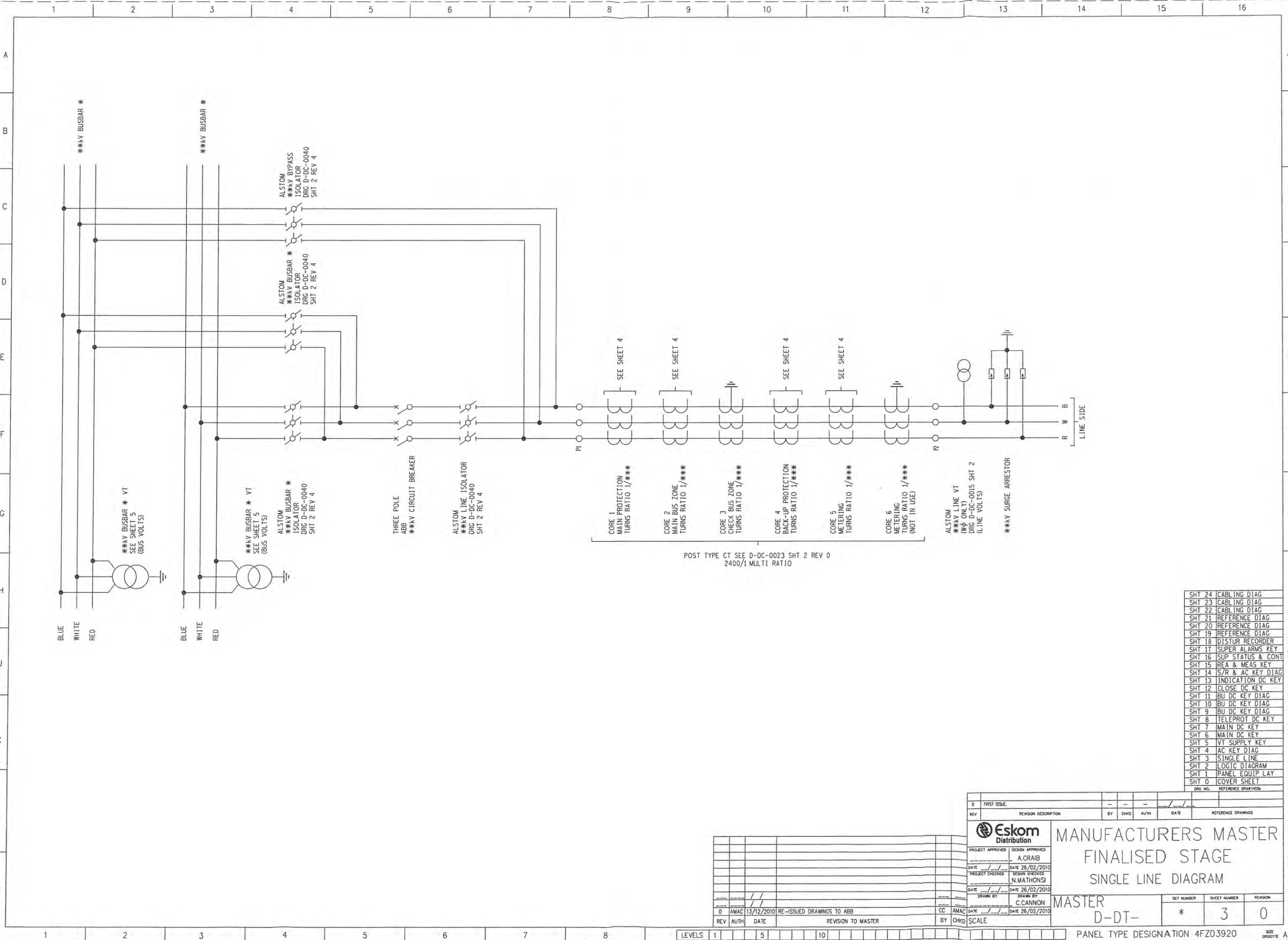
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SIYANQOBA 132 kV
BULK ELECTRICAL SUPPLY
PROPOSED 40MVA, 132 kV LINE
SERVITUDE

DESIGN: M LYON JNR Pr Eng	ENGINEER: M LYON Pr Eng, Pr CPM
APPROVED:	DRAWN: C DE BEER Pr Tech Eng
TOTAL NO. OF STANDS: N/A	SCALE:
TOTAL CONNECTIONS: N/A	1 : 10 000 (A1)
ADMD: N/A	DATE:
COORDINATE SYSTEM: WG29	11 MAY 2021
DRAWING NUMBER: VE2001-1-SERV	SHEET 01 OF 01 REVISION:
	0





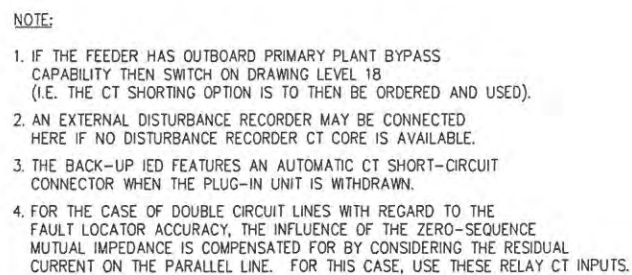
SHT 24	CABLING DIAG
SHT 23	CABLING DIAG
SHT 22	CABLING DIAG
SHT 21	REFERENCE DIAG
SHT 20	REFERENCE DIAG
SHT 19	REFERENCE DIAG
SHT 18	DISTUR RECORDER
SHT 17	SUPER ALARMS KEY
SHT 16	SUP STATUS & CONT
SHT 15	REA & MEAS KEY
SHT 14	S/R & AC KEY DIAG
SHT 13	INDICATION DC KEY
SHT 12	CLOSE DC KEY
SHT 11	BU DC KEY DIAG
SHT 10	BU DC KEY DIAG
SHT 9	BU DC KEY DIAG
SHT 8	TELEPROT DC KEY
SHT 7	MAIN DC KEY
SHT 6	MAIN DC KEY
SHT 5	VT SUPPLY KEY
SHT 4	AC KEY DIAG
SHT 3	SINGLE LINE
SHT 2	LOGIC DIAGRAM
SHT 1	PANEL EQUIP LAY
SHT 0	COVER SHEET

REV	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
AUTH	AMAC																
DATE	13/12/2010																
REVISION TO MASTER	RE-ISSUED DRAWINGS TO ABB																

Eskom Distribution		MANUFACTURERS MASTER	
PROJECT APPROVED: A.CRAIB		FINALISED STAGE	
DATE: 26/02/2010		SINGLE LINE DIAGRAM	
PROJECT CHECKED: N.MATHONSI			
DATE: 26/02/2010			
DRAWN BY: C.CANNON			
DATE: 26/02/2010			
BY: CHKD		SCALE	
REV: 0		AMAC	
DATE: 13/12/2010		RE-ISSUED DRAWINGS TO ABB	
BY: CHKD		SCALE	

SET NUMBER	SHEET NUMBER	REVISION
0	3	0

MASTER D-DT-	*	3	0
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[illegible]PANEL TYPE DESIGNATION 4FZD392C