



PARTICULAR SPECIFICATION
E06 : ELECTRICAL MEDIUM AND LOW VOLTAGE
CABLE INSTALLATION

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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 procurement and 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.

E06.2 PARTICULAR SPECIFICATIONS

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

G01: PARTICULAR SPECIFICATION FOR COLOUR CODES

G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION

E02: ELECTRICAL CABLE RACKS

E03: ISOLATOR PUSHBUTTON STATIONS

E04: MOTOR CONTROL CENTRES

E05: ELECTRICAL LOW VOLTAGE POWER AND CONTROL CABLES

E07: ELECTRICAL INDUSTRIAL WELDING PLUGS, COUPLERS AND SOCKET OUTLETS

E08: WIRING

E06.3 COMPETENCE OF PERSONNEL

It is a definite requirement that the Contractor shall only employ personnel fully conversant with the cable manufacturer's recommendations to lay, joint and terminate cables. When contractors are working on medium voltage equipment they shall be conversant with the medium voltage regulations and operating procedures. There shall be direct supervision at all times when working in the HT substations. Only competent persons who have the relevant qualifications and experience to work with 6.6 & 11 kV systems shall be allowed to work on the HT network.

Cables, cable jointings, cable terminations and cable accessories shall be installed in accordance with the manufacturer's installation instructions by competent personnel. Where cables are installed but not terminated onto equipment, the cable end shall be fitted with end-caps to prevent the ingress of moisture or other undesirable elements into the cables.

E06.4 MATERIALS

E06.4.1 Medium Voltage Cable Joints and Terminations

The medium voltage cable joints and terminations shall be of the heat shrink type.

E06.4.2 Low Voltage Cable Joints and Terminations

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

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 offer a minimum degree of protection according to SANS 1222 of IP 66, shall be suitable for type " EXe " equipment, shall be corrosion proof and shall 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.

Bi-metallic aluminium-copper lugs, shall be used according to the manufacturer's specifications, where solid aluminium conductors are terminated onto copper busbars.

E06.4.3 Earth Continuity Conductors

Earth continuity conductors shall comprise of stranded copper conductors of cross-section indicated in the detailed specification.

A single earth conductor may be used where two or more cables run together, providing the earth conductor cross-sectional area is based on the largest size cable in the run.

E06.4.4 Cable Route Markers

Cable route markers shall be constructed of reinforced concrete and shall be of dimensions to be approved by the engineer.

E06.4.5 Cable Warning Tape

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

The plastic warning tape shall be installed on all cable routes (LV and MV) at 200 mm above the top cable layer. Where a cable route exceeds 600 mm in with multiple warning tapes shall be run in such a way that the space between adjacent warning tapes does not exceed 185 mm.

E06.4.6 Concrete Protective Slabs

Concrete protective slabs shall have the following dimensions:

Length 1 000 mm

Width 350 mm

Thickness 50 mm

The slabs shall be constructed of 20 MPa concrete and each slab shall be reinforced with one longitudinal and three transverse mild steel rod of minimum diameter 8 mm. The slabs shall be manufactured in such a way that the slabs interlock with each other thus avoiding shifting of the slabs after installation.

E06.4.7 Cable Sleeves

Cable sleeves shall be installed where necessary. The sizes of the sleeves to be installed shall as detailed in the specifications.

E06.5 EXCAVATIONS

E06.5.1 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.

Where surplus material has to be disposed of the Contractor shall dump the material in the area provided by him.

The Contractor shall at his own cost load and transport to the above-mentioned site all surplus material, unsuitable material for backfilling etc.

E06.5.2 Trench Routes

The cable trench shall be excavated along the routes indicated on the relevant drawings.

The trench shall be absolutely straight and shall comply with all requirements. The Engineer shall determine the length of the trench to be excavated, which shall not exceed 400 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 of the engineer.

E06.5.3 Cable Trench

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:

For MV cables 1,0 m and for all LV cables the trench shall be deep enough so that the top layer of LV cables is buried a minimum of 500 mm below final ground levels.

