



**TABLE OF CONTENTS**

	<u>PAGE</u>
<b>1 SCOPE .....</b>	<b>4</b>
<b>2 TREE CUTTING .....</b>	<b>8</b>
<b>3 POLES .....</b>	<b>8</b>
3.1 GENERAL.....	8
3.2 POLE SPACING.....	8
3.3 POLE PLANTING .....	8
3.4 POLE EARTHING.....	8
3.5 WOODEN POLES .....	9
3.5.1 <i>General specification</i> .....	9
3.6 CONCRETE POLES.....	10
3.6.1 <i>General</i> .....	10
3.6.2 <i>Design</i> .....	10
3.7 MONOPOLE STEEL STRUCTURES.....	11
3.7.1 <i>Design</i> .....	11
3.7.2 <i>Paint and Finishing</i> .....	11
<b>4 STAY ASSEMBLIES .....</b>	<b>12</b>
4.1 GENERAL.....	12
4.2 STAY WIRE.....	12
4.2.1 <i>General</i> .....	12
4.2.2 <i>Stay wire for SWER line</i> .....	12
4.2.3 <i>Stay wire for LV line</i> .....	12
4.3 STAY ROD.....	12
4.4 STAY ROD BASE PLATE .....	13
4.4.1 <i>Base plate for SWER line stay rod</i> .....	13
4.4.2 <i>Base plate for LV line stay rod</i> .....	13
4.5 PREFORMED STAY FITTINGS.....	13
4.5.1 <i>General</i> .....	13
4.5.2 <i>Pole top make off</i> .....	13
4.5.3 <i>Prefomed guy grips</i> .....	13
4.6 STAY INSULATOR.....	13
4.7 STAY GUARDS.....	13
4.8 OTHER STAY ACCESSORIES .....	14
4.8.1 <i>Cable clamps</i> .....	14
4.8.2 <i>Eye-bolt assembly</i> .....	14
<b>5 EXCAVATION .....</b>	<b>15</b>
5.1 GENERAL.....	15
5.2 POLE HOLE EXCAVATION.....	15
5.3 STAY HOLE EXCAVATION.....	16
5.4 COMPACTING OF HOLES .....	16
5.5 ROCK ANCHORS .....	16
<b>6 LINE CONFIGURATION .....</b>	<b>17</b>
6.1 GENERAL.....	17
6.1.1 <i>Galvanizing</i> .....	17
6.1.2 <i>Bolts and nuts</i> .....	17
6.2 VERTICAL HLP CONFIGURATION .....	17
<b>7 LINE CONDUCTOR .....</b>	<b>18</b>
7.1 GENERAL.....	18
7.2 CONDUCTOR SIZE .....	18

PART B-04: SWER OVERHEAD CONDUCTOR DISTRIBUTION SYSTEM

7.3	LINE JOINTS .....	18
7.4	MINIMUM ELECTRICAL CLEARANCES (VERTICAL) .....	19
7.5	MINIMUM ELECTRICAL CLEARANCES (GUIDELINES FOR BUILDINGS AND PARALLEL LINES) .....	20
7.6	POWER LINE AND COMMUNICATION LINE CROSSINGS .....	20
<b>8</b>	<b>INSULATORS.....</b>	<b>21</b>
8.1	GENERAL.....	21
8.1.1	<i>Types of insulators</i> .....	21
8.1.2	<i>Electrical design</i> .....	21
8.1.3	<i>Mechanical design</i> .....	21
8.1.4	<i>Clamps and conductor fittings</i> .....	21
8.2	STRAIN INSULATORS.....	22
8.2.1	<i>Porcelain disc insulator</i> .....	22
8.2.2	<i>Long rod insulator</i> .....	22
8.3	INTERMEDIATE INSULATORS.....	22
8.3.1	<i>Porcelain line post insulator</i> .....	22
8.3.2	<i>Cycloaliphatic line post insulator</i> .....	22
<b>9</b>	<b>LINE FITTINGS .....</b>	<b>23</b>
9.1	PREFORMED BINDING TIES.....	23
9.2	PREFORMED DEAD ENDS .....	23
9.3	THIMBLE CLEVIS .....	23
9.4	PARALLEL GROOVE CLAMPS.....	23
9.5	VIBRATION DAMPERS.....	23

**1 SCOPE**

- (a) This part of the specification deals with the erection and commissioning of a complete Single Wire Earth Return (SWER) overhead distribution line with bare conductor and wooden Steel or concrete poles, stay assemblies, insulators, strain and suspension clamps.
- (b) Bare overhead distribution in built-up areas shall as far as possible be avoided, especially on the low voltage side.
- (c) This specification shall be read in conjunction with the following standards referenced below:

**GENERAL INFORMATION**

The following Standards and Acts shall take precedence:

- National Electricity Act of Namibia
- Occupational Health and Safety Act of Namibia
- Labour Act of Namibia
- Quality of Service Standard
- Quality of Supply Standard
- NamPower Specifications for the Erection of Overhead Power Lines
- NamPower Specifications and General Conditions for Survey and Route Clearing for New Power Lines

