PART B-05

TITLE: UNDERGROUND CABLE DISTRIBUTION UP TO AND INCLUDING 33kV

SPECIFICTION NO: B-05

INCEPTION DATE: AFTER GAZETTING (WORKING DOCUMENT FOR A 3 YEAR PERIOD)

AMENDMENTS / REVISIONS

DATE	PAGE	PARAGRAPH	DESCRIPTION	ORIGINATOR	APPROVED

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1. SCOPE

This part of the specification deals with the material requirements, installation, testing and commissioning of medium and low voltage underground cables in accordance with the following standards listed below:

GENERAL INFORMATION

The following Standards and Acts shall take precedence:

- National Electricity 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

UNDERGROUND DISTRIBUTION CABLES

Regional Standards

NRS 013 : Medium voltage cables

NRS 074 : Low voltage (600/1000 V) cable systems for underground electrical distribution

SANS 1411-1 : Materials of insulated electric cable and flexible cords Part 1: Conductors

SANS 1411-2 : Materials of insulated electric cable and flexible cords Part 2: Polyvinyl Chloride (PVC)

SANS 1411-3 : Materials of insulated electric cable and flexible cords Part 3: Elastomers

SANS 1411-4 : Materials of insulated electric cable and flexible cords Part 4: Cross-linked Polyethylene (XLPE)

SANS 1411-5 : Materials of insulated electric cable and flexible cords Part 5: Halogen free, flame retardant materials

SANS 1411-6 : Materials of insulated electric cable and flexible cords Part 6: Armour

SANS 1411-7 : Materials of insulated electric cable and flexible cords Part 7: Polyethylene (PE)

SANS 1507 : Electric cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3300V)

SANS 1507-1 : Electric cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3300V) Part 1: General

SANS 1507-2 : Electric cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3300V) Part 2: Wiring cables

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SANS 1507-5 : Electric cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3300V) Part 5: Halogen-free distribution cables

SANS 1507-6 : Electric cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3300V) Part 6: Service Cables

SANS 10198-1 : The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 1: Definitions and statutory requirements

SANS 10198-2 : The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 2: Choice of cable type and methods of installation

SANS 10198-3 : The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 3: Earthing systems – general provisions

SANS 10198-4 : The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 4: Current ratings

SANS 10198-5 : The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 5: Determination of thermal and electrical resistivity of soil

SANS 10198-6 : The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 6: Transportation and storage

SANS 10198-7 : The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 7: Safety Precautions

SANS 10198-8 : The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 8: Cable laying and installation

SANS 10198-9 : The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 9: jointing and termination of extruded solid dielectric insulated cables up to 3.3kV

SANS 10198-10: The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 10: Jointing and termination of paper-insulated

SANS 10198-11: The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 11: Jointing and termination screened polymeric insulated cables

SANS 10198-12: The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 12: Installation of earthing system

SANS 10198-13: The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 13: Testing, commissioning and fault location

SANS 10198-14: The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 14: Installation of aerial bundled conductor (ABC)

SANS 97 : Electric Cables- Impregnated paper insulated metal sheathed cables for rated voltages 3.3/3.3kV to 19/33kV (Excluding pressure assisted cables)

SANS 1339 : Electric cables- Cross linked polyethylene (XLPE) insulated cables for rated voltages 3.8/6.6kV to 19/33kV

International Standards

BS 6004 : Electric cables. PVC insulated, non-armoured cables for voltages up to and including 450/750 V, for electric power, lighting and internal wiring

IEC 60189 : Low Frequency Cables and wires with PVC Sheeth

IEC 60055 : Paper Insulated Metal-Sheathed Cables for Rated Voltages up to 36kV

IEC 60183 : Guide to the selection of high voltage cables

IEC 60227 : Polyvinyl chloride insulated cables of rated voltages up to and including 1kV

IEC 60228 : Conductors of insulated cables

IEC 60502 : Power cables with extrudedinsulation and their accessories for rated voltages from 1kV up to and including 36kV

2. UNDERGROUND CABLE AND CABLE ACCESSORIES FOR MEDIUM VOLTAGES UP TO AND INCLUDING 33KV.

2.1 XLPE Distribution Cables

The cable shall be of the cross linked polyethylene (XLPE) insulated type in conformity with SANS 1339, SANS 1507-4 and NRS 013

Conductor size	As required for Design Specifications and in accordance with SANS 10198-2, and SANS 10198-4
Conductor material	Stranded copper or aluminium
Insulation	XLPE in accordance with SANS 1411-4
Number of cores	3
Operating voltage	up to 33 kV depending on design specifications
Type	A or B (individually screened)
Construction	Conductor, extruded semi-conductive conductor screen, XLPE insulation, extruded semi-conductive core screen, core identification, individual core copper tape earth screen. The three cores laid up with fillers, binder tape and covered with a non-permeable PVC sheath

2.2 PVC Distribution Cables

The cable shall be of the Polyvinyl Chloride (PVC) insulated type in conformity with NRS 013 and SANS1507-3.