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 trim the trenches and clean up the bottom of the trenches after he has completed the required excavation. Bedding and cables shall not be laid until the trench has been approved by the engineer. 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.

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.

E06.5.4 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:

- one joint : 2,5 m long x 1,25 m wide
- two joints : 3,0 m long x 1,5 m wide

E06.5.5 Excavated Material

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

E06.5.6 Inspection and Measurement of Excavations

Once the excavations for cable trenches and joint pits have been completed, the Contractor shall give the Engineer 24 hours notice to inspect the trench and to be present when the measurements are made. No inspections shall be undertaken on Saturdays, Sundays and public holidays.

Full detail of the cable trench dimensions and classification of the type of excavation shall be recorded and signed by the Contractors representative and the engineers representative as the final quantities for such excavations.

Inspections and recordings shall be completed before the installation of any bedding or backfilling. The Contractor shall be responsible to keep all records as proof of progress and as basis for claims for payment.

E06.5.7 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.

E06.6 **CABLE TERMINATIONS**

E06.6.1 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:-

- conductor no 1 : left (red)
- conductor no 2 : centre (white)
- conductor no 3 : right (blue)

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

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

A P4000 channel 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 clause 5.2.1 (d) of 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 employed.

E06.6.2 Cable Terminations with Heat-Shrinkable Materials

The complete 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 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 kits shall include suitable boots for the covering of the terminal studs on the Equipment. The ends shall be terminated strictly in accordance with the termination manufacturer's specification and shall withstand the same test voltage as the rest of 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 flash-over under wet or contaminated conditions and to ensure additional mechanical strength. This shall be achieved with shrunk- on insulating spacers and rain sheds.

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.

E06.7 **CONNECTION OF CABLE CONDUCTORS**

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.

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.

Suitable 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 16mm² 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.

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

E06.8 CABLE JOINTS INSTALLATION

E06.8.1 General

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

Jointing shall only be carried out by personnel competent in jointing the types of cable used and shall be carried out strictly in accordance with the manufacturer's instructions.

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.

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

Joints shall be fully waterproof and airtight and shall be free of voids and airpockets.

The joint shall not impair the anti-electrolysis characteristics of the cable.

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. The joints shall be completely covered by a watertight sheath to prevent corrosion.

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.

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

High voltage cable joints shall be of the heat shrinkable type.

E06.8.2 Cable Joints with Heat Shrinkable Materials

The complete joint 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 kit.

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.

Heat-shrinkable joints kits shall be used for all high voltage (above 1 kV) joints.

Where cable joints are required to be made in the course of a cable run, a joint hole shall be excavated of sufficient size to enable the cable joiner to work efficiently and unimpeded.

E06.9 CABLE AND CABLE ROUTE 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, Clause 7.1.3(c).

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 which 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.

Cable route markers shall consist of concrete blocks in the shape of truncated pyramid, approximately 300 mm high, 150 x 150 mm at the top and 250 x 250 mm at the bottom.

Aluminium plates shall be cast into the top of the blocks in such a manner that they cannot be pried loose. The wording "ELECTRICAL CABLE" shall be stamped on the plates as well as direction arrows and the cable voltage rating.

Cable markers shall be installed on the surface along all the underground routes and shall project 35 mm above normal ground level unless the projected markers could be a hazard to pedestrian or other traffic in which case they shall be installed flush with the surface.

Cable markers shall be installed at the beginning and ending of a cable run (e.g. where a cable enters a substation or building), at all changes of direction, above all Joints, above cable pipe entries and exits and at intervals not exceeding 50 m along the cable route and at each cable joint. The position of cable markers shall be indicated on the "as built" drawings.

Where cables cross other services such as water pipes, sewage pipes and other cables or where the chance exists that the cable may be damaged as a result of excavation by others, the cable shall be protected by means of reinforced concrete slabs. The slabs shall protect the cable for a distance of 500 mm on either side of the crossing.