The following Standard shall be used as reference:

- NRS 033 : Electricity Distribution – Guidelines for the application design, planning and construction of medium voltage overhead power lines up to and including 33kV, using wooden pole structures and bare conductors.
- NRS 034 : Guidelines for the provision of electrical distribution networks in residential areas.
- NRS 043 : Code of practice for the joint use of structures for power and telecommunication lines
- NRS 059 : Recommendations to minimize problems associated with the theft of transformer neutral and neutral earthing copper conductors
- NRS 060 : Code of practice for clearances for electrical systems with rated voltages up to and including 145kV, for the safety of persons
- NRS 082 : Recommended maintenance policy for electricity networks
- SANS 10280 : Overhead power lines for conditions prevailing in South Africa

**OVERHEAD CONDUCTORS**

**Regional Standards**

- SANS 182-1 : Conductors for overhead electrical Transmission line part 1: Copper wires and stranded copper conductors (metric units)
- SANS 182-2 : Conductors for overhead electrical Transmission line part 2: Stranded aluminium conductors
- SANS 182-3 : Conductors for overhead electrical Transmission line part 3: Aluminium conductors, steel reinforced
- SANS 182-5 : Conductors for overhead electrical Transmission line part 5: Zinc-coated steel wires for conductors and stays.
- SANS 1418-1 : Aerial bundled conductor system Part 1: Cores
- SANS 1418-2 : Aerial bundled conductor system Part 2: Assembled insulated conductor bundles
- SANS 1713 : Electric cables –Medium voltage aerial bundled conductors for voltages from 3.8/6.6kV to 19/33kV
- NRS 020 : Cable ties for use with ABC
- NRS 018 : Fittings and connectors for low voltage overhead power lines using ABC.

**International Standards**

- BS EN 13601 : Specification for copper for electrical purposes.
- IEC 60889 : Hard Drawn Aluminium Wire for Overhead Conductors
- IEC 61089 : Round Wire Concentric Lay Overhead Electrical Stranded Conductors.
- IEC 62219 : Overhead Electrical Conductors – Formed Wire, Concentric Lay , Stranded Conductors

**INSULATORS**

**Regional Standards**

- NRS 066 : Medium voltage insulators
- SANS 60273 : Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
- SANS 60305 : Insulators for overhead lines with nominal voltage above 1000V – ceramic or glass insulator unit for a.c. systems – characteristics of insulator units of the cap and pin type.
- SANS 60383-1 : Insulators for overhead lines with nominal voltage above 1000V. Part 1: Ceramic or glass insulator units for a.c. systems – definitions, test methods and acceptance criteria.

**PART B-04: SWER OVERHEAD CONDUCTOR DISTRIBUTION SYSTEM**

---

- SANS 60383-2: Insulators for overhead lines with nominal voltage above 1000V. Part 2: Insulator strings and insulator sets for a.c. systems – definitions, test methods and acceptance criteria.
- BS EN 60305 : Insulators of ceramic material or glass for overhead lines with a nominal voltage greater than 1000 V. Requirements
- SANS 60720 : Characteristics of line post insulators
- SANS 60815 : Guide to the selection of insulators in respect of polluted conditions
- SANS 61109 : Composite insulators for a.c. overhead lines with a nominal voltage greater than 1000V – Definitions, test methods and acceptance criteria.
- SANS 61462 : Composite insulators – Hollow insulators for use in outdoor and indoor electrical equipment – Definitions, test methods, acceptance criteria and design recommendations.

**International Standards**

- BS 3288 : Insulator and conductor fittings for overhead power lines.
- IEC 1109 : Composite insulators for AC overhead lines with nominal voltage greater than 1000V
- IEC 60168 : Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1kV.
- IEC 60273 : Characteristics of indoor and outdoor post insulators for nominal system voltages greater than 1kV
- IEC 60383 : Insulators for overhead lines with nominal voltage above 1kV
- IEC 60433 : Insulators for overhead lines with a nominal voltage greater than 1kV for ceramic insulators.

**POLES**

- NRS 038 : Concrete poles
- SANS 470 : Concrete poles for telephone, power and lighting purposes
- SANS 753 : Pine poles, cross arms and spacers for power distribution, telephone systems and street lighting
- SANS 754 : Eucalyptus poles, cross-arms and spacers for power distribution and telephone systems

**WOOD PRESERVATIVES**

- SANS 592 : Wood preservatives containing high temperature creosote and coal tar
- SANS 593 : Wood preservatives containing low and medium temperature creosote and coal tar
- SANS 10005 : The preservative treatment of timber

**EARTHING**

- SANS 10199 : The design and installation of an earth electrode
- SANS 1063 : Earth rods and couplers
- SANS 10200 : Neutral Earthing in medium voltage industrial power systems
- SANS 10292 : Earthing of low-voltage (LV) distribution systems
- ESKCAAB4 : Zinc coated earth conductor, guy and stay wire for transmission lines.

