



**public works**

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Department:  
Public Works  
**REPUBLIC OF SOUTH AFRICA**

**STANDARD**

**ELECTRICAL SPECIFICATIONS**

**SECTION A: PREAMBLE TO STANDARD SPECIFICATIONS**

**SECTION B: INSTALLATION SPECIFICATIONS**

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**SECTION A****A.1 PRE-AMBLE TO STANDARD SPECIFICATION FOR ELECTRICAL INSTALLATIONS****GENERAL****1. INTRODUCTION**

- (a) These Standard Specifications cover the general technical requirements for the equipment, materials, installation, testing, commissioning and maintenance of electrical installations for the Department. These requirements shall be read in conjunction with the Documents as specified below.
- (b) "Document" shall mean the complete set of contract documents, including the Department's Tender Conditions, Tender Qualifications, the Standard Specification and the Detail Technical Specification including all drawings and variation orders issued in terms of the contract.
- (c) "Contractor" shall mean the person, partnership, company or firm appointed for the supply, installation, testing, commissioning and maintenance of the Electrical Installation. In the case of the Electrical Installation being a sub-contract, nominated in terms of the Main Contract or otherwise, the word "Contractor" shall also mean "Sub-Contractor" in terms of the Sub-Contract Conditions for the specific installation. Where applicable the Builder or Principal Contractor shall be referred to as "Main Contractor".

**2. INSTALLATION WORK**

- (a) The complete installation shall comply with the requirements of this Specification. Should any discrepancies or contradictions exist between this specification and the Detail Technical Specification for the specific installation, then the latter shall take precedence.

In the event of discrepancies between the drawings, specifications and bill of quantities the Department shall decide whether the work as executed shall be remeasured on site or whether remeasurement shall be effected from the working drawings only.

- (b) The Department's authorised representative will inspect the installation from time to time during the progress of the work. Discrepancies will be pointed out to the Contractor and these shall be remedied at the Contractor's expense. Under no circumstances shall these inspections relieve the Contractor of his obligations in terms of the Documents.
- (c) The Contractor shall notify the Department timeously when the installation reaches important stages of completion (e.g. before closing cable trenches, before casting concrete, etc.) so that the Department's authorised representative may schedule his inspections in the best interest of all parties concerned.

**3. REGULATIONS**

- (a) The installation shall be erected and tested in accordance with the Acts and Regulations as indicated in PW 379 or PW 379 (Civil) – "Standard Conditions in respect of the Supply-, Delivery and Installation of Electrical-, Mechanical-, Pneumatic- and Vacuum Operated Equipment, Control Systems, Plant and Materials".
- (b) The Contractor shall issue all notices and pay all of the required fees in respect of the installation to the authorities, and shall exempt the Department from all losses, claims, costs or expenditures which may arise as a result of the Contractor's negligence in complying with the requirements of the regulations.
- (c) It shall be assumed that the Contractor is conversant with the above-mentioned requirements. Should any requirement, by-law or regulation, which contradicts the requirements of this Document, apply or become applicable during erection of the Installation, such requirement, by-law or regulation shall overrule this Document and the Contractor shall immediately inform the Department of such a contradiction. Under no circumstances shall the Contractor carry out any variations to the installation in terms of such contradictions without obtaining the written permission to do so from the Department.

**4. SITE CONDITIONS**

Tenderers are advised to visit the site and acquaint themselves with all local conditions pertaining to the execution of the installation before tender closing date. No claims from the Contractor which may arise from insufficient knowledge of site access, type of site, labour conditions, establishment space, transport and loading/unloading facilities, power and water supply, etc. will be considered after submission of tenders.

For services where prior permission is required before contractors can visit the site, a visit will be arranged for all interested parties.

**5. ARRANGEMENTS WITH THE SUPPLY AUTHORITY**

- (a) The contractor shall give all notices required by and pay all necessary fees, including any inspection fees, which may be due to the local Supply Authority unless specified to the contrary.
- (b) It shall be the responsibility of the Contractor to make the necessary arrangements with the local Supply Authority at his own cost and to supply the labour, equipment and means to inspect, test and commission the installation to the satisfaction of the Local and Supply Authorities.
- (c) The Contractor shall supply and install all notices and warning signs that are required by the relevant laws, regulations and/or the Documents.

**6. MATERIAL AND EQUIPMENT**

- (a) All material and equipment shall conform in respect of quality, manufacture, tests and performance, with the requirements of the South African Bureau of Standards or where no such standards exist, with the relevant current Specification of the British Standards Institution.
- (b) All material and equipment shall be of high quality and suitable for the conditions on site. These conditions shall include weather conditions as well as conditions under which materials are installed, stored and used. Should the materials not be suitable for use under temporary site conditions then the Contractor shall at his own cost provide suitable protection until these unfavourable site conditions cease to exist.
- (c) The Contractor shall, where requested to do so, submit samples of equipment and material to the Department for approval prior to installation. Samples may be retained in the Department's possession until the contract is completed after which they will be returned.

**7. CONNECTIONS INVOLVING ALUMINIUM (CABLES AND TRANSFORMERS)**

As a result of the fact that aluminium flows when subjected to pressure and electrical connections based on this principle thus loses proper contact during the course of time, it should be noted that bolted connections between aluminium and copper or any other metal is not acceptable to this Department.

**8. CODES OF PRACTICE OR STANDARD SPECIFICATION**

Where reference is made to any Code of Practice or Standard Specification in this document the latest edition or amendment shall be applicable, except where specified to the contrary.

**SECTION B.1****B.1 INSTALLATION AND TERMINATION OF CONDUITS AND CONDUIT ACCESSORIES****1. GENERAL****1.1 SCOPE**

1.1.1 This section covers the installation of conduits and conduit accessories in buildings and other structures under normal environmental conditions and for system voltages up to 600 V.

1.1.2 The following types of conduit installations are included:

- (a) Screwed metallic conduit - black enamelled and galvanised.
- (b) Plain-end metallic conduit - black enamelled and galvanised.
- (c) Non-metallic conduit.
- (d) Flexible conduit.

1.1.3 Conduits may be installed as follows:

- (a) In open roof spaces.
- (b) Cast in concrete.
- (c) Surface mounted against walls, concrete slabs, etc.
- (d) In wall chases.

1.1.4 Where conduits are to be installed in concrete, this shall be undertaken while the building work is still in progress. Conduits may only be surface mounted where specified or where the Department has given its written consent.

1.1.5 Under no circumstances will conduit having a wall thickness of less than 1,6mm be allowed in screeding laid on top of concrete slabs.

1.1.6 Bending and setting of conduit must be done with special bending apparatus manufactured for the purpose and which are obtainable from the manufacturers of the conduit systems. Damage to conduit resulting from the use of incorrect bending apparatus or methods applied must on indication by the Department's inspectorate staff, be completely removed and rectified and any wiring already drawn into such damaged conduits must be completely renewed at the contractor's expense.

1.1.7 Tenderers must ensure that general approval of the proposed conduit system to be used is obtained from the local electricity supply authority prior to the submission of their tender. Under no circumstances will consideration be given by the Department to any claim submitted by the contractor, which may result from a lack of knowledge in regard to the supply authority's requirements.

1.1.8 For light and socket outlet circuits, the conduit used shall have an external diameter of 20mm. In all other instances the sizes of conduit shall be in accordance with the "Wiring Code" for the specified number and size of conductors, unless otherwise directed in part 2 of this specification or indicated on the drawings.

**1.2 OTHER SERVICES**

Conduits may not be installed closer than 150 mm to pipes containing gas, steam, hot water or other materials, which may damage the conduits or conductors. Conduits may not touch pipes of other service

installations in order to prevent electrolytic corrosion. Where this is unavoidable, cathodic protection shall be provided.

Conduit and conduit accessories used for flame-proof or explosion proof installations and for the suspension of luminaries as well as all load bearing conduit shall in all instances be of the metallic screwed type.

## **2. SCREWED METALLIC CONDUIT**

### **2.1 GENERAL**

2.1.1 In general, screwed steel conduit shall be used in the wiring of buildings.

2.1.2 The installation shall comply with SANS 10142.

### **2.2 GALVANISED CONDUIT**

Galvanised conduit and accessories shall be used in the following:

- (a) In damp areas.
- (b) In areas exposed to the weather.
- (c) For all installations within 50 km of the coast.
- (d) In plenum chambers containing humidifying equipment.
- (e) For surface mounted conduit installations in kitchens and boiler rooms.
- (f) In screeds resting directly on soil.
- (g) For connection points to future installations.
- (h) For underground conduit containing earthing conductors.
- (l) In buildings where animals are housed such as cattle, sheep, dogs, etc.

### **2.3 TERMINATIONS**

#### **2.3.1 Spouted Connections.**

Conduits shall be connected directly to draw-boxes with spouted connections. Conduits shall be screwed tightly home and no threads shall be visible.

#### **2.3.2 Switchboards, Power skirting, etc.**

Conduits shall be terminated by means of a brass female bush and two locknuts in pressed steel switchboards and distribution boxes, cable ducts, power skirting, etc. The conduit end shall only project far enough through the entry hole to accommodate the bush and locknut. Alternatively the method detailed in 2.3.3 may be used.

#### **2.3.3 Draw-boxes.**

A female bush and two locknuts shall be used to terminate conduits at draw-boxes and outlet boxes without spouts, should there be sufficient room in the box. Where there is insufficient room, a coupling, brass male bush and locknut may be used with sufficient allowance for the reduction of the internal diameter by the male bush.

#### **2.3.4 Holes.**

Holes to accommodate brass bushes shall be large enough to accommodate the bush with a minimum of clearance.

#### **2.3.5 Bush-nuts.**

Bush-nuts for the connection of earth conductors to conduits are not acceptable.

### **2.4 SCREWS, BOLTS AND NUTS**

Steel locknuts of thick gauge steel with milled sides shall be used in all cases. Cadmium-plated bolts and nuts shall be used except where the installation is exposed to the weather in which case brass bolts and

nuts shall be used. Screws shall be installed in all tapped holes in fittings and accessories to prevent damage to the screw thread by concrete or plaster. The screws shall be screwed completely down to prevent damage to the thread on the screw.