E06.10 GENERAL INSTALLATION OF CABLES

E06.10.1 Sand Bed for Cables

A sand bed layer of soft soil shall be installed and levelled at the bottom of each trench after the trench has been approved by the engineer, and prior to cable laying.

The minimum thickness of the sand bed layer is 50 mm.

If the material that has been excavated is not suitable for the sand bed layer then suitable soil shall be imported for this purpose. The cost thereof shall be included in the unit price for the excavation unless otherwise specified.

An adequate quantity of soil similar to the sand bed material shall be available next to the excavation for the sand bed cover before an inspection of the cables is called for. The sand bed cover for MV cables shall be a minimum of 150 mm thick and for LV cables shall be 100 mm thick and shall be placed directly after the cable(s) has been inspected.

If the soil for the sand bed and sand cover has to be sifted, a sieve with holes not larger than 6 mm shall be used.

E06.10.2 Laying of Cables

The cable shall, after the completion of the trench, 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 the cables which are already installed are not damaged.

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.

The medium-voltage cables shall be laid in such a manner that the beginning of a drum shall be laid from the end of the previous drum to ensure that the lay of the cores remain the same.

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

- Cable drum number
- Size of cable
- Laid from where to where
- Length of cable
- Date laid

The Contractor shall be liable for the repair of the cable due to the faulty manufacture of the cable, should this information not be recorded directly after the cable has been laid.

Every cable shall be marked by means of a aluminium label on which the size of cable and its source or destination and cable number is punched. The label shall be installed around the inner PVC sheath immediately above the cable gland.

E06.10.3 Verification 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.

The engineer's representative shall inspect all cable trenches before backfilling to ensure that the laying of cables complies with the specification.

During this inspection the Contractor's and engineer's representative shall record the lengths for all cables and all such records shall be signed by both representatives as the final quantities. The Contractor shall be responsible to keep the records as proof of progress and as basis for claims for payment.

E06.10.4 Road Crossings

The cable sleeves shall be installed 1,5 m 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.

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.

E06.10.5 Crossing of Other 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
GPO Cables	0,3	0,3
Water pipes	0,3	0,3
Sewer pipes	0,3	0,8
Stormwater pipes	0,3	0,6
Other electrical cables	0,15	0,15 (other than LV cables in same route)
LV cables on same route	0,100	One cable diameter or larger cable

E06.10.6

Backfilling of Trenches

When the cable has been laid, inspected and approved and the sand bed cover as specified in the clause on "Sandbed for cables" has been 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.

E06.11

INSTALLATION OF CABLES IN PURPOSE-BUILT TRENCHES (CABLE DUCTS)

E06.11.1

General

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

E06.11.2

Installation

Cables shall be installed in one of the following ways:-

- on horizontal cable trays;
- on horizontal metal supports with suitable clamps;

- on vertical cable trays or metal supports fixed to the side of the trench. Cables shall be clamped in position.

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

E06.11.3 Covers

The covering of concrete trenches shall as a rule fall outside the scope of the electrical installation. The Contractor shall, however, 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.

E06.11.4 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:-

- Reinforced concrete covers;
- Sand and cement screed;
- Removable chequer plates.

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.

E06.12 **INSTALLATION OF CABLE LADDERS**

Cable ladders shall be installed within accessible civil constructed cable ducts. These ducts may form part of the scope of works or may be existing.

Cable ladders are required to be installed within the motor control centre station, on site reticulation, and on access platforms to the mechanical equipment.

Cable ladders shall be installed within accessible cable duct and 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.

Cable ladders shall be supported with the struts, channels, brackets, clamps, cantilever arms and nuts/bolts/washers.

The platform mounted cable ladder reticulation shall 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.

Unless otherwise agreed, all screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, springwashers, etc shall be stainless steel 316.

E06.13 INSTALLATION OF CABLES ON LADDERS AND STRUCTURES

E06.13.1 Installation

Cables may be installed in one of the following ways:-

- on horizontal cable ladders with stainless steel strapping;
- against vertical cable ladders with stainless steel strapping;
- against horizontal or vertical metal supports or brackets with stainless steel strapping;
- with stainless steel strapping when fixed to structures.