**PAINT AND FINISHING**

- NRS 002 : Graphical Symbols and Labelling for electrical diagrams
- SANS 1091 : National colour standards for paints
- SANS 935 : Hot dip galvanised zinc coatings on steel wire
- SANS 121 : Hot dip galvanised coatings on fabricated iron and steel articles.
- SANS 10064 : The preparation of steel surfaces for coating
- SANS 679 : Zinc chromate primers for steel.
- BS 183 : Specification for galvanized steel wire.
- BS 381 : Paint
- BS 2569 : Zinc Metal Spraying

**ASSEMBLIES AND ASSOCIATED ACCESSORIES**

- NRS 022 : Electricity Distribution – Stays and associated Components
- NRS 051 : Suspension and strain fittings for insulated supporting structures used in medium voltage aerial bundled systems.
- NRS 053 : Accessories for medium voltage power cables (3.8/6.6 kV to 19/33 kV)

**2 TREE CUTTING**

- (a) A tree shall only be cut with the landowner as well as the Ministry of Environment's approval and in accordance with NamPower's Specifications and General Conditions for Survey and Route Clearing for New Power Lines.
- (b) All cut ends of branches or trunks on the standing tree shall be treated with a sealing compound as soon as possible after the cut has been made.
- (c) All cut-offs shall be properly removed from site.

**3 POLES**

**3.1 General**

- (a) Poles shall always be planted in a straight line as far as possible.
- (b) All pole marking tags shall face the roadside or all shall face the same direction, 3.5m from the butt.
- (c) Planting of poles next to roads or streets shall comply with the specifications of the responsible roads authority.
- (d) LV, SWER and Street lighting (i.e. electricity services) and telephone services shall not share a pole.
- (e) Care must be taken that the required clearances are adhered to.
- (f) Should SWER and LV installations share the same pole, a taller pole shall be used to keep LV connections on the same height as if for a LV pole.

**3.2 Pole spacing**

- (a) The spacing of poles shall be as indicated on the layout drawings.
- (b) In urban areas pole spacing shall follow the planned erven layout. The normal pole spacing for low voltage lines shall be 35m while for medium voltage lines it shall be 70m. Outside townships the spacing shall be up to 200m.

**3.3 Pole planting**

Poles shall be planted vertically plumb and in line and sufficiently stayed to maintain that position where necessary. Proper compacting of the ground around a pole is essential and shall be achieved with a 1:10 cement/sand (soilcrete) mixture for the backfill, if specified by the Engineer.

**3.4 Pole earthing**

An earth down lead conductor (stranded galvanised steel wire, size 3 /4.00mm) shall be stapled to each SWER pole, connected at the top lowest conductive part and installed along the pole, stapled at 300mm intervals up to 500mm below the lowest conductive part the earth wire shall be looped around the part of the pole that is to be buried in the ground to the bottom of the pole stapled at 500mm intervals.



**PART B-04: SWER OVERHEAD CONDUCTOR DISTRIBUTION SYSTEM**

**3.5 Wooden poles**

**3.5.1 General specification**

The wooden poles shall comply with the following specifications:

- Type** Pine or Eucalyptus transmission poles shall be supplied and installed as approved by the Engineer
- Standards**
- a) The poles shall comply with SANS 753 (Pine Poles) or SANS 754 (Eucalyptus Poles) and shall bear the SABS/SANS mark of approval.
  - b) The creosote preservative for the poles shall comply with the requirements for type A1 of SANS 592.
  - c) The impregnation of the preservatives shall be carried out in accordance with SANS 10005 using the empty cell vacuum pressure process.
- Sizes** : Wooden poles

<b>Pole length</b>	<b>Pole top</b>	<b>Application</b>	<b>Planting depth</b>
5m	80-99mm	Service connections	1.0m
7m	120-139mm	ABC	1.3m
8m	120-139mm	ABC	1.3m
9m	140-159mm	ABC	1.5m
11m	160-179mm	SWER	1.8m
11m	180-199mm	SWER transformer structures	1.8m
12m	180-199mm	SWER	2m
13m	180-199mm	Special SWER application	2.2m
14m	200-219mm	Special SWER application	2.2m
15m	200-219mm	SWER	2.2m

**Strength** : The group strength of the poles shall be 55Mpa.

**Finish of top end** : The top end shall be square cut single.

**Banding** : Poles shall be loop tension banded at both ends.

**Plant tags** : The poles shall be provided with identification tags bearing:

- (i) the identification mark of the plant at which the pole was treated eg. 5x
- (ii) the year during which the pole was treated eg. '08
- (iii) the class of wood preservative used (see SANS 10005) eg. A1
- (iv) the number of the charge in which the pole was treated eg. 137
- (v) the group strength or maximum fibre stress in bending eg. 55Mpa.