## **2.5 CONDUIT ENDS**

Conduit ends shall be cut at right angles to ensure that ends butt squarely at joints. Threads shall not be visible at joints and connections except at running joints. The total length of the thread on the two conduit ends shall not exceed the length of the coupling.

## **2.6 JOINTS**

All conduit ends shall be reamed and all joints tightly screwed. Only approved couplings shall be used. Running joints with long threads shall be kept to a minimum and locknuts shall be provided to ensure a strong mechanical and a continuous electrical joint. Running joints in screwed conduit are to be avoided as far as possible and all conduit systems shall be set or bent to the required angles. The use of normal bends must be kept to a minimum with exception of larger diameter conduits where the use of such bends is essential.

## **2.7 FINISH**

All joints shall be painted with red lead to prevent them from rusting in damp areas, areas within 50 km of the coast and in cases where the installation is exposed to the weather for any length of time. Where the galvanising or black paint has been damaged, the area shall first be cleaned and a coat of zinc base paint applied subsequently. Additional coats of paint shall only be applied after the undercoat has completely dried. All surface mounted non-galvanised metallic conduit must be painted. (Refer to par. 8.8 of Section B1).

## **2.8 CONTINUITY**

Mechanical and electrical continuity shall be maintained throughout the conduit installation.

## **3. PLAIN-END METALLIC CONDUIT**

As an alternative to the screwed conduit, plain-end conduit complying with the Department's standard specification for "CONDUITS AND CONDUIT ACCESSORIES", par. 7 of Section C1, may be installed subject to the following additional conditions:

- 3.1 Bending and setting of plain-end conduit must be done with special benders and apparatus manufactured for this purpose and which are obtainable from the suppliers of the system. Damaged conduit resulting from the use of incorrect bending apparatus shall be completely removed and any wiring already drawn into such damaged conduits shall be completely renewed at the Contractor's expense.
- 3.2 Screwed conduit must be used in the following instances:
  - (a) In flameproof installations.
  - (b) Load bearing conduit.
  - (c) For the suspension of luminaries.
  - (d) Surface mounted conduit.
- 3.3 Plain-end conduit and associated accessories shall be manufactured of mild steel having a minimum thickness of 1,2 mm and shall comply with SANS 1065. Conduit manufactured of lighter gauge material, i.e. 0,97 mm, will not be permitted.
- 3.4 All conduit and accessories used in areas within 50 km of the coast shall be hot-dip galvanised to SANS 32 & 121. In inland areas Electro-galvanised or cadmium-plated accessories will be accepted.

## 4. NON-METALLIC CONDUIT

### 4.1 INSTALLATION CONDITIONS

Where specified for a particular service, non-metallic conduit may be installed under the following conditions:

- 4.1.1 All non-metallic conduit shall comply fully with SANS 950 and shall be installed in accordance with Appendix C of the same specification as well as SANS 10142.
- 4.1.2 Insulated heat-resistant boxes shall be used for outlets of totally enclosed luminaires and other fittings where excessive temperatures are likely to occur.
- 4.1.3 Luminaires and other fittings shall not be supported by non-metallic conduit or conduit boxes. These fittings shall be secured to the surrounding structure in a way that is acceptable to the Department. Refer to the Department's standard specification for "INSTALLATION OF LUMINAIRES", Section B9.
- 4.1.4 The conduit shall be supported and fixed with saddles with a maximum spacing of 1 m, even in roof spaces. (Refer to SANS 10142.) The Contractor shall supply and install all additional supporting timbers required.
- 4.1.5 It shall be possible to rewire the completed installation in the future without undue difficulty.
- 4.1.6 Non-metallic conduit and fittings shall not be used under the following conditions:
  - (a) Outside a building (unless protected, or sheltered under eaves).
  - (b) For mechanical load bearing.
  - (c) Where they may be subjected to temperatures below -10°C or above 70°C for prolonged periods.
  - (d) As primary electrical insulation.
  - (e) In areas where they may be subject to mechanical damage.
  - (f) For applications other than those for which they are designed.
  - (g) In concrete slab unless specified to the contrary.

### 4.2 PAINTING OF CONDUITS

Exposed conduit may be painted with normal oil or PVA paints, but care must be taken to ensure that the paint used does not contain any component that will soften or have any other detrimental effect on the materials from which the conduit and fittings are manufactured.

### 4.3 CONNECTING OF CONDUIT TO METAL EQUIPMENT/COMPONENTS

When any part of a non-metallic conduit system has to be connected to metal equipment or components (e.g. switchboard, surface socket-outlet or switch box, existing metallic conduit system, etc.) fittings and joints manufactured specifically for this purpose must be used. Non-metallic conduit must not be threaded to fit metallic connectors.

### 4.4 BENDS

In conduit of nominal size not exceeding 25 mm, bends may be made in accordance with par. 4.5. In all other cases bends must be achieved by the use of accessories that are introduced into the conduit run. Bends shall comply with SANS 10142.

### 4.5 BENDING

Conduit of nominal size up to and including 25mm may be cold bent by hand provided that the radius of the bend is greater than six times the nominal size of the conduit, and that the external angle of the bend does not exceed 90°. The procedure (which involves the use of a bending spring) should be as follows:

- (a) Determine the angle through which the conduit is to be bent.
- (b) Warm the cold conduit over the length to be bent by rubbing with hands.
- (c) Select a bending spring which matches the conduit size and insert in to the conduit at the point where the bend is required.
- (d) Bend the conduit slowly with one motion (either with the hands alone approximately 1 m apart, or across the knee) to double the required angle, release the conduit and, when its position is stable, withdraw the bending spring (turning it in an anti-clockwise direction to reduce its diameter) and gently correct the angle.
- (e) Install and secure the conduit immediately following bending.

#### **4.6 ADHESIVE JOINTS**

All adhesive joints must be made in a clean dry area. The surfaces of all components to be bonded must be dry and clean.

The insertion depth should be marked on the conduit end and the adhesive applied (by means of a soft clean brush) as quickly as possible to the surfaces to be bonded by brushing lengthwise along the conduit, ensuring that a thin coating of uniform thickness is formed. The joint must be made immediately after the application of the adhesive by pushing the prepared parts squarely together with a twisting motion to the full insertion depth. Care must be taken to avoid squeezing adhesive into the cableway and all excess adhesive must be wiped off.

NOTE: Solvent adhesives contain highly volatile liquids and their containers should not be left open.

#### **4.7 Cutting**

A fine-tooth hacksaw should be used to cut conduit to the required length. Each cut end should be square and free from swarf, burrs and loose material. When determining the length of conduit to be cut, allowance must be made for the length of couplings or accessories attached to the conduit. Incorrect determination will cause bulging of the conduit or insufficient joint length.

### **5. FLEXIBLE CONDUIT**

- 5.1 In installations where the equipment has to be moved frequently to enable adjustment during normal operation, for the connection of motors or any other vibrating equipment, for the connection of thermostats and sensors on equipment, for stove connections and where otherwise required by the Department, flexible conduit shall be used for the final connection to the equipment.
- 5.2 The installation shall comply with SANS 10142.
- 5.3 Flexible conduit shall preferably be connected to the remainder of the installation by means of a draw-box. The flexible conduit may be connected directly to the end of a conduit if an existing draw-box is available within 2 m of the junction and if the flexible conduit can easily be rewired.
- 5.4 Flexible conduit shall consist of metal-reinforced plastic conduit or PVC-covered metal conduit with an internal diameter of at least 15mm, unless approved to the contrary. In false ceiling voids, flexible conduit of galvanised steel construction may be used. connectors for coupling to the flexible conduit shall be of the gland or screw-in type, manufactured of either brass or mild steel plated with either zinc or cadmium.

### **6. INSTALLATION REQUIREMENTS**

#### **6.1 POSITIONS OF OUTLETS**

All accessories such as boxes for socket-outlets, switches, lights, etc. shall be accurately positioned. It is the responsibility of the Contractor to ensure that all outlets are installed level and square, at the correct height from the floor, ceiling or roof level and in the correct position relative to building lines and equipment

positions as specified. It shall be the responsibility of the Contractor to determine the correct final floor, ceiling and roof levels in conjunction with the Main Contractor. Draw-boxes shall not be installed in positions where they will be inaccessible after completion of the installation. Draw-boxes shall be installed in inconspicuous positions to the approval of the Department's representative and shall be indicated on the "as built" drawings.

## 6.2 COVER PLATES

All draw-boxes and outlets shall be fitted with cover plates, either as part of the switch or socket assembly or with blank cover plates if unused. Blank cover plates shall match other cover plates in the same area. Flush mounted cover plates in both ceilings and walls shall overlap the draw-box and edges of the recess. If the fixing lugs are substantially deeper than the finished wall surfaces, suitable coiled steel wire or tubes shall be used as spacers.

## 6.3 DRAW-WIRES

Galvanised steel draw-wires shall be installed in all unwired conduits e.g. conduits for future extensions, telephone installations and other services.

## 6.4 BENDS

A maximum of two 90 bends or the equivalent displacement will be allowed between outlets and/or boxes.

Draw-boxes shall be installed at maximum intervals of 15 m in straight runs. All bends shall be made without heating the conduit or without reducing the diameter of the conduit. The inside radius of a bend shall not be less than five times the outside diameter of the conduit. (Refer to SANS 10142,

## 6.5 WALL SOCKET-OUTLETS

Where more than one socket-outlet is connected to the same circuit, the conduit shall be looped from one outlet box to the following on the same circuit. Where a metal channel is used, the conduit may be installed from the channel directly to the outlet box on condition that the conductors can be looped from one outlet to the next without making any joints in the wires.

## 6.6 LUMINAIRES

Where the conduit end is used to support luminaries, a ball-and socket type lid shall be fitted to the pendant box in all cases where the conduit is longer than 500 mm. In all other cases a dome lid may be used. Where luminaries are specified which are fixed directly to the pendant box, the pendant box shall be fixed independently of the conduit installation except where the pendant box is cast into concrete.

