

**JOHANNESBURG WATER (SOC) Ltd.**  
**BULK WASTEWATER**

**PARTICULAR SPECIFICATION**  
**E06 : ELECTRICAL MEDIUM AND LOW**  
**VOLTAGE CABLE INSTALLATION**



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## DOCUMENT CONTROL SHEET

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**PARTICULAR SPECIFICATION: VOLUME E06: ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE  
INSTALLATION**

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## **E06.1 SCOPE**

This section covers the installation of cables for the distribution of electrical power to be installed in soil trenches, electrical cable ducts, buildings and structures for system voltages up to 11 kV at 50 Hz.

### **E06.1.1 Statutory Documents and Standards**

The installation will be conducted in accordance with the requirements of the following standards. Where any document or standard is referenced, it shall be deemed the latest version of that document.

- |                                      |   |                                                                                                             |
|--------------------------------------|---|-------------------------------------------------------------------------------------------------------------|
| (a) SANS 10198                       | : | The selection, handling and installation of electric power cables of rating not exceeding 33 kV             |
| (b) SANS 1507                        | : | Electrical cables with extruded solid dielectric insulation for fixed installations                         |
| (c) SANS 10142-1                     | : | The wiring of premises Part 1 – Low Voltage installations                                                   |
| (d) SANS 1213                        | : | Mechanical Cable Glands                                                                                     |
| (e) DIN EN 50655-2<br>VDE 0278-655-2 | : | Fingerprinting for heat shrinkable components for low and medium voltage applications up to 20,8/36 (42) kV |

### **E06.1.2 Particular Specifications to be read in conjunction with this specifications**

This specification shall be read in conjunction with the following specifications:-

- |         |   |                                                                  |
|---------|---|------------------------------------------------------------------|
| (a) E02 | : | ELECTRICAL CABLE RACKS                                           |
| (b) E03 | : | ISOLATOR PUSHBUTTON STATIONS                                     |
| (c) E04 | : | MOTOR CONTROL CENTRES                                            |
| (d) E05 | : | ELECTRICAL LOW VOLTAGE POWER AND CONTROL CABLES                  |
| (e) E07 | : | ELECTRICAL INDUSTRIAL WELDING PLUGS, COUPLERS AND SOCKET OUTLETS |
| (f) E08 | : | WIRING                                                           |
| (g) E12 | : | ELECTRICAL MEDIUM VOLTAGE CABLES                                 |

## **E06.2 GENERAL**

### **E06.2.1 Cable theft prevention**

Consideration must be given at design stage for the risk posed by cable theft. The routing of cables on site must be so that there is minimum risk of cable theft. This can be effected by avoiding use of bare earth copper cables, burying cables where possible, covering with secured covers, using a concrete paving over a cable route and any other approaches that will reduce probability of cable theft. As each site has different exposure to the risk of cable thefts, the user plant personnel must be involved in a risk assessment exercise to determine measures that may be applied on a site-by-site basis.

Cable runs outside of buildings must be buried. Where cables need to cross, rise onto structures, enter buildings or link structures, cable ladders may be used. In such cases, cable racks must be covered to prevent access. The cover may be bolted, welded in such a way that it is secure and may not be easily removed by simple tools.

### **E06.2.2 Competence of Personnel**

Contractor supervisors overseeing work on or the installation of MV equipment and cables on site

will be authorised under the Operating Regulations for High Voltage Systems (ORHVS). A valid authorisation certificate will be submitted with each tender. All contractor personnel working on medium voltage equipment shall work under the direct supervision of the authorised supervisor.

Cables, cable joints, cable terminations and cable accessories shall be installed in accordance with the manufacturer's installation instructions by competent personnel. The Contractor shall only employ personnel fully conversant with the cable manufacturer's recommendations to lay, joint and terminate cables.

### **E06.3 CABLE INSTALLATION ON CABLE RACKS AND STRUCTURES**

#### **E06.3.1 Installation of Cables**

Cables may be installed in one of the following ways:

- (a) On horizontal or vertical cable ladders;
- (b) Against horizontal or vertical metal supports or brackets;
- (c) Fixed to structures.

#### **E06.3.2 Installation of Cable Ladders**

Cable ladders shall be installed:

- (a) Within Motor Control Centre stations,
- (b) On access platforms to the mechanical equipment;
- (c) In accessible cable duct.

Cable ladders shall be supported with struts, channels, brackets, clamps, cantilever arms ext. The corrosion protection of the support elements shall be of the same system as that of the cable ladder. Nuts/bolts/washers shall be used as fasteners. Unless otherwise agreed, all screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be stainless steel 316.

On access platforms, the cable ladder will be installed at minimum of 150 mm from the supporting concrete structure. Crevice corrosion of the metal elements in contact with concrete surface shall be eliminated by means of a suitable layer of non-shrink grouting.