E06.13.2 Spacing of Supports

E06.13.2.1 General

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. Unless otherwise specified herein, this method shall apply to all cable installations.

E06.13.2.2 Spacing of Supports of Restrained Cables

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 off-set 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 ²)	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

E06.13.3 Grouping and Spacing of Cables

Cables with a cross-sectional area of more than 16 mm² shall, as a rule, 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.

High voltage cables shall be separated from other cables and services throughout the installation and shall as far as possible be installed in separate floor trenches, pipes or metal channels. 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 1 m 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.

E06.14 INSTALLATION OF MCC'S

Unless otherwise stated, each MCC shall be installed on a cable duct within an MCC room. Purpose made MCC supports shall be manufactured and installed to support the MCC. The contractor shall design and submit the details of the supports to Engineer for approval prior to the manufacturing of the MCC supports.

E06.15 TESTING

Each cable shall be tested after installation in accordance with SABS 150 (up to 1 kV), SANS 97 and SANS 1339 (up to 11 kV), as well as the requirements of the Local and Supply Authorities.

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.

LV cables shall be tested by means of a suitable megger at 1 kV and the insulation resistance shall be tabulated and certified.

HT cables shall be pressure-tested in accordance with Table 2 and the exact leakage current shall be tabulated and certified.

Table 2

Cable Rating (kV)	TEST VOLTAGE (kV applied for 15 minutes)				
	Paper-insulated Cables				XLPE-insulated Cables
	Between Conductors		Conductors to Sheath		Conductors to Screen
	AC (rms)	DC	AC (rms)	DC	DC
6,6	12	18	12	18	11
11	20	30	20	30	18

On completion of the tests on any cable, the Contractor shall without delay, submit 3 copies of the certified test reports to the Engineer.

E06.16 COMPLETION

The Engineer reserves the right to inspect the installation at any stage during the course of construction. Such inspections will, however, 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:-

- overall length of each cable.
- 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 to each joint, shall be used.
- the location of all cable markers in relation to permanent reference points.
- identification numbers of all cables.

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

E06.17 MEASUREMENT AND PAYMENT

Excavation

<u>Item</u>	<u>Unit</u>
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Excavate in all materials for trenches, backfill, compact and dispose of surplus material	m ³
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This rate shall apply to all the excavations.

The unit of measurement shall be the cubic metre of material excavated in trenches, classified according to the depth and width specified listed. The width classification shall be in accordance with the authorised dimensions and the depth classification in accordance with the total depth of the trench and not with the depth range in which the material is situated before excavation. The depth of excavation shall be measured to the underside of the bedding.

The tendered rate shall include full compensation for clearing and grubbing the trench areas and the temporary removal of improvements from the line of the trench, for excavating the trench, preparing the bottom of the trench, separating material unsuitable for backfill, keeping the excavations safe, dealing with any surface or subsurface water, measuring, classification and keeping of all records and for separating topsoil and selected backfill material where necessary.

The rate shall furthermore cover the costs of installing the sand bed and sand cover, backfilling, compacting and disposing of the surplus material.

<u>Item</u>	<u>Unit</u>
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Extra over for excavating in hard material	m ³
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The unit of measurement shall be the cubic metre of material excavated and classified as hard, in accordance with the classification set out hereunder.

The tendered rate shall be paid over and above the rate tendered for excavation in full

compensation for the additional cost of excavating in hard material instead of soft.

The tendered rate shall include full compensation for any overbreak as well as the additional backfilling required, reinstating the trench bottom, and for any other incidentals resulting from overbreak.

The materials excavated shall be classified as follows for payment purposes:

Hard Material

Material which cannot be excavated efficiently except with the use of pneumatic tools, blasting or wedging and splitting, and shall include boulders exceeding 0,15 m³ in volume.

Soft Material

All material not classified as hard material.