## 6.7 FLUSH MOUNTED OUTLET BOXES

The edges of flush mounted outlet boxes shall not be deeper than 10 mm from the final surface. Spacer springs shall be used under screws where necessary.

## 6.8 EXCESS HOLES

All excess holes in draw-boxes or other conduit accessories shall be securely blanked off by means of brass plugs to render the installation vermin proof.

## 6.9 DEBRIS

Care shall be taken to prevent debris or moisture from entering conduits during and after installation. Conduit ends shall be sealed by means of a solid plug which shall be screwed to the conduit end. Conduits shall be cleaned and swabbed to remove oil, moisture or other debris that may be present before conductors are installed. Swabs shall not be attached to the conductors.

6.10 Defects

Each length of conduit shall be inspected for defects and all burrs shall be removed. All conduits that are split, dented or otherwise damaged or any conduits with sharp internal edges shall be removed from site. The Contractor shall ensure that conduits are not blocked.

6.11 WITHDRAWAL OF CONDUCTORS

To ensure that all electrical conductors are easily withdrawable from conduits and to ensure that there are no joints in the conductors, the Department's representative will have the right to have the conductors of any circuit removed at his discretion. If the conductors are found to be in a satisfactory condition after having been withdrawn, the Department shall bear the cost of withdrawing and re-installing such conductors. If the conductors are found to have been damaged during installation or removal or if joints are found, they shall be replaced and the cost shall be borne by the Contractor.

**7. INSTALLATION IN CONCRETE**

7.1 TIMEOUS INSTALLATION

In order not to delay building operations, the Contractor shall ensure that all conduits and accessories which are to be cast in concrete are placed in position in good time. The Contractor or his representative shall be in attendance when the concrete is cast.

7.2 DRAW-BOXES

Draw-boxes, expansion joints and round ceiling boxes shall be installed where required and shall be neatly finished to match the finished slab and wall surfaces. Ceiling draw-boxes shall be of the deep type. In hollow block slabs, rear-entry draw-boxes shall be used. In columns where flush mounted draw-boxes are installed, the conduits shall be offset from the surface of the column immediately after leaving the draw-box.

7.3 ELBOWS

Elbows for conduits of 32mm dia. and smaller and sharp bends will not be allowed in concrete slabs.

7.4 COVER PLATES

Draw-boxes and/or inspection boxes shall, where possible, be grouped together under a common approved cover plate, and must preferably installed in passages or male toilets. The cover plate shall be secured by means of screws.

7.5 NEUTRAL AXIS

All conduits shall be installed as close as possible to the neutral axis of concrete beams, slabs and columns. The conduits shall be rigidly secured to the reinforcing to prevent movement towards the surface of the concrete.

7.6 FIXING TO THE SHUTTERING

All conduits, draw-boxes etc. shall be securely fixed to the shuttering to prevent displacement when concrete is cast. Draw-boxes and outlet boxes shall preferably be secured by means of a bolt and nut installed from the back of the box through the shuttering. Fixing lugs may also be used to screw the boxes to the shuttering. Wire will not be accepted for securing boxes to the shuttering where off-shutter finishes are required. Where fibreglass shuttering is used by the Builder, the equipment shall be fixed to the steel only and no holes shall be drilled or made in shuttering. All draw-boxes and outlet boxes shall be plugged with wet paper before they are secured to the shuttering.

Before any concrete slabs are cast, all conduit droppers to switchboards shall be neatly spaced and rigidly fixed.

**7.7 CONCRETE FLOOR SLABS**

Conduits will not be allowed in concrete floor slabs of boiler rooms (or boiler houses), laundries or other damp areas. All socket outlets and three phase outlets in damp areas shall be supplied from above with galvanised conduit and accessories.

**7.8 EXPANSION JOINTS**

As far as possible, conduits shall not be installed across expansion joints. Where this is unavoidable a conduit expansion joint shall be provided. (Refer to par. 10)

**7.9 SCREEDS**

The installation of conduits in floor screeds shall be kept to a minimum. Where conduits are installed in screeds, the top of the conduit shall be at least 20 mm below the surface of the screed. Where the screed is laid directly on the ground, galvanised conduits shall be used. This ruling will always be applicable to the lowest floor of a building. A minimum distance of twice the outside diameter of the conduit shall be left free between adjoining conduits. Conduits shall be secured to the concrete slab at intervals not exceeding 2 m. The Contractor shall ensure that conduits are not visible above the screed where the conduits leave the screed.

**7.10 INSPECTION**

All draw-boxes, conduits, etc. which are installed in concrete shall be cleaned with compressed air and provided with draw-wires two days after removal of the shuttering. Errors that occurred during the installation of the conduits, or any lost draw-boxes, or blocked conduits shall be immediately reported to the Department by telephone and confirmed in writing in order that an alternative route can be planned and approved by the Department before the additional concrete is cast. Any additional cost shall be for the Contractor's account.

**8. SURFACE INSTALLATIONS AND INSTALLATIONS IN ROOF SPACES**

Wherever possible, the conduit installation is to be concealed in the building work; however, where unavoidable or otherwise specified, conduit installed on the surface must be plumbed or levelled and only straight lengths shall be used.

**8.1 APPEARANCE**

- (a) All conduits shall be installed horizontally or vertically as determined by the route and the Contractor shall take all measures to ensure a neat installation.
- (b) Where conduits are to be installed directly alongside door frames, beams, etc. that are not true, conduits shall be installed parallel to the frames, beams, etc.
- (c) All labels shall be removed from surface mounted conduit.

**8.2 SADDLES**

Conduits shall be firmly secured by means of saddles and screws and in accordance with SANS 10142. Where saddles are used to secure vertical lengths of conduit connected to surface mounted switch boxes or socket outlet boxes, the saddles shall be spaced so that the intervals between the box and the first saddle, between any two successive saddles and between the last saddle and the ceiling or roof are equidistant. Conduits shall be secured within 150 mm before and after each 90° bend and within 100mm of each outlet box.

**8.3 JOINTS**

Joints will only be allowed in surface conduit lengths exceeding 3,5 m. Threads shall not be visible at joints of completed installations, except where running joints are used. Running joints will be allowed only when absolutely necessary. All running joints shall be provided with locknuts and shall be painted with red lead immediately after installation.

#### 8.4 ACCESSORIES

Inspection bends or tee pieces shall not be used. Non-inspection type bends may be used in the case of 32mm or 50 mm diameter conduits. All draw-boxes supporting luminaries or other equipment shall be fixed independently of the conduit installation.

#### 8.5 OFFSETS

Where an offset is required at conduit terminations or crossovers, the conduit shall be saddled at the offset.

#### 8.6 CROSS-OVER

Conduit routes shall be carefully planned to avoid crossovers. Where a crossover is inevitable, one conduit only shall be offset to cross the other. Crossovers shall be as short as possible and shall be uniform. Alternatively, crossovers shall be installed in purpose-made boxes. This method shall be employed on face brick walls and in other circumstances where required by the Department.

#### 8.7 PARALLEL CONDUIT

Parallel conduit runs shall be equidistant and saddles shall be installed in line. Alternatively, a special clamp may be used to secure all conduits in unison. In the case of conduits of different diameters, the latter method shall only be used if a purpose-made clamp designed to accommodate the various conduit sizes, is provided.

#### 8.8 PAINTING OF CONDUIT

All surface mounted conduits and accessories shall be painted with two coats of a high quality enamel paint or as otherwise specified. The colour shall comply with the colour code specified for the installation or where no code has been specified, shall match the colour of the surrounding finishes.

#### 8.9 CONDUIT IN ROOF SPACES

8.9.1 In open roof spaces (no ceiling) conduits shall run along the wall plates and the rafters. The installation of conduits suspended between the rafters is not acceptable.

8.9.2 Conduit in roof spaces shall be installed parallel or at right angles to the roof members and shall be secured at intervals not exceeding 1,5 m by means of saddles screwed to the roof timbers for metallic conduit and 1m for non-metallic conduit.

8.9.3 Nails or crampets will not be allowed.

8.9.4 Under flat roofs in false ceilings or where there is less than 900 mm clearance, or in instances where the ceilings are insulated with glass-wool or other insulating material impeding access, the conduit shall be installed in a manner which allows for wiring from below the ceilings.

8.9.5 Conduit runs from switchboards shall terminate in fabricated sheet steel draw-boxes installed directly above or in close proximity to the boards. Refer to the Department's standard specification for "CONNECTIONS TO SWITCHBOARDS", par. 2 of Section B10.

8.9.6 Spare conduits covering the total number of spare ways on switchboards, shall be provided between the boards and the roof draw-box.

8.9.7 Where non metallic conduit has been specified for a particular service, the conduit shall be supported and fixed with saddles with a maximum spacing of 450mm throughout the installation. The contractor shall supply and install all additional supporting timbers in the roof space as required.

#### 8.10 FIXING TO WALLS

Only approved plugging materials such as aluminium inserts, fibre plugs or plastic plugs, etc., and round-head screws shall be used when fixing saddles, switches, plugs etc. to walls. Wood plugs are not acceptable nor should plugs be installed in joints in brick walls.

## 9. FUTURE EXTENSIONS

### 9.1 OPEN ROOF SPACES

Conduits intended for future switches and socket outlets, shall terminate 40 mm above the tie beams in roof spaces with more than 900 mm free space. The conduit ends shall be threaded and fitted with a coupling and brass plug.

### 9.2 CONCRETE SLABS

Conduit ends shall protrude 150 mm from the concrete to facilitate the installation of future extensions above, below or to the side of the concrete slabs. All these conduits shall be connected to a draw-box, which is cast into the concrete within 2 m of the end of the concrete. Conduit ends shall be threaded and fitted with a coupling and brass plug. In cases where holes cannot be drilled through the shuttering to accommodate the conduit end, a deep draw-box with rear entry may be placed over the conduit end.