In accessible cable duct, cable ladder shall be supported by a 50mm high strut section securely fixed to the wall. The corrosion protection of the strut shall be of the same system as that of the cable ladder

To minimise cable theft, long cable runs on cable ladders should be avoided. For high risk areas where cable racking is used or, such cable racks must be covered with solid covers of the same material and complying with the same paint specification as the racking itself. Such covers must be bolted onto the rack in such a way that either special tools or a disk grinder would be required to remove these covers. If any additional methods to prevent cable theft are required, such requirements will be made clear to the contractor at the time of tender. This will also apply to all areas where cables are exposed or where cables are visible to by passers.

Before any cables are laid, the Engineer or his representative will inspect all cable racks.

#### **E06.3.3 Installation of Cable Supports**

Cable supports must be 3CR12-grade stainless steel, 304-grade stainless steel or 316-grade stainless steel and electric orange powder coated as for the cable racks. The size of angle iron supports must be such that no part of a cable projects beyond the support.

#### **E06.3.4 Grouping and Spacing of Cables**

Wherever possible cable racks must be mounted in the vertical plane to avoid accumulation of dirt and debris. Only single layers of cable will be allowed on a rack, to reduce de-rating and for ease of replacement and/or repairs. No more than two cables may be run on a single angle profile (3CR12) support.

Cables with a cross-sectional area of more than 16 mm<sup>2</sup> shall, be spaced two outside cable

diameters apart, for which no grouping correction factor need be applied.

Where parallel cable runs are installed at different levels (e.g. on parallel cable trays), and where the spacing of the layers is not specified, a minimum spacing of 300 mm shall be maintained.

Medium voltage cables shall be separated from other cables and services throughout the installation, and shall be installed in separate floor trenches, pipes or metal channels as far as possible. Where this is not feasible, a minimum spacing of 500 mm shall be maintained.

Cables for telephone, communication and alarm systems and all other low voltage systems (less than 50 V), shall be separated from power cables. In building ducts, a physical barrier shall be provided between power cables and cables for other services. Where armoured cables are used for such other services, they shall be at least 500mm away from power cables or shall be installed on separate cable trays. In the case where unarmoured cables are used for these other services, they shall be installed in separate metal channels or conduits.

#### E06.3.5 Fixing of Cables on Cable Racks and Supports

UV stabilised PVC straps may be used for cables up to 4core x 25mm<sup>2</sup>. For cables of larger diameter than this (i.e. 30mm diameter and larger), stainless steel strapping must be used. All cables must be individually strapped.

#### E06.3.6 Spacing of Cable Supports

The most generally known method of supporting cables is the restrained installation where the distance between supports is small enough to prevent any noticeable sag in the cable.

The maximum spacing between cleats (clamps) to which cables are fixed in horizontal and vertical cable routes shall be determined from Table 1 below. Additional cleats shall be installed at each bend or offset in the cable run. The maximum distance between supports or cleats for multi-core control cables shall be 20 times the outside diameter of the cable with a maximum spacing of 500 mm for unarmoured cables and 30 times the outside diameter of the cable with a maximum spacing of 1 m for armoured cables. A minimum of 20 mm ventilation clearance shall be maintained between cables and the wall to which they are cleated. Spacing of supports for cables for high voltage lighting shall be in accordance with Table 8 of SANS 10142.

**Table 1: Maximum Spacing of Supports (Cleats) (mm)**

FOR RESTRAINED CABLE				
Cross-sectional area of Cable conductors (mm <sup>2</sup> )	Wire Armoured Cables		Other than Wire Armoured Cables and Unarmoured Cables	
	Horizontal Cable Routes	Vertical Cable Routes	Horizontal Cable Routes	Vertical Cable Routes
1,5	500	750	300	400
2,5	500	750	300	400
4,0	600	750	300	400
6,0	600	750	300	400
10,0	750	900	400	500
16,0	750	1 000	400	500
25,0	900	1 000	400	500
35,0	900	1 000	400	500
Above 35,0	900	1 000	400	500

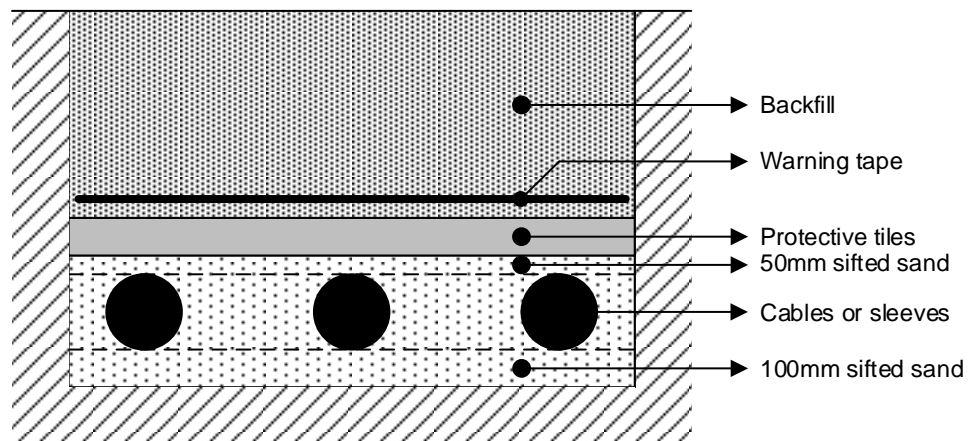
### E06.4 **CABLE INSTALLATION IN CABLE TRENCHES**

#### E06.4.1 General

The Contractor shall preserve the site as far as possible. Only the minimum of trees, shrubs,

rocks, etc. shall be removed and cleared for the cable route.