Conductor size	As required for Design Specifications and in accordance with SANS 10198-2, and SANS 10198-4
Conductor material	Stranded copper or aluminium
Insulation	PVC in accordance with SANS 1411-2
Number of cores	3
Operating voltage	up to 3.3 kV depending on design specifications
Type	A or B (individually screened)
Construction	copper conductor insulated with compounds of polymers or of co-polymers of vinyl chloride (PVC)

2.3 PILC Distribution Cables

The cable shall be of the Paper Insulated Lead Sheathed Cable (PILC) type in conformity with NRS 013 and SANS 97.

The following cables are covered by this standard:

Fully impregnated, general purpose, single core cables of rated voltages 3,8/6,6kV , 6.35/11kV, 12,7/22kV and 19/33kV;

Fully impregnated, heavy duty, or drained general purpose, single core cables of rated voltages 3,8/6,6kV and 6.35/11kV;

Fully impregnated, general purpose, three core belted cables of rated voltages 3,8/6,6kV , 6,6/6,6kV, 6,35/11kV and 11/11kV;

Fully impregnated, general purpose, three core screened cables of rated voltages 6,35/11kV , 12,7/22kV and 19/33kV;

Fully impregnated, heavy duty, or drained general purpose, three core belted cables of rated voltages 3,3/3,3kV, 3,8/6,6kV 6,6/6,6kV, 6,35/11kV and 11/11kV;

Fully impregnated, heavy duty, or drained general purpose, three core screened cables of rated voltages 6,35/11kV .

Conductor size	As required for Design Specifications and in accordance with SANS 10198-2, and SANS 10198-4
Conductor material	Copper or Aluminium and Lead Sheaths
Insulation	Paper in accordance with SANS 97
Number of cores	3
Operating voltage	up to 33 kV depending on design specifications
Type	A or B (individually screened)
Construction	Single core or three core impregnated paper insulated metal sheathed cables.

2.4 Cable Accessories (3.3, 6.6, 11, 22, 33kV)

The cable accessories shall be designed to ensure satisfactory operation under the site conditions specified and under normal and fault conditions. All current carrying connectors and insulating materials shall be of ample section and surface area and shall have been tested for carrying the currents and for providing the insulation corresponding to the cable size specified. Reference shall be made to SANS 10198-5 when determining thermal and electrical resistivity of soil. Cable laying accessories shall conform to SANS 10198-8.

2.5 Cable Joints (3.3, 6.6, 11, 22, 33kV)

Cable through joints shall be of the heat shrink type approved by the Engineer as per item 3.4 below, for XLPE type cables. Through joints shall be suitable for jointing the cable specified supplied with sleeve, all insulating, electrical field stress relieving and jointing materials, conductor jointing sleeves (ferrules) and instructions. Approved joints as per item 3.4 below shall be used. Each kit shall be packed in a separate box containing all materials required to make a complete installation. The following standards are to be adhered to:

SANS 10198-10 : Jointing and termination of paper insulated cables.
SANS 10198-11 : Jointing and termination of screened polymeric insulated cables.

2.6 Cable Terminations (3.3, 6.6, 11, 22, 33kV)

The cable terminations shall be terminated using heat shrink type approved cables by the engineer in accordance with NRS 013. Terminations shall be suitable for terminating the cable at terminals on switchgear and transformers positioned outdoor and indoor, and on overhead lines. The terminations shall be supplied in kit form complete with gland. All stress relieving field guide and insulating materials as well as boots and sleeves for obtaining a complete installation.

The following standards shall be adhered to:

SANS 10198-10 : Jointing and termination of paper insulated cables.
SANS 10198-11 : Jointing and termination of screened polymeric insulated cables.

3. UNDERGROUND CABLE AND CABLE ACCESSORIES FOR LOW VOLTAGES UP TO AND INCLUDING 400V.

3.1 Armoured 4-core LV cables

Cables shall be manufactured in accordance with SANS 1507 and shall be constructed as follows:

(a) Armoured cables: PVC-insulated/PVC-bedded/steel wire armoured/black extruded PVC onto sheath (PVC/PVC/SWA/PVC).

(b) The PVC insulation and covering shall be ultra violet stabilized and manufactured to SANS 1411 Part 2.