### 9.3 COVER PLATES

Unused boxes for switches and socket-outlets shall be covered with metal cover plates. Unused boxes for luminaries shall be covered with round galvanised metal cover plates, which fit tightly against the finished surface. The cover plate shall overlap the outlet box and recess.

### 9.4 GALVANISED CONDUIT

Galvanised conduit shall be installed at all free ends intended for future extensions. The conduit shall be treated with a paint, which will prevent corrosion and white rust.

## 10. EXPANSION JOINTS

10.1 Where conduits cross expansion joints in the structure, approved draw-boxes which provide a flexible connection in the conduit installation shall be installed. Refer to the Department's standard drawing No EE3/136/139.

10.2 The draw-box shall be installed adjacent to the expansion joint of the structure and a conduit sleeve, one size larger than that specified for the circuit, shall be provided on the side of the draw-box nearest the joint. The one end of the sleeve shall terminate at the edge of the joint and the other shall be secured to the draw-box by means of locknuts.

10.3 The circuit conduit passing through the sleeve shall be terminated 40 mm inside the draw-box and in the case of metallic conduit, the conduit end shall be fitted with a brass bush. The gap between the sleeve and the conduit at the joint shall be sealed with 'Pratley Tic-Tac' or equal sealing compound, to prevent the ingress of wet cement. In the case of metallic conduit, an earth clip shall be fitted to the conduit projection inside the draw-box and the conduit bonded to the box by means of 2,5mm<sup>2</sup> bare copper earth wire and a brass bolt and nut.

10.4 The end of the other circuit conduit shall be secured to the draw-box by means of locknuts and a brass bush in the case of screwed metallic conduit or a standard bushed adaptor for other conduit types.

10.5 In the case of metallic conduit, a 2,5mm<sup>2</sup> bare copper wire shall be installed between the first conduit boxes on either side of the joint, in addition to an earth wire, which may be specified for the circuit. The conduit boxes shall be drilled and tapped and the earth wire shall be bonded to the boxes by means of lugs and brass screws.

10.6 Suitable steel cover plates shall be screwed to draw-boxes installed along the expansion joint. The cover plates shall be installed before the ceilings are painted.

10.7 Where a number of conduits are installed in parallel they shall cross the expansion joint of the structure via a single draw-box. A number of draw-boxes adjacent to each other will not be allowed.

**11. CHASES AND BUILDER'S WORK**

- 11.1 Except where otherwise specified the Builder or Main Contractor shall be responsible for the builder's work related to the installation of conduits, outlet boxes, switchboard trays, bonding trays and other wall outlet boxes and will undertake the necessary chasing and cutting of walls and the provision of openings in ceilings and floors for luminaries and other electrical outlets. The Contractor shall notify the Builder or Main Contractor of his requirements and the responsibility lies with the Contractor to ensure that all builder's work is clearly indicated or marked in accordance with his requirements.
- 11.2 Electrical materials to be built in must be supplied, placed and fixed in position by the Contractor when required to do so by the Builder or Main Contractor. The Contractor shall also ensure that these materials are installed in the correct positions.
- 11.3 Where no Builder or Main Contractor is available, the Contractor must provide all chases and is required to cover conduits installed in chases by a layer of 4:1 mixture of coarse sand and cement, finished 6 mm below the face of the plaster and roughened. Chases shall be deep enough to ensure that the top of conduits are at least 12 mm below the finished surface of the plaster.
- 11.4 Where the Contractor is responsible for the cutting of chases or the building in of conduits and other equipment, he will be held responsible for all damage as a result of this work and will be required to make good to the satisfaction of the Department.

This ruling is particularly applicable but not exclusively to the rewiring and renewal of existing installations. Chases shall be made by means of a cutting machine.

- 11.5 Under no circumstances shall face brick walls or finished surfaces be chased or cut without the written permission of the Department. Where it is necessary to cut or drill holes in the concrete structure, the prior permission of the Department shall be obtained.

**SECTION B2****B2. INSTALLATION OF WIRING CHANNELS, UNDERFLOOR DUCTING AND POWER SKIRTING****1. RESPONSIBILITY OF THE CONTRACTOR**

The Contractor shall supply and install all wiring channels, underfloor ducting and power skirting as specified or as required for the cable, socket outlet and wiring installation including the necessary supports, hangers, fixing materials, bends, angles, junctions, T-pieces, etc. He shall further liaise with the Main contractor to verify the position of holes and access routes through the structure and finishes.

(Refer to the Department's quality specification for "WIRING CHANNELS, UNDERFLOOR DUCTING AND POWER SKIRTING", Section C2 to determine which types are acceptable).

**2. WIRING CHANNELS****2.1 FIXING**

The Contractor shall supply and install all hangers, supports or fixings for the channels. Channels up to and including 76 x 76 mm shall be supported at maximum intervals of 600 mm and larger channels at maximum intervals of 1 m. Channel runs shall be carefully planned to avoid clashes with other services and to ensure that all covers can be removed after completion of the entire installation. Purpose made clamps, hangers, etc. shall be used as required. Where it is not possible to support the channels at the specified intervals, they shall be supported in a sound manner to the satisfaction of the Department.

**2.2 INSTALLATION IN CONCRETE**

Where channels are cast into concrete, the insert type shall be used. Additional spacer blocks shall be used where necessary to prevent ducts from being deformed while the concrete is cast. Channels shall be filled with polystyrene or other suitable fillers to prevent the ingress of concrete and shall be securely fixed in position to the shuttering.

**2.3 COVER PLATES**

All channels up to and including 127mm width shall have snap-in cover plates of metal or PVC. Cover plates for wider channels shall be of metal and shall be fixed by means of screws at suitable intervals to prevent warping. Cover plates shall be installed over the full length of the channels. Flush mounted wiring channels shall be fitted with overlapping metal cover plates with plastic edge trim to cover irregularities in the wall recess.

**2.4 JOINTS**

Adjoining lengths shall be aligned and securely joined by means of fishplates fixed by mushroom bolts, washers and nuts or connection pieces that are pop-riveted to both adjoining sections. All adjoining sections shall be rectangular and shall butt tightly. Covers shall fit tightly across the joints.

Where channels cross expansion joints in the structure, suitable expansion joints shall be provided in the channels by means of fishplates pop-riveted or screwed to the channel on one side of the expansion joint and floating freely in the channel on the other side of the expansion joint.

**2.5 SUPPORT FOR CONDUCTORS**

All conductors in inverted cable channels shall be retained by means of metal clips or metal spacer bars at not more than 1m centres. Where vertical duct lengths exceed 5m, conductors installed in the channels shall be secured at intervals not exceeding 5m to support the weight of the conductors. Clamps shall be provided in suitable draw-boxes for this purpose.

## 2.6 CONDUIT CONNECTIONS

Conduit connections shall be terminated by means of two locknuts and a brass female bush. Where the channel is wide enough, conduit connections may be made by means of a conduit box and hole through the back or side of the channel. All holes through which conductors pass shall be fitted with bushes or grommets or shall be sleeved.

## 2.7 INTERNAL FINISHES

Bends and T-joints shall be constructed to ensure compliance with the allowable bending radii specified in SANS 10142, Appendix D in the case of PVC-insulated cables and conductors and shall comply with the relevant specification in the case of other cables. Burrs and sharp edges shall be removed and the inside edges of the joints shall be lined with rubber cement or other suitable rubberised or plastic compound to prevent laceration of the conductor insulation.

## 2.8 VERMIN PROOFING

All cable channels shall be vermin proofed after installation. Holes shall be covered by means of screwed metal plugs or by means of metal strips, which are bolted, or pop-riveted to the channel. Wooden or other plugs which are driven into holes or other temporary plugs or covers are not acceptable.

## 2.9 SERVICES

Multiple duct runs or internal metal partitions shall be used where conductors for power, control, communication and other services are present.

# 3. UNDERFLOOR DUCTING

## 3.1 GENERAL

3.1.1 Two or three compartment underfloor ducting as specified shall be supplied and installed in the positions and according to the layouts indicated on the drawings.

3.1.2 Three compartment ducting shall have a cross-section of approximately 200 x 32mm, subdivided into three approximately equal compartments, of which the centre compartment shall be used for electrical power distribution with the two outer compartments for telephone and other light current services respectively.

3.1.3 Unless specified to the contrary in the Detail Technical Specification or on the drawings, each compartment shall be provided with openings (occurring in line) at 1,5 m centres to permit installation of pedestals or recessed outlets in accordance with the design of the system. The openings shall have removable, flush, cover plates and shall have prepared fixing holes for future installation of pedestals or recessed outlets. The centre of the openings shall be offset a distance of 200 mm from the building nodule lines.

## 3.2 JUNCTIONS

The underfloor ducting installation shall be provided with flush cross-over, T-junction and right angle bend draw-boxes installed in the runs of ducting, generally as indicated on the drawings. The junction boxes shall be complete with cross-over of services. The junction boxes shall have nominal 300 x 300mm removable cover plates secured by means of four countersunk screws.

## 3.3 PEDESTAL UNITS

Where the system accommodates floor pedestal units, these shall consist of pressed steel or die cast aluminium units, suitable for either two or three services, as specified in the Detail Technical Specification. Where the pedestals are installed on vinyl tiled or similar floors which will be subject to washing, a matching waterproofing gasket shall be supplied below each pedestal to render the junction waterproof.

**3.4 INSTALLATION**

The underfloor ducting, junction boxes, pedestals, outlets and other accessories shall be installed strictly in accordance with the manufacturer's instructions and according to the following procedure:

- a) The underfloor ducting shall be installed on a mortar bed, provided by the Plasterer for purposes of levelling the channel to the final floor screed level. The Contractor shall assist the Plasterer in marking out the layout of the ducting to enable the mortar bed to be laid. Final height of the underfloor ducting shall be determined in close liaison with the Builder.
- b) After installation of the mortar bed, the components of the underfloor ducting shall be assembled and installed by the Contractor, following which the screeding will be completed.

**3.5 TERMINATIONS**

Up bends manufactured by the supplier of the underfloor ducting shall be supplied and installed wherever the ducting is terminated at a switchboard, telephone duct or telephone distribution box or where the ducting terminates behind power skirting.