**Drilling of poles** : Templates shall be used for drilling holes required to fix cross-arms, brackets, indicators, etc. to the poles.

### **3.6 Concrete poles**

#### **3.6.1 General**

Concrete poles shall be one of the following types, as specified by the purchaser and approved by the engineer and in accordance with SANS 470:

- (a) Reinforced concrete pole,
- (b) Partially prestressed concrete pole, or
- (c) Prestressed concrete pole

Poles shall be manufactured in accordance with NRS 038

#### **3.6.2 Design**

##### **4.6.2.1 Length, tip and butt dimensions**

The overall length of the pole shall be as specified by the Engineer, and shall be one of the following standard lengths: 4m, 7m, 9m, 10m, 11m, 12m, 15m, 18m, 21m and 24m. The tip and butt dimensions of the 4m up to 11m poles shall be as per the detailed figures in NRS 038.

##### **4.6.2.2 Cover of reinforcement**

The minimum thickness of the overall reinforcement in the case of centrifugally spun poles shall be not less than 15mm over the entire length of the pole. In the case where poles are manufactured by any other process the cover shall not be less than 20mm.

When poles are required for use in aggressive soils the special additional requirements may include one or more of the following:

- Protective coatings;
- Additional concrete cover to reinforcement;
- Replacement of cement with slagment;
- Higher factor of safety (to limit crack widths)

**PART B-04: SWER OVERHEAD CONDUCTOR DISTRIBUTION SYSTEM**

---

4.6.2.3 Finish

The finished product will have a smooth external surface free from honeycombing. All corners shall be clean, straight and rounded to a radius of at least 5mm.

4.6.2.4 Holes

Holes shall be provided in the poles during the manufacturing of the poles. These holes shall be used for the attachment of strain or suspension and other equipment. The holes shall be positioned as specified in the relevant figures detailed in NRS 038. Drawings indicating the specified poles with pole holes shall be furnished to the Engineer for approval **prior** to ordering thereof.

On all transformer poles, the integral earthing facility EW 2900 and EW 8700 shall be replaced with a PVC conduit embedded in the concrete to protect the earth conductor in order to allow for separate earthing of the SWER and LV earth in accordance with SANS 10292. This separate earthing is necessary when the earth resistivity value of the transformer structure is above 1 ohm. On all other SWER poles the earthing ferrules (EW 2200 and EW 8000) shall be provided for earthing of the poles.

4.6.2.5 Pole strength

Pole strengths shall comply to table 1, NRS 038 and SANS 470.

**3.7 Monopole Steel Structures**

3.7.1 Design

All steel structures shall be manufactured in accordance with industry standards and ISO certifications in accordance with SANS 121. Steel structures shall be galvanised in order to protect the structure from corrosion.

3.7.2 Paint and Finishing

Painting and finishing shall be in accordance with BS 2569 and SANS 1091. Where the galvanised coating has been damaged during erection and after all assemblies have been attached to the structure, zinc metal paint in accordance SANS 2569 shall be applied to the areas for protection against corrosion.

## 4 STAY ASSEMBLIES

### 4.1 General

- (a) The position of stays may or may not be indicated on the drawings or in the site instructions to be issued, but it is the responsibility of the Contractor to provide staying adequate to maintain correct tension of the line and the verticality of every pole in the line.
- (b) Struts and fly stays shall only be installed where it is not possible to install a stay.
- (c) Stay wires shall be installed with approved preformed materials.
- (d) The angle between the stay and the poles shall be between 30 and 45 degrees. The stay must be made off on the pole, as near as practical to the point of resultant stress.
- (e) For terminal poles of vertical arrangements (e.g. SWER line on top and LV line below), at least two stays shall be used to prevent deformation of the pole, with the stay plates buried at least 1.8m apart.

### 4.2 Stay wire

#### 4.2.1 General

Stay wires shall comply with SANS 182-5 and shall be manufactured from zinc-coated stranded steel wires. Generally stay wires shall be galvanized steel strand of the type with BS 183 Grade 700. Strength shall be a minimum of 450kPa for both MV and LV line stays. Stay wires and their associated fittings shall be tested in the manner specified for conductors, and the breaking load shall not be less than 95% of the stay wire breaking load. Any deviation from the above required stay wires strand sizes shall be determined in accordance with SANS 185-5.

Thimbles shall be used with guy grips to support wires through the stay rod eye. A combination of guy grips and pole top make offs shall be used as indicated in the drawings.

#### 4.2.2 Stay wire for SWER line

The number and standard diameter of wires shall be 7 /4.00mm or nearest complying with 450kPa. The overall diameter shall be 12.19mm (min.) in accordance with SANS 182-5.

#### 4.2.3 Stay wire for LV line

The number and standard diameter of wires shall be 5 /4.00mm or nearest complying with 450kPa. The overall diameter shall be 10.97mm (min.) in accordance with SANS 182-5.