The cable trench will be arranged as shown in figure 2 below:



**Figure 2:** Cable trench arrangement

#### E06.4.2 Trench Routes

The cable trench shall be excavated along the route indicated on the relevant drawing. The routing should preferably traverse through the lowest theft risk areas as much as is possible.

The trench shall be as straight as possible and shall comply with all requirements. The Engineer shall determine the length of the trench to be excavated, which shall not exceed 300 m, before the cable is installed and the trench backfilled.

If any obstacle or interference should be encountered, which may require alterations to the trench or routes, such alterations shall receive prior written approval from the Engineer.

#### E06.4.3 Excavation of Cable Trenches

The exact positioning of trenches shall be approved on site by the Engineer and excavations shall not commence until approval has been received.

The trench shall be excavated to a depth indicated on the drawings for the different cables. Where depths are not indicated on the drawings, the following shall apply:

Cable trenches shall be excavated deep enough so that the top layer of the cables is buried a minimum of 600 mm below final ground levels for LV cables and 1000mm for MV cables.

The Contractor shall excavate by hand where he cannot excavate by means of machines due to limited access and the proximity of other services.

The bottom of the trench shall be level and shall follow the contours of the final ground level. Where the excavation is in excess of the required depth, the excavation shall be backfilled and compacted with suitable material to the required depth.

The Contractor shall remove all sharp projections, which could damage the cable where the trench is excavated through rocky formations, and shall remove all loose rocks, material, etc. from the bottom of the trench.

The Contractor shall trim the trenches and clean up the bottom of the trenches after he has completed the required excavation.

#### E06.4.4 Excavation of Jointing Chambers

Jointing pits shall be excavated to a depth of 1,2 m and shall be rectangular in shape and large enough for the cable jointers to work comfortably and in an efficient manner. Where more than one joint is to be made in the same position the joint pit shall be large and long enough to allow staggered joints to be made. The minimum size of a joint pit shall be as follows:

- (a) One joint : 2,5 m long x 1,25 m wide

(b) Two joints : 3,0 m long x 1,5 m wide

E06.4.5 Excavated Material

No excavated material shall be left closer than 300 mm from the side of the excavation. The excavated material shall take up as small an area as possible with the safety of the workers and Works taken into consideration. The excavated material suitable for bedding material shall be placed separately on one side of the trench so that it is available when required.

Where surplus material or material unsuitable for backfilling has to be disposed of, the Contractor shall load and transport the material in the area provided to him, where it will be dumped.

E06.4.6 Inspection of Excavations

All cable excavations will be inspected by the Engineer prior to cable laying and backfilling commences.

The Contractor shall give the Engineer 24 hours' notice to do the inspections. No inspections shall be undertaken on Saturdays, Sundays and public holidays.

E06.4.7 Measurement of Excavations

Full detail of the cable trench dimensions and classification of the type of excavation shall be recorded by the contractor. The report will be presented to the Engineer as the final quantities for such excavations. The Contractor shall be responsible to keep all records as proof of progress and as basis for claims for payment. Inspections and measurements shall be completed before the installation of any bedding or backfilling.

The Contractor shall give the Engineer 24 hours' notice to be present when excavation are measured. No measurements shall be undertaken on Saturdays, Sundays and public holidays.

E06.4.8 Maintenance of Excavations

The Contractor shall maintain the excavation in a good condition, free of water, mud, loose ground, rocks, stones, gravel and other strange material until the cables are installed and the excavation is backfilled and compacted.

E06.4.9 Bedding Sand

A 100mm layer of sifted bedding sand free from sharp objects and rocks shall be laid and levelled at the bottom of each trench after the trench has been approved by the engineer, and prior to cable laying.

If the soil for the sand bed and sand cover has to be sifted, a sieve with holes 6 mm or smaller shall be used. Where this material is not available, the contractor shall import suitable material for such purposes. Where bedding has already been laid, the Engineer may instruct the Contractor to demonstrate that the minimum thickness of bedding has been provided for before authorising cable laying to proceed.

E06.4.10 Cable Laying

After approval of the trench, the cable shall be laid with the minimum of delay so that the trench can be backfilled. The Contractor shall, however, not backfill the trench until each length of cable has been inspected and approved by the engineer.

Only one cable shall be laid at a time and the Contractor shall take precautions that installed cables are not damaged. Cables should be laid with sufficient slack to relieve stresses.