Notwithstanding the above classification, all material excavated from previously constructed fills, embankments, pavement layers and from above existing services shall be classified as soft material.

The decision of the Engineer as to the classification of the material shall be final and binding and any objection as to the classification shall be made before the excavation has been backfilled.

<u>Item</u>	<u>Unit</u>
Extra over for excavating by hand in all materials	m ³

The unit of measurement shall be the cubic metre of trench material excavated by means of hand tools as instructed or authorised in writing by the Engineer where the use of conventional excavating equipment is either impractical or likely to cause damage to services, trees or property or where the electrical Contractor has to excavate by hand where he cannot excavate by machine.

The volumes of the trench excavation will be computed from the length and the depth to the bottom of the specified bedding layer and the minimum base widths specified in the drawings. The rate shall cover the cost of complying with the safety and protection requirements specified except where particular items are scheduled to cover particular costs for the excavation.

The tendered rate shall be paid extra over the rates in full compensation for the additional expense of excavating by means of hand labour instead of conventional trenching equipment.

<u>Item</u>	<u>Unit</u>
Extra over for using backfill material obtained from:	
(a) borrow areas	m ³
(b) sources provided by the Contractor	m ³

The unit of measurement shall be the cubic metre of imported backfill material.

The tendered rate for paid extra over and shall be in full compensation for the additional cost of excavating and selecting of suitable material and the moving of the material to the backfilling site.

The above items will not be measured for payment unless importation has been ordered in writing. The volume will be computed from the trench width and the depth from ground level to the top of the sand bed cover as shown on the tender drawings. The rate for material from designated borrow pits shall cover the cost of excavation and selection of suitable material, the moving of the material to the backfilling site, and the disposal of the material that becomes surplus as a result of the importation, all within 0,5km.

The tendered rate for sources provided by the Contract paid extra over jointing and termination of MV cable shall cover the cost of the acquisition of the material and of the disposal of the surplus material resulting from the importation together with all the costs of transporting the material to the site regardless of distance.

<u>Item</u>	<u>Unit</u>
Backfill inverted culvert cable trench	m ³

The tendered rate shall be the cubic meter of cable trench backfilled.

The tendered rate shall include full compensation for importing and separating material suitable for backfilling, providing the bedding material, keeping the cable trench safe, dealing with any surface of subsurface water, measuring classification and keeping of all records.

The rate shall furthermore cover the cost of installing the sand bed and sand cover, backfilling and installing covers of the trench route. The covers will be provided by others.

<u>Item</u>	<u>Unit</u>
Lay MV cable	m

The unit of measurement shall be the linear length in meter of MV cable installed.

The tendered rate shall include full compensation for the handling, inspection, laying, cutting and testing the cable. Cables will be measured linearly over all lengths laid. No extra will be allowed for jointing, overlaps and termination.

<u>Item</u>	<u>Unit</u>
Jointing and termination of MV cable	No

The unit of measurement shall be the number of MV cable joints or terminations.

The tendered rate shall include full compensation for the cost of providing the kits, complete with compound, ferrules and cable lugs, the cost of cutting the cable, handling and fitting the kits and the cost of testing the joints and terminations.

<u>Item</u>	<u>Unit</u>
Lay LV cable	m

The unit of measurement shall be the linear length in meter of LV cable installed.

The tendered rate shall include full compensation for the handling, inspecting, laying, cutting and testing the cable. Cables shall be measured linearly over all lengths laid. Separate items shall be scheduled for each size and each type of cable laid.

<u>Item</u>	<u>Unit</u>
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Install LV and MV cable on cable ladder m

The unit of measurement shall be the length of LV and MV cable installed on cable ladder.

The tendered rate shall include full compensation for the handling, inspection, laying, cutting and testing the cable. Cables shall be measured linearly over all lengths laid. Separate items shall be scheduled for each size and each type of cable laid.

Item **Unit**

Termination of LV cables No

The unit of measurement shall be the number of LV cable terminations.

The tendered rate shall include full compensation for providing the cable glands and shrouds, the cost of handling, fitting and cutting the cable. Separate items shall be scheduled for each size and type of cable.