### 4.3 Stay rod

Stay rods for LV installations shall be 12mm in diameter and 1500mm long, for SWER installations the stay rod shall be 16mm in diameter and 2000mm long. Both SWER and LV stay rods shall be non-adjustable. Stay rod diameters may be reduced as long as compliance to 450kPa is maintained.

Stay rods may not be bent when installed in sandy soil conditions, special permission must be acquired from the Engineer to bend the rods i.e. in hard rock conditions where stay rod holes were drilled. Cold bending of stay rods shall not be acceptable. Coastal or corrosive environments may require sleeving and extra material according required specifications.

#### 4.4 Stay rod base plate

##### 4.4.1 Base plate for SWER line stay rod

Stay rod base plates shall be 350mm x 350mm x 6mm hot dipped galvanized steel. Base plates may be cut round to a diameter 375mm or octagonal to a width of at least 375mm, but shall after being cut still be galvanized to SANS 935 and BS 2569 standards.

##### 4.4.2 Base plate for LV line stay rod

Stay rod base plates shall be 300mm x 300mm x 6mm hot dipped galvanized steel. Base plate may be cut round to a diameter of 300mm or octagonal to a width of at least 300mm, but shall after being cut still be galvanized to SANS 935 and BS 2569 standards.

#### 4.5 Preformed stay fittings

##### 4.5.1 General

All material used for the stay work shall be galvanized. The minimum number and size of stays shall be used with each type of line support. All stays shall be taken down at an angle to the pole of approximately 30-45 degrees consistent with adequate stay tension.

##### 4.5.2 Pole top make off

Pole top make off - galvanized guy grip pole top dead end – double wire guy grip, equivalent to PLP type, complete to SANS standards for pole diameter of 130mm to 200mm.

LV pole top make off shall be approved by the Engineer.

SWER pole top make off shall be approved by the Engineer.

##### 4.5.3 Preformed guy grips

Preformed galvanized steel guy grip with thimble and stay insulator dead ends shall be used.

LV stay guy grips shall be approved by the Engineer in accordance with NRS 053.

SWER stay guy grips shall be approved by the Engineer in accordance with NRS 053.

#### 4.6 Stay insulator

In each SWER stay assembly, a fibreglass guy strain insulator having a minimum W.F.O. of 300kV and 700mm creepage distance shall be fitted. The SWER stay insulator shall be of the 100kN type for 7 /4.00mm stay wire and of the 34kN type for 5 /4.00mm LV stay assemblies, where specified, and shall be in accordance with NRS 022. Fully glazed porcelain strain stay insulator of the 35kN type shall be used for LV installations. Porcelain insulators shall not be installed upside down.

#### 4.7 Stay guards

(a) Because stays are vulnerable to mechanical damage and be a danger to pedestrians and traffic, all stays in the vicinity of public paths and roadways shall be fitted with stay guards.

(b) Where a stay is very exposed to traffic, these guards shall be 2m long (minimum) wooden poles of minimum diameter 120mm, buried to a minimum depth of 1m and

**PART B-04: SWER OVERHEAD CONDUCTOR DISTRIBUTION SYSTEM**

---

protruding at least 1m out of the ground. The exposed part shall be painted yellow road marking paint. Arrangement of stay guards shall be such that the stay is adequately protected.

- (c) On less vulnerable stays, a stay warning pipe will be sufficient. These stay guards should enclose the stay wire from the top of the stay rod  $\pm 2$ m above ground and should have a minimum diameter of 32mm. Stay warning pipes shall be painted a bright yellow colour with black stripes to be easily visible during day or night time. A cable clamp shall be fitted to the stay wire above the warning pipe to prevent any sliding of the pipe along the stay wire. The thread of the cable clamp shall be damaged after installation.
- (d) Where the stay wire passes between low voltage conductors the stay wire must be insulated with a plastic sleeve and clamped at the ends.

**4.8 Other stay accessories**

**4.8.1 Cable clamps**

Galvanized cable clamps suitable for use with a double 9.75mm and 10.97mm diameter stay wire shall be supplied and installed.

**4.8.2 Eye-bolt assembly**

M20 x 250mm eyebolt with 240mm thread, complete with 2 curved washers, 60 x 60 x 2 washers, spring washers and hexagonal nuts. Minimum breaking load shall be greater than 60kN.

**5 EXCAVATION**

**5.1 General**

- (a) Rates for excavation shall include all labour, tools and plant, refilling and compacting, restoration of surfaces, removal or surplus material, bearing in mind the possible need to re-instate existing facilities where these are damaged and hire a registered land surveyor to calculate the position and to replace any surveyed pegs removed in the process of excavation or refilling.
- (b) Rates shall also include, where necessary, timbering and shoring.
- (c) In case where more than one billed rate is applicable to any single excavation, or to a group of such excavations, the quantity or excavation at each separate rate shall be measured and form the basis for payment. The Engineer may, however, in his discretion, determine an intermediate rate based on the average proportion of each applicable rate and may use such intermediate rate for evaluation of the prices of such excavation.
- (d) Tenders shall be based on billed quantities and any variations shall be measured on site during the course of excavation work.
- (e) The contractor shall advise the Engineer before backfilling excavations, to enable the Engineer to determine the applicable rates. Sufficient notice shall be given to the Engineer to enable the Engineer to arrange a visit to site to determine the applicable rates.
- (f) The soil type shall be identified and classified in accordance with the sole discretion of the Engineer.