The method to be used for laying cables shall be approved by the Engineer prior to the commencement of the laying of the cables.

Cable rollers shall be used when cables are drawn into trenches. The cable rollers shall be placed so that the cable does not touch the bottom or the sides of the trench. The rollers shall be of an approved construction without any sharp metal parts, which could damage the cables.

If the Contractor intends using a winch to draw the cable into the trench, a cable stocking shall be used or the draw wires shall be soldered to the cable so that the tension is exerted on all the cores, lead sheath and/or steel wire armouring at the same time.

The maximum tension on a cable during laying operations shall not exceed the value specified



by the manufacturer.

Should the Engineer not be satisfied with the manner or method employed to lay the cable he shall have the authority to instruct the Contractor to lay the cable by hand or in accordance with approved standards.

Medium-voltage cables shall overlap by at least 1m, but not more than 1,5m at joints.

Sufficient lengths of cable shall be left at the beginning and end of the cable routes to allow for the termination of the cables. Where necessary the Engineer shall decide on what length of cable is to be left. The Contractor shall take the necessary precautions to protect the cable ends until they are terminated. The cable ends shall be sealed by means of lead or heat-shrink sealing caps to ensure that the cable is waterproof.

Where cables are drawn through sleeves, care shall be taken that they are not kinked or excessively bent. No bend in a cable shall have a radius less than the minimum-bending radius specified by the cable manufacturer.

The Contractor shall keep accurate records of each length of cable laid. The following information shall be recorded:-

- (d) Cable drum number
- (e) Size of cable
- (f) Laid from where to where
- (g) Length of cable
- (h) Date laid

E06.4.11 Inspection of Cables

The Contractor shall be solely responsible for inspecting all cables before backfilling to ensure that the correct type and number of cables have been installed. All cable installation will be inspected by the Engineer prior to backfilling commences.

The Contractor shall give the Engineer 24 hours' notice to do the inspections. No inspections shall be undertaken on Saturdays, Sundays and public holidays.

E06.4.12 Measurement of Cables

Full detail of the cable length shall be recorded by the Contractor. The report will be presented to the Engineer as the final quantities for such installation. The Contractor shall be responsible to keep all records as proof of progress and as basis for claims for payment. Inspections and measurements shall be completed before the any backfilling commences.

The Contractor shall give the Engineer 24 hours' notice to be present when cables are measured. No measurements shall be undertaken on Saturdays, Sundays and public holidays.

E06.4.13 Sifted Sand topping

A 50mm layer of sifted bedding sand free from sharp objects and rocks shall be laid and levelled on top of the installed cables, prior to laying of the protective concrete tiles. If the soil for the sand bed and sand cover has to be sifted, a sieve with holes 6mm or smaller shall be used. Where this material is not available, the contractor shall import suitable material for such purposes.

E06.4.14 Concrete Protective Slabs

Protective concrete tiles will be installed above the sifted sand topping. Protective concrete tiles in trenches are there to provide protection against hand digging and warning of cables below. These tiles therefore can be paving blocks, precast wall slabs, etc. Requirements are that the tiles are not less than 38mm thick and will not break under their own weight (i.e. when the longest span of the tile or slab is supported on its ends) or when laid in the trenches by commonly accepted means. The tiles must also not break when the soil is compacted. The tiles must cover the entire width and length of the trench. Before purchasing any protective tiles, the contractor must submit details of the proposed tiles to the engineer for approval.

E06.4.15 Cable Warning Tape

Cable warning tape shall be installed on all cable routes (LV and MV) at 300 mm above the

protective concrete slabs. Where a cable route exceeds 600 mm in width, multiple warning tapes shall be run in such a way that the space between adjacent warning tapes does not exceed 185 mm.

The plastic cable warning tape shall consist of a strip of polyethylene of thickness 0,04mm and of nominal width 230 mm. The tape will be completely impregnated with a pigment such that the colour of the tape is yellow, colour No B49 of SANS 1091. A black-triangle and an electric flash symbol and the words "Danger, Gevaar, Ingozi" will be printed on the tape at intervals not exceeding 1m along its length.

#### E06.4.16

##### Backfill

When the protective tiles are installed, the trench shall be backfilled with soil containing not more than 40% rock or shale which shall be able to pass through a 100 mm sieve and which is approved by the Engineer.

Where more than 40%, but less than 70% rock occurs, the Contractor shall replace the rock with imported soil. However, should more than 70% rock occur then all the backfilling material shall be imported.

- (a) The Contractor may import further stone-free material to the site or sieve the excavated material for sand bedding and cover but payment shall only be compensated for the actual quantity of imported material required as determined by the engineer. The quantity of imported material required shall be calculated from the nominal trench width.
- (b) The excavated material shall be backfilled in layers of 150 mm and shall be well compacted and consolidated to 90% MOD AASHTO. Where necessary the Engineer may require that a mechanical vibrator be used for compacting the trench.
- (c) The Contractor shall maintain the completed sections of the cable trench in a proper safe condition for the duration of the contract. The Contractor shall refill and compact the trench where subsidence occurs.
- (d) After completion of the work, the route of the cable shall be neatly finished off and cleared. All stones bigger than 25 mm as well as all loose organic material and rubble shall be removed.