**3.6 WIRING**

3.6.1 Power circuit wiring shall be installed in the centre compartment of the underfloor ducting. Sufficient slack shall be provided to allow for the installation of a floor pedestal outlet at each opening in the ducting, whether an outlet is specified at that position or not. This provision shall take the form of loops in the wiring, including the earth wire, wherever the openings occur. The loops shall be pushed back into the channel and the cover plates replaced. In the instances where pedestals/outlets are not installed, these provisions shall of necessity only be made for the area covered by the circuit and not for the run from the switchboard.

3.6.2 The entire underfloor ducting installation shall be effectively earthed and bonded together.

3.6.3 Galvanised draw-wires shall be supplied and installed along the entire length of the telephone and light current service compartments of the underfloor ducting. The draw-wires shall be interrupted at the junction boxes, with enough slack left coiled up to facilitate the drawing in of cables by others.

**3.7 EXPANSION JOINTS**

Where expansion joints in the buildings are crossed by underfloor ducting, expansion joints shall be provided as detailed in par. 2.4 of this section.

**4. POWER SKIRTING****4.1 GENERAL**

4.1.1 Two or three compartment power skirting as specified shall be supplied and installed in the positions and according to the layouts indicated on the drawings.

4.1.2 The top compartment shall be used for power wiring and switched socket outlets, whilst the bottom compartments shall be for telephone and other light current services.

**4.2 MODULE**

4.2.1 The power skirting shall be manufactured from 1mm (minimum) thick sheet steel or aluminium (as specified) in approximately 2,5m lengths.

4.2.2 The covers shall be manufactured in modular lengths, as specified in the Detail Technical Specification or otherwise in 1 m lengths and shall be secured to the wall channel by means of toggle or swivel nuts. Snap-in covers are also acceptable.

4.2.3 At the building module lines, covers of specified length or otherwise in 250 mm lengths shall be installed, against which partition walls may be installed, thereby trapping these covers. The removable modular covers shall be installed between these "fixed" covers.

- 4.2.4 Each modular cover associated with the power compartment shall be punched and prepared for the installation of either a 13A or a 16A, 3-pin standard flush switched socket outlet, whether any is specified or indicated for that module or not. Where socket outlets are not installed, the punched holes shall be blanked off with a metal blanking plate, painted the same colour as the power skirting and installed at the back of the covers. These blanking plates shall be easily removable to permit future installation of socket outlets.
- 4.2.5 Unless otherwise specified, no provision shall be made on the covers of the telephone or light current services compartments for the installation of sockets.
- 4.2.6 Factory-made end covers shall be installed at the ends of all runs of power skirting. All internal and external bends or offsets shall be factory-made and shall be installed to provide a neat and workmanlike appearance.

#### 4.3 PAINTING

The power skirting shall be painted in a colour as specified in the Detail Technical Specification. The painting of steel power skirting shall comply with the Department's "STANDARD PAINT SPECIFICATION", Section C39. Aluminium power skirting shall be anodised. The power skirting channels and covers shall be individually wrapped or packed to protect them against damage in transit and before installation.

#### 4.4 SOCKET-OUTLETS

- 4.4.1 Standard 13 A or 16 A, 3-pin flush switched socket outlets (100 x 50 mm nominal size) shall be supplied and installed in the positions indicated on the drawings and as specified in the Detail Technical Specification.
- 4.4.2 The switched socket outlets shall be secured to the channel by means of suitable brackets.
- 4.4.3 After installation of the modular front covers, they shall be screwed to the socket outlets to ensure proper alignment between the two components. Separate standard covers need not be provided for the socket outlets.

#### 4.5 CONDUIT FEEDERS

- 4.5.1 Conduits for the circuit wiring to the power skirting shall be installed in the floor slab and shall terminate in flush conduit or boxes, behind the power skirting and installed to match the height of the power, telephone and light current services compartments of the skirting.
- 4.5.2 The wiring/cables shall pass through large diameter holes cut in the rear of the power skirting. The holes shall be suitably bushed or trimmed to prevent damage to the wiring or cables.
- 4.5.3 Alternatively conduits feeding to the telephone compartment may be terminated in boxes facing upwards in the floor slab immediately below the power skirting, with suitable bushed or trimmed openings being provided through the bottom of the power skirting duct for the cables to pass through. (Applicable only where the power skirting occurs at floor level).

#### 4.6 POWER SKIRTING AT DOORWAYS

Where a section of power skirting is interrupted by a doorway, bridging conduits shall be installed to interconnect the power skirting sections. Where conduits are not specifically indicated, a minimum of 1 x 32mm bridging conduit shall be installed for each of the power, light current and telephone compartments.

#### 4.7 CLEANING

Prior to fitting front covers, the power skirting shall be thoroughly cleaned to remove all dust and rubble and damage to paintwork where this has occurred, shall be repaired.

**SECTION B3****B.3 INSTALLATION OF CABLE TRAYS AND LADDERS****1. GENERAL**

Cable trays and cable ladders complying with the Department's standard specification for "CABLE TRAYS AND LADDERS", Section C3 shall be supplied and installed where specified and/or where generally suitable for cable distribution.

**2. RESPONSIBILITY OF THE CONTRACTOR**

The Contractor shall supply and install all cable trays and/or ladders as specified or as required by the cable routes including the necessary supports, clamps, hangers, fixing materials, bends, angles, junctions, reducers, T-pieces etc. He shall further liaise with the Main Contractor for the provision of holes and access through the structure and finishes.

**3. SUPPORTS**

Cable tray supports shall consist of two steel hangar rods, at least 8mm in diameter, on both sides of the tray with a substantial steel cross-member on the underside of the tray and bolted to the rods. Alternatively, cable trays may be cantilevered from walls on suitable brackets.

**4. SPACING OF HORIZONTAL SUPPORTS**

4.1 Horizontal trays shall be supported at the following maximum intervals:

- |     |   |                      |
|-----|---|----------------------|
| (a) | 1,2 mm to 1,6 mm thick metal with 12mm to 19 mm return trays.                         | 1m maximum spacing   |
| (b) | 2,5 mm thick metal trays with 76 mm return  | 1,5m spacing.        |
| (c) | Cable ladders with 76mm side rail of 2mm thickness and with crossrungs.               | 1,5m spacing         |
| (d) | Metal cable ladders other than c) above, including site manufactured angle iron types | 1m spacing           |
| (e) | 3 mm thick PVC trays with 40mm return.  | 1m maximum spacing   |
| (f) | 4 mm thick PVC trays with 60mm return   | 1,5m maximum spacing |

4.2 In addition to the above spacing on the longitudinal run, trays and ladders shall be supported at each bend, offset and T-junction.

**5. JOINTS**

5.1 Joints shall be smooth and without projections or rough edges that may damage the cables. The Contractor will be required to cover joints with rubber cement or other non-hardening rubberised or plastic compounds if in the opinion of the Department joints may damage cables.

5.2 Joints shall as far as possible be arranged to fall on supports. Where joints do not coincide with supports, joints shall be made by means of wrap-around splices of the same material as the tray and at least 450mm long. The two cable tray ends shall butt tightly at the centre of the splice and the splice shall be bolted to each cable tray by means of at least 8 round head bolts, nuts and washers. Splices shall have the same finish as the rest of the tray.

5.3 Splices as described above shall be provided at joints, which do coincide with supports if the loaded tray sags adjacent to the joint due to the interruption of the bending moment in the tray.

## 6. FIXING TO SUPPORTS

Trays shall be bolted to supports by at least two round head bolts per support. Bolts shall be securely tightened against the tray surface to avoid projections which might damage cables during installation.

## 7. FIXING TO THE STRUCTURE

- 7.1 Where installed on concrete or brick, the supports for cable trays and ladders shall be securely fixed by means of at least 2 heavy duty, expansion type anchor bolts. Cantilevered trays shall be supported by a minimum of two 6mm diameter expansion bolts per support.
- 7.2 It is the responsibility of the Contractor to ensure that adequate fixing is provided since cable trays and ladders that work loose shall be rectified at his expense. The fixing shall take into account site conditions that prevail during installation.
- 7.3 Where installed on vertical steelwork, cable trays and ladders shall be fixed by means of 6mm diameter bolts and nuts.
- 7.4 On horizontal steelwork, use may alternatively be made of "CADDY" type fasteners.
- 7.5 Horizontal trays and ladders shall in general be installed 450 mm below slabs, ceilings, etc. to facilitate access during installation of cables.
- 7.6 Multiple runs shall be spaced at least 300 mm apart unless a different spacing is specified in the Detail Technical Specification.

## 8. INSTALLATION OF CABLES

Cables shall be installed adjacent and parallel to each other on the trays with spacings as specified in the Department's standard specification for "INSTALLATION OF CABLES", Section B6, and snaked slightly to allow for expansion. Cables shall present a neat appearance and shall under no circumstances be bunched. Cables shall be clamped at maximum intervals of 3 m when installed on horizontal trays and at maximum intervals of 600 mm when installed on vertical trays.

## 9. EARTHING

Metal trays and ladders shall be bonded to the earth bar of the switchboard to which the cables are connected. Additional bare copper stranded conductors or copper tape shall be bolted to the tray or ladder where the electrical continuity cannot be guaranteed. These additional conductors or tapes shall always be installed in outdoor applications and in coastal regions.

## 10. CORROSION

PVC trays shall be used in corrosive atmospheres. All supports shall be adequately protected against corrosion, preferably with a powder coated paint finish in accordance with the Department's "STANDARD PAINT SPECIFICATION", Section C39.

**SECTION B4****B.4 FIXING MATERIALS****1. RESPONSIBILITY**

It is the responsibility of the Contractor to position and securely fix conduits, ducts, cables and cable channels, switchboards, fittings and all other equipment or accessories as required for the Installation. The Contractor shall provide and fix all supports, clamps, brackets, hangers and other fixing materials.

**2. FINISHING**

All unpainted supporting steelwork installed by the Contractor shall be wire brushed and given one coat of rust-resisting primer, followed by one coat of high quality enamel paint before any other equipment is fixed.