**5.2 Pole hole excavation**

The poles shall be planted at the following minimum depths:

<b>Pole length</b>	<b>Planting depth</b>
5m	1.0m
7m	1.3m
8m	1.3m
9m	1.5m
10m	1.7m
11m	1.8m
11m	1.8m
12m	2m
13m	2.2m
14m	2.2m
15m	2.2m

Care must be taken to excavate holes such as to let the undisturbed side of the excavation wall take the load.

**5.3 Stay hole excavation**

Stay holes shall be vertical, not less than 1.5m deep and no wider than necessary to accommodate the base plate, with a narrow side channel cut to embed the rod at the correct angle. The base plate and portion of rod within the stay hole shall be firmly packed with hard material, soilcrete or grout in accordance with the design specifications and approval of the Engineer.

**5.4 Compacting of holes**

- (a) The soil used for backfilling the hole after the pole has been planted shall be slightly damped for good compaction purposes.
- (b) When filling up a hole, layers of 300mm soil shall be added at intervals and compacted with a mechanical compactor or with a hand stomper, weighing more or less 25kg.
- (c) Proper compacting of the ground around a pole is essential and may be achieved with a 1:10 cement/sand mixture (soilcrete) for the backfill.

**5.5 Rock Anchors**

Rock anchors shall be utilised in areas of soft and hard rock. Rock anchors shall be 1500mm long by 12mm in diameter at 450kPa. Anchors are installed utilising drilling machinery and high pressure grouting cement.



**6 LINE CONFIGURATION**

**6.1 General**

Only line post insulator structures as per the approved detail NamPower SWER drawings shall be used.

**6.1.1 Galvanizing**

Except where specified to the contrary, all iron and steel used in the construction of the Contract Works shall be galvanized in accordance with SANS 121 after all sawing, shearing, drilling, punching, filling, bedding and machining are completed. Galvanizing shall be applied by the hot process (except the electro-galvanizing shall be permissible for steel wires), and for all parts other than steel wires shall consist of a suitable thickness of zinc coated or not less than  $0.61\text{kg/m}^2$  of surface. The zinc shall be smooth, clean, or uniform thickness and free from defects.

The preparation for galvanizing and the galvanizing itself shall not adversely affect the mechanical properties of the coated material.

**6.1.2 Bolts and nuts**

All metal parts shall be secured by means of bolts and nuts whose minimum diameter shall be 20mm. All bolts, nuts and screw threads shall comply with SABS135 (there is no SANS equivalent) and galvanized in accordance with SANS 121 unless otherwise approved. Bolts and nuts shall be of steel with hexagonal heads. The nuts of all bolts for attaching to the tower plats, brackets or angles supporting insulator sets or droppers to earth conductor clamps shall be locked by approved means.

No screwed threads shall form part of the shearing plane between members.

Unless otherwise approved, all bolts and screwed rods shall be galvanized including the threaded portions; all nuts shall be galvanized with the exception of the threads, which shall be greased.

When in position all bolts or screwed rods shall project through corresponding nuts, but such projection shall not exceed the diameter of the actual bolt.

Where different grades of steel are used, bolts of any given diameter and length shall be the same grade of steel.

**6.2 Vertical HLP configuration**

Vertical HLP configuration shall be installed and erected according to the approved detailed drawings and NamPower specification.

**7 LINE CONDUCTOR**

**7.1 General**

- (a) Stranded aluminium steel reinforced conductor (ACSR), in accordance with SANS 182, SANS 1713 and BS EN 13601, shall be used.
- (b) Cable drums shall always be stored neatly and on cable jacks.
- (c) Conductor running-out blocks shall be installed on all pole positions to run out the conductors. **Conductors shall not be dragged along the ground.** All three conductors shall be tensioned simultaneously using a dynamometer, rated chain-ratchet pullers and “come-alongs” specially designed for the particular conductor.
- (d) Midspan joints shall not be allowed at rail or road crossings.
- (e) Strain structures as well as the appropriate pole lengths shall be utilised in accordance with SANS 10280 at road and railway crossings, in order to meet the required clearance requirements.
- (f) Stringing of conductors shall be according to manufacturers’ specifications and in accordance with NRS 033 and SANS 10280.