#### E06.4.17

##### Identification and Marking of Cable Routes

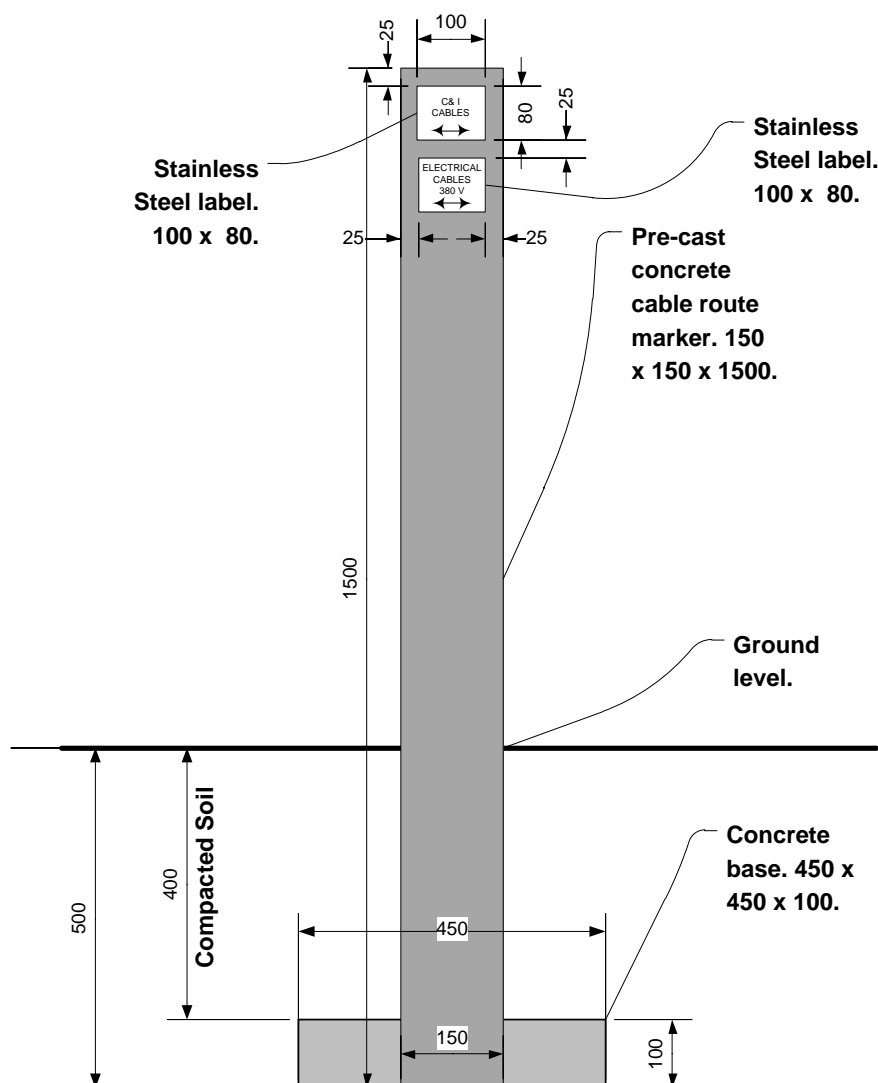
Cable route markers, in the form of concrete pre-cast posts, which stand 1.0m above ground level, secured in the ground, must be installed every 50m on straight runs and at every change in direction of the trench. Movable route markers will not be acceptable. The post must be equipped with a stainless steel plate engraved with "ELECTRICAL CABLES", the cable voltage and the direction indicated in which the cables run. If there are C&I cables in the same trench, there must be a separate label engraved with "C&I CABLES", and the direction indicated in which the cables run. If there are data communication cables in the same trench, there must be a separate label engraved with "DATA CABLES" and the direction indicated in which the cables run. These labels must be cast into the concrete post so that they cannot be pried off.

At the bottom of the post, a 450 x 450 x 100mm concrete base must be cast to ensure that the route marker can only be removed if it is deliberately dug out of the ground. Steel reinforcing mesh of MRM reference 156, in accordance with SANS 1024 is required in the concrete and the concrete compressive strength of the base must not be less than 15 MPa. (Note: Reinforcing mesh to MRM 156 consists of 3.55mm diameter wire used to create 100 x 100 mm squares).

These route markers must be installed right next to the trench and not over the cables, so that the trench can be re-opened without affecting the route marker. The labels on the route marker must be on the trench side of the route marker.

Cable route markers must be protected in areas of high vehicle traffic.

Figure 1 below provides the required detail of these cable route markers.