**3. STRUCTURAL STEEL**

Supports, brackets, hangers, etc. may only be welded to structural steel members where prior permission of the Department has been obtained. "CADDY" or similar fasteners may be used to fix equipment to structural steel members.

**4. SCREWS AND BOLTS**

Where holes exist in equipment to be fixed, bolts and fixing screws as specified shall be used. Where sizes are not specified, the largest bolt or screw that will fit into the hole shall be used.

**5. WALL PLUGS**

Where the fixing holes in brick or concrete walls are smaller than 10mm dia. and where the mass of the equipment is less than 10kg, wall plugs may be used to fix conduits, cables and other equipment. Fibre or plastic plugs shall be used. Wooden Plugs are not acceptable. Aluminium plugs may be used in face bricks. Plugs installed in joints between bricks are not acceptable. A masonry drill of the correct size shall be used to drill holes for plugs. Round-headed screws of the correct diameter to match the specific plug shall be used throughout.

**6. ANCHOR BOLTS**

Where the fixing holes are 10mm and larger or where the mass of the equipment is 10kg, equipment shall be fixed by means of expanding anchor bolts or by means of bolts cast into the concrete or built into walls.

**7. GALVANISED EQUIPMENT**

Brass screws bolts and nuts shall be used to fix galvanised equipment.

**8. SHOT-FIRED FIXING**

8.1 Materials such as metal cable ducts or channels may be fixed against walls and concrete slabs by means of the shot-fired fixings.

8.2 The Contractor shall ascertain whether this method of fixing will carry the weight of the material including conductors, cables and other items of equipment to be installed later. Should it be found that the method of fixing is inadequate and supports tend to loosen, the Contractor will be required to fix the material by an alternative method to the satisfaction of the Department.

8.3 Where the shot-fired method is used, warning signs shall be placed at all entrances leading to the area where this work is in progress. The Contractor shall take all reasonable precautions to prevent accidents. Refer also to The Occupational Health and Safety Act.

8.4 Nails and explosive charges recommended by the manufacturer shall be used throughout.

**9. CLAMPS AND BRACKETS**

Clamps and brackets used to fix or support equipment such as cable trays, ducts, etc. shall be of a purpose-made type suitable for the specific application. Refer also to the Department's standard specification for "CABLE TRAYS AND LADDERS", Section B3 and "INSTALLATION OF WIRING CHANNELS", Section B2.

**SECTION B5****B.5 WIRING**

This section covers wiring in approved wire-ways for electrical installations in buildings or other structures under normal environmental conditions for 50 Hz systems not exceeding 600 V.

**1. TYPE OF CONDUCTORS**

PVC-insulated or equivalent, stranded copper conductors and bare stranded or green PVC-insulated copper earth conductors complying with the Department's quality specification for "PVC-INSULATED CABLES", Section C4, shall be used exclusively. Only where cables are specified or in instances where the exceptions stipulated in SANS 10142 are applicable, may the Contractor deviate from this requirement.

**2. WIRE-WAYS**

- 2.1 All unarmoured conductors shall be installed in conduits, cable channels (trunking) or power skirting and shall under no circumstances be exposed. Cable channels and power skirting shall be of metal construction unless specifically approved to the contrary.
- 2.2 Tenderers must note that common wire-ways will only be permitted for relatively light current-carrying conductors such as lighting and socket-outlet circuits. Refer also to par. 4 below. Heavy current-carrying conductors such as feeders to distribution boards and large power points, must be installed in separate conduits or wire-ways.

**3. ORDER OF WORK**

Wiring shall only be carried out after the wire-way installation has been completed, but before painting has commenced. Debris and moisture shall be removed from the wireways prior to the installation of the conductors.

**4. CIRCUITS**

Conductors that are connected to different switchboards, shall not be installed in the same wireway. The wiring of one circuit only will be allowed in a 20 mm dia. conduit with the exception of the wiring from switchboards to fabricated sheet metal boxes close to switchboards in which case more than one circuit will be allowed. For larger conduit sizes the requirements of SANS 10142, shall be met.

**5. LOOPING AND JOINTS**

A loop-in wiring system where conductors are looped from outlet to outlet, shall be employed. Joints in conductors shall be avoided as far as possible but where it becomes unavoidable, joints will be accepted in cable channels only and not in conduits. Joints shall be soldered or shall alternatively consist of approved ferruling, properly covered with heat-shrink sleeves. The use of PVC insulation tape is not acceptable.

**6. GROUPING OF CONDUCTORS**

In cases where the conductors of more than one circuit are installed in the same wireway, the conductors of each separate circuit (including earth conductor) shall be taped at intervals of 1m with PVC insulation tape. The conductors of different circuits shall however remain separate in order that any given circuit can be withdrawn. Conductors entering switchboards or control boards shall be grouped and bound by means of plastic or metal bands (not tape).

**7. CABLE TRAYS**

Conductors may only be installed directly on cable trays if specifically approved by the Department. In these cases cable trays shall be at least 2m above walkways or working areas. Conductors of the same circuit shall be grouped in the same manner as described in the previous paragraph. All the conductors on the

cable tray shall then be tied down securely to the cable tray at intervals of 2m or less by means of plastic or metal bands (not tape).

## 8. DRAWING-IN OF CONDUCTORS

When conductors are drawn through conduit, care shall be taken that they are not kinked or twisted. Care shall also be taken that the conductors do not come into contact with materials or surfaces that may damage or otherwise adversely affect the durability of the conductor.

## 9. THREE-PHASE OUTLETS

9.1 With the exception of three-phase outlets, circuits connected to different phases shall not normally be present at lighting, switch or socket outlet boxes. Where this is unavoidable, barriers shall be provided between terminals or connections of the various phases and the box shall be suitably labelled internally to indicate the presence of three phase voltages.

9.2 A neutral conductor shall be installed to all three phase outlets intended for equipment connection, whether sockets or isolators, irrespective of whether the particular equipment normally requires a neutral or not.

## 10. VERTICAL CONDUIT INSTALLATION

Conductors installed in vertical wire-ways shall be secured at intervals not exceeding 5m to support the weight of the conductors. Clamps shall be provided in suitable drawboxes for this purpose.

## 11. CONNECTIONS

The insulation of conductors shall only be removed over the portion of the conductors that enter the terminals of switches, socket outlets or other equipment. When more than one conductor enters a terminal, the strands shall be securely twisted together. Under no circumstances shall strands be cut off.

## 12. EARTHING CONDUCTORS

12.1 When earth continuity conductors are looped between terminals of equipment, the looped conductor ends shall be twisted together and then soldered or ferruled to ensure that earth continuity is maintained when the conductors are removed from a terminal.

12.2 The installation shall be earthed to comply with SANS 10142.

12.3 The installation shall be bonded to comply with SANS 10142.

## 13. COLOURS

The colours of conductor insulation shall comply with SANS 10142. The colours of conductors for sub-circuits shall as far as possible correspond with the colour of the supply phase. The colours of conductors for wiring to two-way and intermediate switches shall preferably differ from the colour of phase conductors.

## 14. SINGLE-POLE SWITCHES

Single-pole switches shall be connected to the phase conductor and not to the neutral conductor.

## 15. SIZE OF CONDUCTORS

Where conductor sizes are not specified, the following minimum conductor sizes shall be used:

Lighting circuits: 1,5mm<sup>2</sup> and 2,5mm<sup>2</sup> copper earth conductor

Socket-outlet circuits: 2,5mm<sup>2</sup> and 2,5mm<sup>2</sup> copper earth conductor.

Bell circuits: 1,5mm<sup>2</sup>

Stove circuits: 10mm<sup>2</sup> and 6mm<sup>2</sup> copper earth conductor

Clock circuits: 1,5mm<sup>2</sup>

## **16. PARTITIONS**

16.1 When wiring is installed in removable partitions, the vertical and/or horizontal metal supports of the walls may be utilised for wiring on condition that:

- (a) the conductors are not exposed,
- (b) the metal supports are properly earthed,
- (c) a separate bare earth continuity conductor is drawn in together with the current carrying conductors and is earthed to the metal parts of the switches and/or the socket-outlets, and
- (d) conductors are installed in the metal and non-inflammable sections of the partitions.

16.2 Conductors enclosed in a copper braiding (harness wiring) may be installed in removable partitions. The braiding can be used as earth continuity conductor. The wiring shall be joined to the conduit (or cable) installation by interconnecting the conductor and the earth conductors in a draw-box using suitable ferrules and heat-shrink sleeves or screwed terminals.

**SECTION B6****B.6 INSTALLATION OF CABLES**

This section covers the installation of cables for the distribution of power in buildings, other structures and in ground for system voltages up to 11 kV, 50 Hz.

**1. GENERAL**

## 1.1 CABLE TYPES

- (a) All cables and jointing and termination accessories used for power distribution shall comply with the Department's Quality Specifications, Section C.
- (b) Cables with copper conductors shall be used throughout unless otherwise specified or approved.
- (c) All unarmoured cables shall be installed in metal trunking, sleeves or conduit unless clearly specified to the contrary.
- (d) XLPE Cables shall only be used in exceptional circumstances with the written permission of the Department.

## 1.2. COMPETENCE OF PERSONNEL

It is a definite requirement that the Contractor shall only employ personnel fully conversant with cable manufacturer's recommendations for joining and terminating cables.

**2. IDENTIFICATION OF CABLES**

- 2.1 Cables shall be identified at all terminations by means of punched metallic bands or marked with labels or tags. (Refer also to SANS 10142).
- 2.2 The use of PVC tape with punched characters is not acceptable.
- 2.3 The identification numbers of cables shall be shown on "as built" drawings of the Installation.