Item **Unit**

Jointing of low voltage cable No

The unit of measurement shall be the number of LV cables joints.

The tendered rate shall include full compensation for the cost of providing the kits, the cost of cutting the cable, handling and fitting the kits and the cost of testing the joints.

Item **Unit**

Supply earth continuity conductor m

The unit of measurement shall be the length in meter of earth continuity conductor supplied.

The tendered rate shall include full compensation for procuring, furnishing and laying the specified earth continuity conductor.

Item **Unit**

Lay earth continuity conductor m

The unit of measurement shall be the length in meter of earth continuity conductor installed.

The tendered rate shall include full compensation for procuring, furnishing and laying the specified earth continuity conductor.

Item **Unit**

Terminate and connect earth continuity conductor No

The unit of measurement shall be the number of earth continuity conductors terminated and connected.

The tendered rate shall include full compensation for supplying all the material required to terminate and connect the earth continuity conductors and the connecting thereof to the earth bars.

Item **Unit**

Supply plastic warning tapem

The unit of measurement shall be the length in meter of plastic warning tape supplied.

The tendered rate shall include full compensation for the supplying, handling and laying the plastic warning tape.

Item **Unit**

Lay plastic warning tapem

The unit of measurement shall be the length in meter of plastic warning tape installed.

The tendered rate shall include full compensation for the supplying, handling and laying the plastic warning tape.

Item **Unit**

Cable record drawings Sum

The unit of measurement shall be the sum.

The tendered rate shall cover the cost of preparing and furnishing the drawings as specified in sub-clause "Information regarding the completed network".

Item **Unit**

Supply and construct plinths for the distribution or junction kiosks No

The unit of measurement shall be the number of plinths supplied and constructed.

The tendered rate shall include full compensation for the supply and delivery of all material required for the plinth, the excavation of the foundation for the plinth and the construction of the plinth.

Item **Unit**

Install distribution or junction kiosks..... No

The unit of measurement shall be the number of distribution or junction kiosks installed.

The tendered rate shall include full compensation for the installing and fastening of the distribution or junction kiosk on the plinth and the casting of a 50 mm floor at the bottom of the plinth.

Item **Unit**

Substation building accessories..... Sum

The unit of measurement shall be the sum.

The tendered rate shall include full compensation for the supply and installing of the substation building accessories specified in the detailed specification.

Item **Unit**

Removal of existing medium voltage cable from existing switchgear No

The unit of measurement shall be the number of existing MV cable removed from existing switchgear.

The tendered rate shall include full compensation for the disconnection and removal of existing medium voltage cables from existing switchgear.

Item **Unit**

Supply cable markers No

The unit of measurement shall be the number of cable markers supplied.

The tendered rate shall include full compensation for the provision of the cable markers and the cost of handling and installing them.

Item **Unit**

Erect cable markers No

The unit of measurement shall be the number of cable markers installed.

The tendered rate shall include full compensation for the provision of the cable markers and the cost of handling and installing them.

Item **Unit**

Supply cable slabs No

The unit of measurement shall be the number of cable slabs supplied.

The tendered rate shall include full compensation for the supplying, handling and installing of the concrete protective slabs where specified.

Item **Unit**

Install cable slabs..... No

The unit of measurement shall be the number of cable slabs installed.

The tendered rate shall include full compensation for the supplying, handling and installing of the concrete protective slabs where specified.

Item **Unit**

Expose, cut and relocate existing cable Sum

The unit of measurement shall be the sum to expose, cut and relocate existing cable.

The tendered sum shall include full compensation to expose the length of cable as specified in the detail specification by hand, taking all the necessary precautions not to damage the cable, cutting the cable and relocating the cable into the existing substation.



Item

Unit

Install LV cable in protective sleeve pipesm

The unit of measurement shall be the length in meter of LV cable installed in sleeve pipes.

The tendered rate shall include full compensation for the installation of LV cable in protective sleeve pipes.