**Figure 1:** Cable Route Markers

E06.4.18

#### Road Crossings

The cable sleeves shall be installed 1,5m below ground level to avoid damage when the roads are constructed.

Unless otherwise specified, two additional sleeves shall be installed for future use at each road crossing.

Sleeves used for crossings shall be straight and undamaged. Bends shall not be allowed in road crossings. Sleeves shall be extended for a distance of 1,0m outside the roadway.

After the installation of the sleeves, the sleeves shall be meticulously backfilled so that no air pockets are left. The trench shall thereafter be backfilled in layers of 150 mm and compacted with mechanical vibrators to 95% modified AASHTO density.

The Contractor shall lay and join the cable sleeves and compact the trench to the satisfaction of the engineer. After installation, the sleeves shall be cleaned and a galvanised steel draw wire installed in the sleeve prior to the sleeve ends being sealed by means of plastic plugs.

E06.4.19

#### Crossing of Services

Where a cable crosses over other services, the cable shall not be installed at a depth less than

800 mm below ground level and if this is not possible, the cable shall be installed underneath the other service and shall be protected in the prescribed manner by means of concrete slabs. The depth of the cable shall be maintained for one metre on either side of the crossing.

If it is not possible to cross over or underneath a service in the prescribed manner, the matter shall be referred to the Engineer for a decision.

The following minimum clearances shall be maintained between electrical cables and other services:-

	Vertical	Horizontal
Water pipes	0,3	1,0
Sewer pipes	0,3	1,0
Storm water pipes	0,3	1,0

## **E06.5 CABLE INSTALLATION IN CABLE DUCTS**

### **E06.5.1 General**

This paragraph covers the installation of cables in build-up trenches, service ducts, etc. inside buildings. The trenches, ducts, etc. will be constructed and installed by others.

The use of this method of cable routing should be avoided where possible as it exposes the cables to high risk of theft. Open channels shall not be used for cable routing on any site.

### **E06.5.2 Installation**

Cables shall be installed in one of the following ways:

- (a) On vertical cable trays or.
- (b) On metal supports fixed to the side of the trench with suitable clamps.

Cables shall be clamped in position.

Cables shall not be bunched and laid on the floor of purpose built trenches.

### **E06.5.3 Covers**

The covering of concrete trenches shall as a rule fall outside the scope of the electrical installation. However, the Contractor shall be responsible for the cutting or drilling and smoothing of holes for cables through chequer plates, concrete or other coverings as required.

Cables shall enter and exit the trench through sleeves protruding 300 mm beyond the covering. The sleeves shall be permanently secured in position and the open space between the cable and sleeves shall be sealed with a non-hardening, watertight compound.

### **E06.5.4 Filled Trenches**

Where specified herein, floor trenches shall be filled with sand.

If a sand filling is specified, the cables shall be fixed to non-corroding supports.

Sand-filled trenches other than in substations shall be covered in one of the following ways:-

- (a) Reinforced concrete covers;
- (b) 100mm of 20MPa concrete;
- (c) Removable chequer plates. However, this will not be acceptable in open spaces.

Reinforced concrete covers shall be used where vehicular traffic may be encountered over trenches. Unless otherwise specified herein, allowance for a mass of 2 tons shall be made.

## **E06.6 CABLE JOINTS**

### **E06.6.1 General**

Joints in cable runs will not be allowed unless authorized by the Engineer.

Jointing shall be carried out strictly in accordance with the manufacturer's instructions. Only personnel competent in the installation of the specific joint will carry out the work.

During outdoor jointing operations, the joint bays shall be adequately covered by tents of waterproof material suitably supported. When necessary, a trench shall be excavated around the bay to prevent the ingress of moisture. The sides of the excavation shall be draped with small tarpaulin or plastic sheeting to prevent loose earth from falling in during jointing operations.

The crossing of cores in joints shall not be permitted under any circumstances. The electrical continuity of all the conductors, screens and armouring shall not be impaired by the joints and the earth continuity shall be accomplished within the joints, i.e. no external earth continuity conductor that will be subject to corrosion, is acceptable.

Joints shall be waterproof and airtight and shall be free of voids and air pockets. The joint shall not impair the anti-electrolysis characteristics of the cable. In the case of joints in cables with an outer PVC anti-electrolysis sheath, the joints shall be subject to the same electrical insulation test as the outer sheath of the cable.

The Contractor shall notify the Engineer timeously of the day on which jointing is to be carried out in order that an inspection may be arranged if so required. Any cable joint not inspected by the Engineer because of insufficient notice being given, shall be opened for inspection and redone at the discretion of the Engineer at the cost of the Contractor.

#### E06.6.2 Medium Voltage Cable Joints

Medium voltage cable joints shall be of the heat shrink type.

The joints shall make minimal, if any, use of insulating or stress relieving tapes. The use of electrical stress control and insulating tubing that is heat-shrunk on to the joint is preferred above other methods.

The materials shall comply with VDE 0278 and the supplier shall be called upon to confirm this aspect before acceptance of the materials or installation.