**3. TRENCHING**

## 3.1 GENERAL

- 3.1.1 The Contractor shall be responsible for all trenching excavations unless specified to the contrary.
- 3.1.2 The Contractor shall, before trenching commences, familiarise himself with the routes and site conditions and the procedure and order of doing the work shall be planned in conjunction with the general construction programme for other services and building requirements.
- 3.1.3 The Contractor shall acquaint himself with the position of all the existing services such as stormwater pipes, water mains, sewer mains, gas pipes, telephone cables, etc. before any excavations are commenced. For this purpose he shall approach this Department's representative, the local municipal authority and any other authority which may be involved, in writing.
- 3.1.4 The Contractor will be held responsible for damage to any existing services brought to his attention by the relevant authorities and shall be responsible for the cost of repairs.
- 3.1.5 The Contractor shall take all the necessary precautions and provide the necessary warning signs and/or lights to ensure that the public and/or employees on site are not endangered.
- 3.1.6 The Contractor shall ensure that the excavations will not endanger existing structures, roads, railways, other site constructions or other property.

**3.2 MECHANICAL EXCAVATORS**

3.2.1 Power driven mechanical excavators may be used for trenching operations provided that they are not used in close proximity to other plant, services or other installations likely to be damaged by the use of such machinery.

**3.2.2**

3.2.2 The use of power driven mechanical excavators shall be subject to the approval of the Department. Should the excavator produce trenches that exceed the required dimensions, payment based on volumetric excavation rates will be calculated on the required dimensions only.

**3.3 BLASTING**

3.3.1 No guarantee is given or implied that blasting will not be required.

3.3.2 Should blasting be necessary and approved by the Department, the Contractor shall obtain the necessary authority from the relevant Government Departments and Local Authorities. The Contractor shall take full responsibility and observe all conditions and regulations set forth by the above authorities.

**3.4 ROUTES**

3.4.1 Trenches shall connect the points shown on the drawings in a straight line. Any deviations due to obstructions or existing services shall be approved by the Department beforehand. Refer also to par. 10.4.

3.4.2 The Department reserves the right to alter any cable route or portion thereof in advance of cable laying. Payment in respect of any additional or wasted work involved shall be at the documented rates.

3.4.3 The removal of obstructions along the cable routes shall be subject to the approval of the Department.

**3.5 SHORING AND WATERLOGGING**

3.5.1 The Contractor shall provide shoring for use in locations where there is a danger of the sides of the trench collapsing due to waterlogging or other ground conditions. Refer to the The Occupational Health and Safety Act.

3.5.2 The strength of shoring must be adequate for site conditions prevailing and the shoring must be braced across the trench.

3.5.3 The Contractor shall provide all pumps and equipment required to remove accumulated water from trenches. Water or any other liquid removed shall be disposed of without any nuisance or hazard.

**3.6 TRENCHING**

3.6.1 Trenching shall be programmed in advance and the approved programme shall not be departed from except with the consent of the Department.

3.6.2 Trenches shall be as straight as possible and shall be excavated to the dimensions indicated in this specification.

3.6.3 The bottom of the trench shall be of smooth contour, and shall have no sharp dips or rises which may cause tensile forces in the cable during backfilling.

3.6.4 The excavated material shall be placed adjacent to each trench in such a manner as to prevent nuisance, interference or damage to adjacent drains, gateways, trenches, water furrows, other works, properties or traffic. Where this is not possible the excavated materials shall be removed from site and returned for backfilling on completion of cable laying.

3.6.5 Surplus material shall be removed from site and disposed of at the cost of the Contractor.

- 3.6.6 Trenches across roads, access ways or footpaths shall not be left open. If cables cannot be laid immediately the Contractor shall install temporary "bridges" or cover plates of sufficient strength to accommodate the traffic concerned.
- 3.6.7 In the event of damage to other services or structures during trenching operations the Contractor shall immediately notify the Department and institute repairs. (Refer to par. 3.1.3 and 3.1.4)
- 3.6.8 Prior to cable laying the trench shall be inspected thoroughly and all objects likely to cause damage to the cables either during or after laying shall be removed.
- 3.6.9 Where ground conditions are likely to reduce maximum current carrying capacities of cables or where the cables are likely to be subjected to chemical or other damage or electrolytic action, the Department shall be notified before installing the cables. The Department will advise on the course of action to be taken.
- 3.6.10 Extreme care shall be taken not to disturb surveyor's pegs. These pegs shall not be covered with excavated material. If the surveyor's pegs are disturbed, they shall be replaced by a person qualified to do so.

### 3.7 DIMENSIONS OF TRENCHES

- 3.7.1 Cable trenches for one or two cables shall not be less than 300 mm wide and need not be more than 450 mm wide. This dimension shall be valid for the total trench depth.
- 3.7.2 The width shall be increased where more cables are installed to allow for the spacings stipulated in par. 4.2.
- 3.7.3 Where trenches change direction or where cable slack is to be accommodated, the Contractor shall ensure that the requirements of the relevant SANS Specification regarding the bending radii of cables are met when determining trench widths.
- 3.7.4 Trench depths shall be determined in accordance with cable laying depths and bedding thickness.
- 3.7.5 Payment will be made on a volumetric excavation rate calculated on the basis of the given maximum dimensions or the actual dimensions, whichever is the lesser. Refer also to par. 3.2.2 and 3.7.1 above.

### 3.8 JOINT HOLES

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 jointer to work efficiently and unimpeded.

### 3.9 BEDDING

- 3.9.1 The bottom of the trench shall be filled across the full width with a 75mm layer of suitable soil sifted through a 6mm mesh and levelled off.
- 3.9.2 Only sandy clay or loam soil with a satisfactory thermal resistivity (not exceeding 1,5°C m/W) may be used for this purpose. Sea or river sand, ash, chalk, peat, clinker or clayey soil shall not be used. The use of crusher sand is acceptable.
- 3.9.3 Where no suitable soil is available on site, the Contractor shall import fill from elsewhere and make all the necessary arrangements to do so. The cost of importing soil for bedding purposes shall be included in the unit rates for excavations.
- 3.9.4 After cable laying a further layer of bedding shall be provided to extend to 75 mm above the cables.
- 3.9.5 The bedding under joints shall be fully consolidated to prevent subsequent settling.

**3.10 CABLE SLEEVES**

- 3.10.1 Where cables cross under roads, railway tracks, other service areas, etc. and where cables enter buildings, the cables shall be installed in Polyethylene (6mm thickness), asbestos cement pipes or earthenware pipes. Pitch fibre and PVC pipes are not acceptable because of the adhesion that occurs after a period of time between the pipe and the sheathing or outer serving of the cables.
- 3.10.2 Pipes shall be joined in accordance with the manufacturer's instructions.
- 3.10.3 Sleeves shall cross roads and railway tracks at right angles.
- 3.10.4 Sleeves shall have a minimum diameter of 100mm. They shall extend at least 2m beyond the tracks of a railway line or of the outermost tracks where there is more than one line. In the case of roads, the sleeves shall extend at least 1m beyond the road edge or kerb on both sides of the road.
- 3.10.5 All sleeves shall be graded 1:400 for water drainage.
- 3.10.6 Cable sleeves shall be installed to the spacings and depths stated in paragraph 4 below.
- 3.10.7 Galvanised metallic sleeves up to and including 76mm dia. shall be supplied and installed by the contractor.
- 3.10.8 The ends of all sleeves shall be sealed with a non-hardening watertight compound after the installation of cables. All sleeves intended for future use shall likewise be sealed.

**3.11 BACKFILLING**

- 3.11.1 The Contractor shall not commence with the backfilling of trenches without prior notification to the Department so that the cable installation may be inspected. Should the Contractor fail to give a timeous notification, the trenches shall be re-opened at the Contractor's cost. Such an inspection will not be unreasonably delayed.
- 3.11.2 For high voltage cables (1 kV to 11 kV) a coloured plastic marking tape shall be installed 400 mm above the cable. The tape shall be yellow, marked with the words "ELECTRIC CABLE/ELEKTRIESE KABEL" in red. These markings shall not be more than 1m apart from centre to centre.
- 3.11.3 Backfilling shall be undertaken with soil suitable to ensure settling without voids. The maximum allowable diameter of stones present in the backfill material, is 75mm.
- 3.11.4 The Contractor shall have allowed in his tender for the importation of suitable backfill material if required.
- 3.11.5 The backfill shall be compacted in layers of 150mm and sufficient allowance shall be made for final settlement. The Contractor shall maintain the refilled trench at his expense for the duration of the contract. Surplus material shall be removed from site and suitably disposed of.
- 3.11.6 On completion, the surface shall be made good to match the surrounding area.
- 3.11.7 In the case of roadways or paved areas the excavations shall be consolidated to the original density of the surrounding material and the surface finish reinstated.

**3.12 CABLE MARKERS (FOR HV CABLES ONLY, EXCEPT WHERE OTHERWISE SPECIFIED)**

- 3.12.1 Cable markers shall be provided along all HV cable routes but need only be provided along LV cable routes where specified.
- 3.12.2 Cable markers shall consist of concrete blocks in the shape of truncated pyramids, approx. 300mm high, 150 x 150mm at the top and 250 x 250mm at the bottom.
- 3.12.3 Brass plates shall be cast into the tops of the blocks in such a manner that they cannot be prised loose. The wording "ELECTRIC CABLE/ELEKTRIESE KABEL" shall be stamped on the brass plates as well as direction arrows and the cable voltage rating.

- 3.12.4 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.
- 3.12.5 Cable markers shall be installed at the beginning and end 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.
- 3.12.6 The position of cable markers shall be indicated on the "as built" drawings.
- 3.13 TRANSNET, PROVINCIAL ADMINISTRATION OR NATIONAL ROAD CROSSINGS
- 3.13.1 The Contractor shall not trench beneath any railway tracks without the TRANSNET Administration's supervision. The Contractor shall request the Department timeously to arrange for the necessary supervision. The cost of such supervision will be paid for by the Department.
- 3.13.2 The Department will arrange for the necessary wayleave and permission to cross TRANSNET property and railway tracks, or Provincial or National road reserves and TELKOM Authority approval of proposed cable routes.
- 3.13.3 The Contractor shall carry out the crossing installation in strict accordance with the TRANSNET and Provincial Administration's requirements and stipulations. Where these requirements are in contradiction with this specification, the Department's ruling shall be sought.
- 3.13.4 The Contractor shall ensure that he will comply with the various Administration's requirements regarding crossing of Provincial and National roads, especially with regard to the safeguarding of the public. The Contractor shall also provide proof of adequate insurance cover against any claim from any accident as a result of work done by the Contractor during the crossing operation. The Department shall also be indemnified from all liability in this regard.
- 3.13.5 The Contractor shall liaise with the various Administrations well in advance regarding the intended dates, times and expected duration of the crossing operations and obtain their approval of the programme and method of operation before commencing with the work.