**7.2 Conductor size**

The following conductor sizes shall be used as a standard for SWER lines:

<b>Code name</b>	<b>Equivalent Cu area mm<sup>2</sup></b>	<b>Stranding and wire diameter mm</b>	<b>Overall diameter Mm</b>	<b>Aluminium area mm<sup>2</sup></b>	<b>Breaking load kg</b>	<b>Current rating Amps</b>
Magpie	6.65	3/4/2.118	5.03	6.65	1190	69

**7.3 Line joints**

Joints for connecting line conductors shall be types approved by the Engineer and unless otherwise approved, tension joints shall be of the preformed wire type. The electrical conductivity and current carrying capacity of each joint shall not be less than those of the line conductor. Tension joints shall not permit slipping off or cause damage to, or failure of the complete line conductor or any part hereof, at a load less than 95% of the ultimate strength of the line conductor as stated.

**7.4 Minimum electrical clearances (Vertical)**

**(a) In positioning lines and equipment, fixing connections and setting of jumpers, the minimum clearances shall be in accordance with SANS 10280 as shown below.**

Maximum r.m.s phase to phase voltage for which insulation is designed kV	Minimum safety clearance Phase to earth m	Minimum safety clearance Phase to phase m	Above ground outside townships m	Above ground in townships m	Above roads in townships, proclaimed roads outside townships and railways m	To communication lines, other power lines or between power lines and cradles m	To buildings, poles and structures not forming part of power lines m
1.1 or less	-	-	4.9	5.5	6.1	0.6	3.0
7.2	0.15	0.2	5.0	5.5	6.2	0.7	3.0
12	0.20	0.3	5.1	5.5	6.3	0.8	3.0
24	0.32	0.4	5.2	5.5	6.4	0.9	3.0
36	0.43	0.5	5.3	5.5	6.5	1.0	3.0
48	0.54	0.61	5.4	5.5	6.6	1.1	3.0
72	0.77	0.89	5.7	5.7	6.9	1.4	3.2
100	1.00	1.14	5.9	5.9	7.1	1.6	3.4
145	1.45	1.68	6.3	6.3	7.5	2.0	3.8
245	1.85	2.7	6.7	6.7	7.9	2.4	4.2
300	2.35	3.6	7.2	7.2	8.4	2.9	4.7
362	2.90	4.3	7.8	7.8	9.0	3.5	5.3
420	3.20	4.8	8.1	8.1	9.3	3.8	5.6
800	5.50	8.9	10.4	10.4	11.6	6.	8.5

**(b) Where the clearance are likely to vary due to the flexibility of connections or the remoteness of fixed supports, the above mentioned clearances shall be increased to suit the conditions pertaining, allowing for swing due to wind etc.**

**7.5 Minimum electrical clearances (Guidelines for buildings and parallel lines)**

<b>Voltage</b>	<b>Building restriction on each side of centre line</b>	<b>Separation distance between parallel lines</b>
1. All voltages below 22kV	9 meters	12 meters
2. 22kV	9 meters	12 meters
3. 33kV	11 meters	14 meters
4. 44kV	11 meters	14 meters
5. 66kV	11 meters	14 meters
6. 88kV	11 meters	14 meters (15m)
7. 132kV and Delta construction 275kV	18 meters (15.5 -20)	15 meters (21-24)
8. 220kV	23.5 meters (19.5 – 21.0)	32 meters (25m)
9. 275kV (horizontal)	23.5 meters	32 meters
10. 400kV	27.5 meters (Stayed) 23.5 meters (Self-supporting)	55 meters
11. 765kV	40 meters	80 meters

Note: The information above is quoted from the *Rights of Way Manual (Module 15979)* and the information in brackets, where the two are different and inconsistent, is quoted from the *Land Survey Manual*.

**7.6 Power line and communication line crossings**

Power lines shall cross communication lines as nearly as possible to right angles. Where this is impractical, the following deviations from right – angle crossings are permitted in accordance with SANS 10280.

1	2
Voltage of route	Permissible deviation from right angle
Below 48 kV	45°
48 kV and above	30°

## 8 INSULATORS

### 8.1 General

#### 8.1.1 Types of insulators

Long rod, Class A insulators shall be used at all cross arms for medium voltage strain, terminal and pole mounted transformer structures. The cycloaliphatic long rod or porcelain insulator shall be puncture proof and of the type as specified in design Detail Specifications as approved by the Engineer. The end fitted attachment shall be of the aluminium alloy clevis and tongue twisted type. The insulator shed material shall have a high resistance to tracking by surface leakage currents and operate normally under adverse weather conditions. All insulators shall conform to the standards referenced in section 1.

Line post type insulators shall be installed on straight line structures and the insulating material shall be a cycloaliphatic resin or porcelain complete with 20mm spindle including nuts and washers. Line post insulators shall furthermore be of the capless, solid-core type, be puncture proof, radio interference free and shall display superior performance in polluted environments. They shall have a basic insulation level of either 135kV or 150kV as specified in the Detail Specification in accordance with standards and the approval of the Engineer. All standards referenced in section 1 shall be adhered to.