(c) The insulation shall be general purpose PVC, 600/1000V grade.

(d) The bedding shall consist of a continuous impermeable sheath of PVC extruded to fit the core or cores closely and in the case of multi-core cables, to fill the interstices between cores.

(e) Armouring shall consist of one layer of galvanized steel wire in the case of multi-core cables and shall conform to SANS 1411 Part 6.

3.2 Single core LV cables/conductors

Single core cables and conductors shall be manufactured in accordance with SANS 1507, and shall be constructed as follows:

(a) PVC insulated/unsheathed in accordance with SANS 1411 Part 2.

(b) The PVC insulation shall be ultra violet stabilized and manufactured to SANS 1411 Part 2.

(c) The conductor shall be of high conductivity annealed stranded copper.

(d) The insulation shall be general purpose PVC, 600/1000 V grade.

3.3 Bare stranded copper conductor

(a) Bare stranded copper conductors shall be used as earth continuity conductors.

(b) The conductors shall be of hard drawn stranded copper compliant to SANS 182.

(c) The bare stranded copper conductors shall be supplied and delivered in rolled lengths.

3.4 LV cable joints and terminations

Joints in underground cables, and terminations, shall be made by means of approved epoxy-resin pressure type jointing kits or products equally approved by the Engineer. Joints must be made by competent cable jointers and entirely in accordance with the manufacturer's instructions using only the materials stipulated in such instructions. Each end of the cables to

be jointed must have a minimum of 1000mm of slack disposed in a loop without stress. Backfilling under joints must be firmly tamped to prevent any subsequent settling.

LV cables shall be made off with sealing glands and materials specially designed for this purpose in compliance with SANS 10198-9.

3.5 LV cables and conductor accessories

3.5.1 Cable glands for armoured cable

(a) Glands to be used for terminating PVC/PVC/SWA/PVC cables shall be of the adjustable type.

(b) Glands shall be suitable for general purpose 600/1000V grade 4-core cable with steel armouring.

(c) The glands shall be made of nickel-plated bronze.

(d) The glands shall consist of a barrel carrying a cone bush screwed into one end and a nickel-plated brass nipple carrying a nickel-plated brass or a heavy galvanized steel locknut screwed into the other end. The galvanizing shall comply with SANS 121.

(e) Non-watertight glands must be easily converted to watertight glands by means of a waterproofing shroud and inner seal kit. On the cable entry side of the barrel a concave groove shall be provided to accommodate the top rim of the waterproofing shroud.

(f) The shrouds shall be made of non-deteriorating neoprene or other synthetic rubber, and shall be resistant to water, oil and sunlight. The shrouds shall fit tightly around the glands and cable.

(g) Glands shall be provided with ISO threads and shall be suitable for the specified cable sizes.

(h) Glands shall be brands approved by the engineer in accordance with SANS 1213.

(i) Each gland shall be supplied with a shroud and water-proofing kit.

3.5.2 Cable termination lugs

Termination lugs shall be tinned copper brand for copper conductors, approved by the engineer. All cable lugs and ferrules shall comply with NRS 028 and IEC 61238.

3.5.3 Cable hoods

(a) Cable hoods for the protection of the cable terminations at tap-offs from the overhead ABC conductors to an underground cable shall be used (from 35mm² up to 50mm² x 4-core cable, for cable sizes above 50mm² cable boots shall be used.)

The tenderer must include specifications of the cable hood offered.

(b) The cable hood shall be suitable for mounting onto a wood pole.

4. HANDLING AND LAYING OF UNDERGROUND CABLES UP TO AND INCLUDING 33KV.

4.1 General

Cable work shall be done in accordance with SANS 10198 and to the satisfaction of the Client and the Engineer. The storage, transportation, handling and laying of underground cables shall conform to SANS 10198 and to BS 6004, and the Contractor shall have adequate and suitable equipment (SANS 10142) and labour to ensure that no damage is done to cables during such operations. Twisted or kinked cables, or cables damaged in any other way, will be rejected.

4.2 Cable routes and positioning

The contractor shall follow the routes indicated on the specification drawings as accurately as possible. Deviations from the routes laid down shall not be made without the engineer's approval.

The final position of cable relative to kerbs, boundaries, and other services shall, where necessary, be indicated to the contractor by the engineer on site and shall be strictly adhered to.

The cable route drawings issued with the inquiry documents are for tender purposes only and the routes may be amended before work on any particular section of the route commences.

In general, where obstacles not provided for in the specification drawings are encountered, cables shall circumvent such obstacles by being laid in as smooth a path as possible around the obstacles and by retaining maximum separation between cables.