The heat-shrinkable and other materials used for joints shall be of a high quality and shall retain their electrical and mechanical properties without deterioration.

Joint kits shall be of a reputable brand.

#### E06.6.3 Low Voltage Cable Joints

Low voltage cable joints shall be of the epoxy-resin type.

The resin filled joint kit shall comprise a self-sealing plastic mould of high mechanical strength having sufficient connector space. The exact amount of cold hardening resin shall be provided in a two-compartment plastic bag. The resin shall have absolute minimum shrinkage. The mould and resin shall be waterproof and non-hygroscopic and shall be resistant to ultraviolet radiation.

Joint kits shall be of a reputable brand.

### **E06.7 CABLE TERMINATION**

#### E06.7.1 General

Connection of cables to switchgear shall always be effected in such a way that the various phases, seen from the front of the switchgear will be in the following positions where practically possible:-

- (a) Conductor no 1 : left (red)
- (b) Conductor no 2 : centre (white)
- (c) Conductor no 3 : right (blue)

Exposed armouring is not acceptable. Glands will be properly fitted with shrouds to cover any bare armouring.

All cable ends shall be supplied with the necessary earth connection.

A strut or other approved means of support shall be provided to remove mechanical stress from the glands.

Cable cores shall be marked with heat-shrunk sleeves where necessary to identify the phases. Refer to SANS 10142.

The current-carrying capacity and breakdown voltage of the cable end shall be the same as for the complete cable.

Cables shall be terminated in accordance with the recommendations laid down by the manufacturers of the cables and glands installed.

#### E06.7.2

##### Cable Glands

All cable glands for indoor and outdoor use shall be Ex rated as per SABS 1213 and have corrosion proof guard. It shall have a minimum IP rating of 68. The cable glands shall be suitable for use in hazardous areas classified for zone 1,2,21 and 22.

Cable glands shall be of the adjustable type gland suitable for indoor use and shall be suitable for use with PVC PVC SWA PVC cables complying with the latest edition of SANS 1507. All glands shall be installed with non-deteriorating neoprene shrouds.

Outdoor use cable glands shall be similar to the indoor use cable glands with an additional feature of a nipple gasket and an inner seal kit, rendering the gland suitable for type "EXe" equipment (increased safety equipment).

In high corrosive areas, such as chlorination, chemical dosing and inlet works areas, the cable gland shall

- (a) offer a minimum degree of ingress protection of IP 66 according to SANS 60529;
- (b) be suitable for type " EXe " equipment;
- (c) be corrosion proof;
- (d) Have a positive seal internal to the cable gland that seals over the cable outer sheath. For these applications, no shrouds are required.

For all gland installations on armoured cable, the outer sheath of the cable shall be cut back in accordance with the gland manufacturers' recommendations, so that a minimum of armouring is exposed between the gland and the outer sheath after gland installation. The shroud shall seal on the outer sheath of the cable.

#### E06.7.3

##### Cable Lugs

Suitable cable lugs shall be used and shall preferably be solidly sweated to cable conductor ends. Lugs may be crimped using mechanical, hydraulic or pneumatic tools specifically designed for this purpose, on condition that evidence is submitted that the system used complies with the performance requirements of BS 4579, Part 1, "Compression joints in copper".

Lugs crimped to cable with a cross-sectional area of more than 16mm<sup>2</sup> shall entail the use of either pneumatic or hydraulic crimping tools. Under no circumstances may a lug be crimped by means of a hammer and/or punch.

Lugs crimped to aluminium shall be subjected to thorough inspection with relation to the material and quality of crimping by the Engineer. Bi-metallic aluminium-copper lugs shall be used according to the manufacturer's specifications, where solid aluminium conductors are terminated onto copper busbars.

Fixing bolts shall be manufactured of cadmium plated high tensile steel and shall match the lug hole size. Contact surfaces between the lug and the busbar shall be thoroughly cleaned and smoothed.

When cutting away insulation from cable conductors to fit into lugs, care shall be taken that no strands are left exposed. Under no circumstances may any of the conductor strands be cut away to fit into lugs. Care must be taken when cutting the insulation not to damage the conductors.

Cables that are connected to clamp type terminals where the clamping screws are not in direct contact with the conductors need not be lugged, but the correct size terminals shall be used.

Ferrules shall be used where cable conductors are connected directly to equipment with screws against the conductor strands.

**E06.7.4**      Medium Voltage Cable Terminations

Heat shrinkable termination kits shall be used for all high voltage (above 1 kV) terminations and shall be applied strictly in accordance with the manufacturer's recommendations.

The complete termination kit shall be packed in a container that is marked for the type of cable insulation and construction as well as the voltage range for which the materials are suitable. An illustrated set of instructions for the installation of the materials shall accompany every termination kit.

The terminations shall make minimal, if any, use of insulating or stress relieving tapes. The use of electrical stress control and insulating tubing that is heat-shrunk on to the terminations is preferred above other methods.