Glass type insulators shall where possible not be used due to vandalism. However glass insulators can be used if the Supply Authority feels it necessary and is in accordance with the standards listed in section 1. Glass insulators are permitted in coastal regions up to 40 km in land from the coastal region, due to corrosion and heavy pollution.

#### 8.1.2 Electrical design

Insulators together with their fittings shall comply with SANS 60305, SANS 60383, BS EN 60305, BS 3288 and IEC 1109 and shall offer a high resistance to damage, caused by malicious vandalism. Insulator material shall be cycloaliphatic resin. As an alternative high grade porcelain insulators shall be used. The flashover and puncture voltages shall not be less than the values stated in the table below. Insulator flashover voltage, wet and dry, shall be less than the puncture voltage.

Shackle insulators shall be used on all low voltage overhead conductors. The shackle insulators suitable for mounting to the pole with a D-bracket shall be of the type specified in the Project Detail Specification in accordance with the Engineer.

#### 8.1.3 Mechanical design

The strength of the insulator shall be such that at the maximum working load of 4kN for line post insulators and 70kN for strain insulators shall be afforded.

#### 8.1.4 Clamps and conductor fittings

Tension conductor clamps shall be of types approved by the Engineer and shall be as light as possible, and shall be designed to avoid any possibility of deforming the stranded conductor and separating the individual strands.

All fittings shall comply with the stranded coupling dimensions specified in the standards listed in section 1.

Intermediate pole conductor binding shall be carried out by means of wrap lock ties complete with neoprene cover.

Tension fittings shall be the preformed wire type, specially designed for the ACSR conductor used together with suitable fittings for securing the tension insulators.

Tension insulator sets and fittings shall be approved by the Engineer to give the minimum required clearances between the jumper conductor and the rim of the live end insulator units.

Adequate bearing area between fittings shall be provided and 'point' or 'line' contacts shall be avoided. All split pins for securing the attachment of fittings of insulator sets shall be of stainless steel type material and shall be backed by washers. D-shackles between insulator and eye shall be installed at all strain positions in accordance with SANS 10280.

## **8.2 Strain insulators**

Strain insulators of the clevis tongue type are required for strain and terminal poles. The insulators shall be cycloaliphatic resin, or high grade porcelain material as specified. Strain insulators shall be complete with galvanized clevis pin (to SANS 121) c/w washer and stainless steel split pin (304 s/steel), for preformed dead end.

Strain insulators shall be installed and connected to cross-arms and A-frames, with D-shackles, clevis thimble and preformed dead end for conductor as per design specifications.

	<u>33kV</u>
Nominal voltage	33kV
Impulse withstand (minimum)	150kV
Mechanical strength (minimum)	70kN

### **8.2.1 Porcelain disc insulator**

High grade porcelain, 70kN mechanical strength. Nominal voltage – 33kV as specified and approved by the Engineer.

### **8.2.2 Long rod insulator**

Cycloaliphatic long rod, min. failing load 70kN, with clevis tongue twisted arrangement with corrosion resistant end caps, complete with galvanized clevis pin (to SANS 121) complete with washer and stainless steel split pin (304 s/steel), preformed dead end type for conductor size as specified – nominal voltage of 33kV as specified.

## **8.3 Intermediate insulators**

Line post insulators are required for the intermediate poles complete with 254mm spindles, curved "VC 37" and "PLP ED208" washer, spring washer and double nuts.

Side ties for Magpie conductor "Orange" shall be used to secure conductor to post insulator.

### **8.3.1 Porcelain line post insulator**

High grade porcelain, for 33kV, 4kN lateral mechanical strength. Complete installed with line ties for specified conductor.

### **8.3.2 Cycloaliphatic line post insulator**

For eyebolt mounting cycloaliphatic line post insulator – cantilever failing load 4kN, for M20 spindle – for 33kV as specified.

**All insulators and equipment shall conform to the requirements stipulated in the standards referenced for insulators in section 1.**

**9 LINE FITTINGS**

**9.1 Preformed binding ties**

The binding ties shall be preformed wrap lock or side ties with pad for Magpie, for the specified line post insulators, as required and detailed in the design specifications and approved by the Engineer.

**9.2 Preformed dead ends**

The preformed dead ends shall be suitable for Magpie conductor and approved by the engineer in accordance with the design specifications.

**9.3 Thimble Clevis**

Complete with stainless steel split pin (Grade 403), and galvanized pin and washer. The thimble clevis shall be Suitable for specified conductor and approved by the Engineer in accordance with the design specifications.

**9.4 Parallel groove clamps**

The parallel groove clamps shall be suitable for making electrical connections to aluminium or copper conductors providing a current carrying capacity suitable for conductor size. A three bolt PG clamp is required. Bi-metallic PG clamps shall be used when copper to aluminium connections are made. All equipment and clamping shall be subject to the Engineer's approval in accordance with design specifications.

**9.5 Vibration dampers**

Vibration dampers of the helical type with damping length of 990mm and total length of 1250mm shall be installed 100mm from each dead end.