Laying depths of cables specified are to final levels of the streets and sidewalks. All levels shall be obtained by the contractor from the Local Authority.

4.3 Handling and laying of cables

The contractor must satisfy himself that the levels of the trenches excavated are suitable and are wide enough to enable him to carry out the work in accordance with SANS 10198-8. The contractor shall be responsible to draw in, lay, thread through pipes, circumvent obstacles, fix in position clamp and saddle where required to walls, poles or switch gear all cables set out in the contract.

Best accepted practice is to be adopted in the handling and laying of cables and the work shall be carried out by persons experienced in the class of work. In particular, attention is drawn to the following:

(1) Cable drums shall not be dropped off transport vehicles but shall be hoisted off with approved equipment.

(2) Cable shall be rolled off drums in the indicated direction, the drums being supported on approved equipment.

(3) When cables are laid out, it shall be supported at points at such a distance apart that the cable is not dragged along the ground and that it is not kinked.

(4) Cables shall be drawn into position or laid, using a sufficient number of rollers and suitable equipment, for negotiating corners to avoid excess bending or damage to the cable.

(5) Cables shall be drawn through cable pipe sleeves so as to ensure minimum damage to cables. Approved equipment, including suitable cable harnesses, shall be used.

(6) Cables shall not be bent in any event to radii smaller than 15 times the overall diameter of the cable.

(7) Cables shall be rolled off drums in the same direction, to prevent corresponding phase cores being crossed at joints.

4.4 Trenching

11kV cables shall generally be laid at a minimum depth of 1000mm below ground level. Main LV feeder cables, unless otherwise instructed, shall be laid at a minimum depth of 800mm below ground level.

Trenches shall not be less than 300mm wide for single and multiple LV service connection cables, and the trench width shall be increased where more than two LV feeder or service connection cables are laid together so that the cables may be placed at least 150mm apart throughout the run.

Streetlight cables buried in trenches under un-tarred roads shall be buried in a trench with minimum depth of 600mm and 300mm wide. Trenches under tarred roads shall be buried a minimum of 500mm deep, and normally in HDPE corrugated sleeving of applicable size, quantity and required spare quantities.

Where the nature of the ground does not permit the excavation of the cable trenches to the specified depth, the engineer may authorize trenches not less than 500mm deep. Such authority shall be given in writing.

The Contractor must take all the necessary precautions to prevent trenching work being in any way a hazard to the public, and to safeguard all structures, roads, railways, sewer works or other property from any risk of subsidence and damage.

Soil type shall be graded by the engineer. The engineer’s decision shall be final.

The following table represents the minimum standards to be applied in respect of 11, 22 and 33kV, 400V feeder, 400V Street light and 230V service connection cables.

TRENCH DETAIL FOR CABLE SETUP NEEDED	TRENCH DEPTH	TRENCH WIDTH	Width between 11,22,33kV Cable	Width between 400V Cable
Single 11,22,33kV	1000mm	450mm	n/a	n/a
2 Parallel 11,22,33kV	1000mm	800mm	600mm	n/a
3 Parallel 11,22,33kV	1000mm	1400mm	600mm	n/a
Single 400V Feeder	800mm	450mm	n/a	n/a
2 parallel 400V Feeder	800mm	450mm	n/a	150mm
3 parallel 400V Feeder	800mm	600mm	n/a	150mm
Single/multiple service connections	600mm	300mm	n/a	None
Streetlight– Un-tarred	600mm	300mm	n/a	None
Streetlight– Tarred	500mm	300mm	n/a	None
Combination of Multiple Cables	800mm	1200mm	500mm	150mm
Combination of single cables	800mm	700mm	n/a	150mm

4.4.1 Excavation of joint chambers

Jointing pits shall be excavated to a depth of 1.2m and shall be rectangular in shape and large enough for the cable jointer to work comfortably and in an efficient manner. The minimum size of a joint pit shall be 2.5m long x 1.5m wide, the pit shall be 3m x 2m for two joints. The cost to excavate joint chambers shall be allowed for in the trenching rate as part of the Bill of Quantities and shall be based on a quantity to be same as the measured through joints.

4.5 Bedding

All cables shall be laid in a bedding of soft sand or sifted soil, 50mm below and 150mm above the cable. Clay soil will not be accepted as bedding.

4.6 Laying

Cable shall be removed from the drum in such a way that no twisting, tension or mechanical damage is caused, and must be adequately supported at short intervals during the whole operation. Particular care must be exercised where it is necessary to draw cables through pipes and ducts, to avoid abrasion, elongation or distortion of any kind. The ends of such pipes and ducts shall be sealed to approval after the drawing in of the cables.