The termination kits shall include suitable boots for the covering of the terminal studs on the equipment. The cable ends shall be terminated strictly in accordance with the termination manufacturer's specification. The cable ends shall withstand the same test voltage as the cable.

The materials shall comply with VDE 0278 and the supplier shall be called upon to confirm this aspect before acceptance of the materials or installation.

The heat-shrinkable and other materials used for the terminations shall be of a high quality and shall retain their electrical and mechanical properties without deterioration.

Terminations shall be made of a material that gives lasting protection against ultra-violet radiation.

The cores of all cables terminated outdoors and the cores of 3,3 kV and higher voltage cables terminated indoors, shall be completely covered with a shrunk-on protective layer against surface tracking, ultra-violet radiation and weathering.

Outdoor terminations shall be designed to prevent flashover under wet or contaminated conditions and to ensure additional mechanical strength. This shall be achieved with shrunk- on insulating spacers and rain sheds.

**E06.7.5**      Cable Identification

Cables shall be identified at all terminations (both ends). The identification of MV cables installed in cable ladders, ducts or to structures shall be to SANS 10142-1.

Both ends of the cable shall be marked with the cable number in accordance with the cable schedule. The cable tag shall comprise of a punched stainless steel strap that shall be tied onto the cable by means of a thin stainless steel tape

The use of PVC tape with punched characters or punched metallic bands or tabs is not acceptable.

The identification number of cables shall be shown on the "as built' drawings of the installation.

**E06.8**      **TESTING OF THE INSTALLATION**

The contractor shall supply factory test certificates for each drum of cable supplied under the Contract.

After the installation is complete, the contractor and the Engineer shall inspect the installation. The Engineer must be notified in advance of the inspection dates. The contractor will keep a snag list, reflecting all items not acceptable to the Engineer. The contractor will correct the snag items as required to the Engineers approval, updating the snag list as the items are completed and accepted/signed off by the Engineer.

On completion of his work, the Contractor will issue an Electrical Certificate of Compliance (CoC). All tests deemed necessary to issue the CoC should be included. The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The Contractor shall notify the Engineer timeously so that he may witness the tests.

Each installed cable shall be tested in accordance with:

- (a) The Occupational Health and Safety Act (OHSA) 1994;  
(b) SANS 97 (Electric cables - Impregnated paper-insulated metal-sheathed cables for rated voltages 3,3/3,3 kV to 19/33 kV)

SANS 97	Duration (min)	Commissioning test voltage between conductors (V)			Commissioning test voltage between conductors / sheath (V)		
Test Wave		3300/ 3300	3800/ 6600	6350/ 11000	3300/ 3300	3800/ 6600	6350/ 11000
		AC (r.m.s)	15	7000	13000	22000	7000
DC	15	9000	19000	31000	9000	11000	19000

- (c) SANS 1339 (Electric cables - Cross-linked polyethylene (XLPE) insulated cables for rated voltages 3,8/6,6 kV to 19/33 kV)

SANS 1339	Duration (min)	Commissioning test voltage between conductors			
Test Wave		(V)			
		6600	11000	22000	33000
VLF (0.1 Hz)	60	11000	19000	38000	57000
Power frequency	60	8000	13000	25000	38000
DC	10	6000	10000	20000	30000

DC voltage testing is likely to cause irreversible damage to XLPE-insulated cable systems. The voltage and duration should be limited to the appropriate values given in the table above. The contractor shall use a DC test set to apply the test voltage. After completion of the DC test, the contractor shall soft-discharge the cable, using either the DC test set or a discharge stick where after the cable will be fully discharged by solidly earthing it for at least 8 h but preferably for 24 h. DC testing shall only be carried out with written permission from the Engineer,

- (d) SANS 1507 (Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V));

SANS 1507	Duration (min)	Commissioning test voltage between conductors (V)			Commissioning test voltage between conductors / earth (V)		
Test Wave		300/ 500	600/ 1000	1900/ 3300	300/ 500	600/ 1000	1900/ 3300
		AC (rms)	15	1000	2000	6000	1000
DC	15	1500	3000	9000	1500	3000	5000

## E06.9

### COMPLETION

The Engineer reserves the right to inspect the installation at any stage during the course of construction. However, such inspections will not deem the portions inspected as being complete or accepted and the Contractor shall remain responsible to complete the installation fully in accordance with this specification.

The Contractor shall carry out a final "as built" survey of the cable routes and present to the Engineer "as built" route plans of the complete installation.

The following information shall be reflected on the plans or submitted as separate schedules with the plans:



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- (a) Overall length of each cable;
- (b) Locations of all joints (if any) in relation to permanent reference points. Dimensions shall be shown and the method of triangulation i.e. two dimensions shall be used to each joint;
- (c) The location of all cable markers in relation to permanent reference points;
- (d) Identification numbers of all cables.

The Works will be deemed incomplete until all tests have been conducted and certified successfully and all "as built" drawings and schedules have been handed to the Engineer.