4.7 Backfilling

Backfilling after bedding is to be carried out with a proper grading of the material to ensure settling without voids, and the material is to be tamped down after the addition of every 150mm. The surface is to be made good as required.

4.8 Protection of cables

(a) Danger tape to specification shall be placed 400mm above all MV and main feeder cables along the entire length of the trench. Where so directed by the Engineer, a concrete layer shall be placed over the bedding layer in order to give the cable additional protection.

(b) At road crossings, cable sleeves shall be installed at a minimum depth of 1000mm, and as instructed by the Engineer.

(c) The danger tape shall be 150mm wide yellow plastic with lightning flash printed onto the tape at intervals.

(d) The tape shall comply with SANS 1091.

4.9 Road Crossings

Cable sleeves for road crossings shall not be installed less than 1000mm below the final street level. Unless otherwise specified two additional sleeves all of the same size shall be installed for future use at each road crossing. Galvanized steel draw wire, 2.0mm in diameter shall be installed in all sleeves and shall protrude 1500mm on each side of the sleeve.

On completion of the installation of sleeves all ends shall be sealed to prevent the ingress of dirt and moisture, after installation of the cables the sleeves shall be resealed.

After installation of the sleeves the trench shall be backfilled and tamped down in layers of 50mm to achieve a density of 95% modified AASHTO.

Sleeve end positions shall be marked with an approved cable marker, a letter “E” shall be cut on either side of the road on the kerbstones where these are in existence.

4.10 Opening up of existing cables

Where it is necessary to expose existing buried cables for any purpose, or when excavating in the vicinity of existing buried cables, pipes, etc., every care is to be exercised and only labourers experienced in such work, and duly warned by the Contractor, shall be employed thereon. The Contractor shall be responsible for making good any damage caused by his work.

4.11 Sleeves/cable ducts

(a) uPVC Class 6 pipes shall be used as sleeves/cable ducts, for example under roads.

(b) The pipe shall be supplied in 6m lengths.

(c) One end of each pipe and bend shall be fluted to form a female coupling so that pipes can be easily joined.

(d) One spare sleeve per cable duct is to be installed and plugged with PVC sheeting.

4.12 Capacity of cable conduits (sleeves)

Where cables are to be drawn into sleeve pipes separate cable conduit runs are to be provided for each main distribution cable. The maximum number of cable to be accommodated in a single cable conduit shall be 3 plus the trench earth i.e. 3 service cables or main cable plus street lighting and/or service cable.

4.13 Kick pipes

(a) HDPE Class 6 pipes shall be used as kick pipes for distribution cables on poles. Suitable diameter pipes shall be supplied in 3m lengths.

(b) 20mm x 0.72mm stainless steel bandit strapping shall be used for fixing of kick pipes against poles.

(c) Galvanized steel saddles shall be used for fixing of cables against poles.

4.14 Trench earth wires

Bare copper earth wire is to be run with all underground cables constituting part of a low voltage distribution system. The BCEW shall have a cross sectional area equal to at least half that of one phase conductor of the cable, but shall not be less than 10mm². A single earth conductor shall be used as earth continuity conductor for two or more cables run together, branch earth wires being brazed on where required. The earth continuity conductor is to be bonded to the cable armouring at each termination of the cable, as well as to local earth bars.

At road crossings, cable sleeves shall be installed at a minimum depth of 1000mm, and as instructed by the Engineer.

Coastal or corrosive environments may require stainless steel rod together with multiple point earthing distribution points. Contractors should contact the supply authority in coastal areas or corrosive areas in order to enquire about the earthing requirements.

4.15 Sealing of ends

Where cables are cut and not immediately made off, the ends are to be sealed without delay.

4.16 Cable markers

Cable route markers of approved manufacture shall be provided at each end of an underground cable route and at all points where such routes deviate from a straight line.

Joints in the cable shall be marked and the maximum distance between route markers shall not exceed 100m.

The cable markers shall be tapered blocks cast from concrete in accordance with approved detail drawings

Each cable marker shall be buried with its upper face 100mm above the natural ground level.

Marking of cable markers shall also be in accordance with approved detail drawings.

5. INSTALLATION OF EARTHING SYSTEMS FOR UNDERGROUND CABLES.

Refer to SANS 10198-7 for earthing requirements regarding the following cable components:

- Metal Sheaths – Multi Core Cables
- Metal Sheaths – Single Core Cables
- Metal Screens
- Armour
- Cross Bonding

Refer to SANS 10198-7 for requirements regarding Protective Multiple Earthing Cables as well as Combined / Neutral Cables.