#### 4. INSTALLATION OF UNDERGROUND CABLES

##### 4.1 INSTALLATION DEPTHS

- 4.1.1 Cables shall be installed at the following minimum depths below final ground level :

Up to 11kV : 800mm

- 4.1.2 All cable depth measurements shall be made to the top of the cable when laid directly in ground or to the top of the duct or sleeve where these are provided.
- 4.1.3 The above depths shall apply to the top layer where cables are installed in layers.
- 4.1.4 The Contractor may only deviate from the above depths provided prior authority in writing has been obtained from the Department. In this event the cables shall be protected with a suitable concrete covering.
- 4.1.5 The depth of cable pipes or ducts beneath railway lines or roads shall be not less than 1,1 m below the formation level.

##### 4.2 CABLE SPACINGS

- 4.2.1 Cables installed in the same trench shall be laid parallel to each other with the following spacings between cables (LV: up to 1 kV; HV: 1 kV to 11 kV):

LV/LV	:	2 cable diameters
LV/HV	:	150mm minimum

HV/HV	:	150mm minimum
LV/HV/PILOT	:	1 cable diameter

- 4.2.2 Where HV and LV cables have to be installed in the same trench, both shall be laid at a depth of 800 mm and then covered with 200mm of soil. The soil shall then be compacted, and then backfilled layer by layer and compacted until the trench is completely backfilled.
- 4.2.3 Cables for telephones, communication systems and other low voltage systems (less than 50 V) shall be separated from power cables by at least 1m. All control or pilot cables without a lead sheath and steel armouring shall be laid at least 300mm from power cables.
- 4.2.4 Cables shall not be buried on top of each other unless layers are specified. The minimum spacing between layers shall be 200mm.

#### 4.3 CABLE LAYING

- 4.3.1 Except where ducts, tunnels or pipes are provided, cables shall be laid directly in the ground.
- 4.3.2 The cable shall be removed from the drum in such a manner that the cable is not subjected to twisting or tension exceeding that stipulated by the cable manufacturer.
- 4.3.3 Cable rollers shall be used as far as possible to run out cables. Rollers shall be spaced so that the length of cable in the trench will be totally suspended during the laying operation and sufficiently close to prevent undue sagging and the cable from touching the ground. Rollers shall also be placed in the trench in such a manner that they will not readily capsize.
- 4.3.4 Cable rollers shall have no sharp projecting parts liable to damage the cables.
- 4.3.5 Where cables have to be drawn around corners, well-lubricated skid plates shall be used. The skid plates shall be securely fixed between rollers and shall constantly be examined during cable laying operations.
- 4.3.6 Where cables have to be drawn through pipes or ducts, a suitable cable sock shall be used and particular care shall be exercised to avoid abrasion, elongation or distortion of any kind. In the case of oil filled cables, a cable sock may never be used. Special eyes giving access to the interior of the cable, must be utilised.
- 4.3.7 The maximum allowable tension when pulling a cable, is 70 N/mm<sup>2</sup> of conductor area.
- 4.3.8 It will be assumed that the price or rates contained in the tender includes for the installation of cables in pipes and ducts or below existing or newly installed services.
- 4.3.9 The Department shall be informed timeously of the intention to carry out all cable laying operations to allow an inspection of the works by the Department if so required.

### 5. INSTALLATION OF CABLES IN CONCRETE TRENCHES

#### 5.1 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.

#### 5.2 INSTALLATION

Cables shall be installed in one of the following ways:

- (a) On horizontal cable trays.
- (b) On horizontal metal supports with suitable clamps.
- (c) On vertical cable trays or metal supports fixed to the side of the trench. The cables shall be clamped in position.

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

### **5.3 COVERS**

5.3.1 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.

5.3.2 Cables shall enter and exit the trench through sleeves protruding 300mm 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.

### **5.4 FILLED TRENCHES**

5.4.1 Where specified, floor trenches shall be filled with fine crusher sand (no river or sea sand).

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

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

- (a) Reinforced concrete covers.
- (b) Sand and cement screed.
- (c) Removable chequer plates.

5.4.4 Method (a) above shall be used where vehicular traffic may be encountered over trenches. Unless otherwise specified allowance for a mass of 2 tons shall be made.

5.4.5 Cable trenches in substations, switch rooms and generator rooms shall be covered in accordance with the Department's standard specification for "COVERING AND SEALING OF CABLE TRENCHES", Par. 9 of Section B13.

## **6. FIXING OF CABLES TO TRAYS OR STRUCTURES**

### **6.1 INSTALLATION**

Cables may be installed in one of the following ways:

- (a) On horizontal cable trays.
- (b) Against vertical cable trays with suitable clamps.
- (c) Against horizontal or vertical metal supports or brackets with suitable clamps.
- (d) On clamps which are fixed to the structure.

### **6.2 CLAMPS**

Suitable clamps (cleats) which will secure cables without damage shall be used. Metal clamps or drilled hard wood blocks shall be used. Clamps shall consist of adjustable metal wings which clamp to a metal support, or consist of two halves that are bolted together. The correct clamp size to fit the cable shall be used. Cables of different sizes may only be fixed by a common clamp when the clamp is specially made to accommodate the various cables.

### **6.3 SPACING OF SUPPORTS**

Two methods of supporting cables are found in practice. The most generally known method is the restrained installation where the distance between supports is small enough to prevent any noticeable sag in the cable. The alternative method is the unrestrained installation where the distance between supports should be great enough to ensure that there will be obvious sag in each span between supports.

**6.4 SPACING OF SUPPORTS OF UNRESTRAINED CABLES**

Large single core cables shall always be installed according to this method. Generally, single core cables with conductors exceeding a cross sectional area of 185mm<sup>2</sup> should be supported at spacings in excess of 2m since the sag between supports will safely accommodate any thermal expansion.

Reducing the spacing between the supports to 1,5m or less shall be avoided at all costs, as expansion cannot be taken up by a change of sag and chances of sheath failure become considerable.

**6.5 SPACING OF SUPPORTS OF RESTRAINED CABLES**

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 550mm for unarmoured cables and 30 times the outside diameter of the cable with a maximum spacing of 900mm for armoured cables. Spacing of supports for cables for high voltage lighting shall be in accordance with Table 8 of SANS 10142. A minimum of 20mm ventilation clearance shall be maintained between cables and the wall to which they are cleated.

**7. GROUPING AND SPACING OF CABLES IN BUILDINGS AND STRUCTURES****7.1 SPACING CORRECTION FACTORS**

Cables shall as a rule be spaced two cable diameters apart, for which no grouping correction factor need be applied.

**7.2 CABLES ON DIFFERENT LEVELS**

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 300mm shall be maintained.

**7.3 SINGLE CORE CABLES**

Where single core cables are installed along a three-phase circuit, the cables shall be installed in trefoil formation and bound together at 300mm intervals.

**7.4 HIGH VOLTAGE CABLES**

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.

**7.5 CABLES FOR OTHER SERVICES**

Cables for telephones, communication systems and 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 installed on separate cable trays or shall otherwise be at least 1m away from power cables. Where unarmoured cables are used for these other services, they shall be installed in separate conduits or metal channels.

TABLE B6.1

Cross-Sectional Area of Cable Conductors (mm <sup>2</sup> )	MAXIMUM SPACING OF SUPPORTS (CLEATS) (mm) FOR RESTRAINED CABLES			
	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	450	750	300	400
2,5	450	750	300	400
4,0	600	750	300	400
6,0	600	750	300	400
10,0	750	900	400	450
16,0	750	1000	400	550
25,0	900	1000	450	550
35,0	900	1000	450	550
Bigger than 35,0	900	1000	450	550

For larger cables the spacing shall be 10 x outside diameter of the cable.

## 8. TERMINATION AND JOINTING OF CABLES

### 8.1 GENERAL

8.1.1 Cable ends shall be terminated with glands or in cable boxes with the associated accessories such as clamps, shrouds, etc. complying in all respects with the Department's quality specifications, Section C.

8.1.2 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:

- No. 1 conductor : left (red) (A)
- No. 2 conductor : centre (white) (B)
- No. 3 conductor : right (blue) (C)

8.1.3 Exposed armoring shall be covered with bitumen-base paint.

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

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

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

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

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

### 8.2 TERMINATION OF PAPER-INSULATED CABLES

8.2.1 The ends shall be terminated in cable end boxes filled with bituminous, cold filling or resin oil semi-fluid compound or heat-shrinkable terminations in accordance with the Department's standard specification for "CABLE END BOXES AND COMPOUND", Section C8 or "CABLE TERMINATIONS AND JOINTS", Section C6.

8.2.2 Heat-shrinkable materials shall only be used in exceptional circumstances with the written permission of the Department.

8.2.3 Before terminating or jointing paper-insulated cables, a test to establish the presence of moisture must be carried out.

The following procedure may be followed:

- (a) Place an adequate quantity of cable impregnating oil in a suitable container and heat up to  $130\text{ C} \pm 5\text{ C}$ .
- (b) Cut a small length ( $\pm 300\text{mm}$ ) of the cable concerned and remove the armouring and sheath, taking care not to handle the dielectric in any way.
- (c) Dip a section of the outer insulating impregnated paper (belt paper) in the heated oil, taking care not to contaminate the tapes with moisture from the hands. If frothing appears on the surface of the oil, this is a clear indication of the presence of moisture in the paper.
- (d) The same procedure should then be repeated on the insulating impregnated paper around the conductors (especially those layers closest to the conductors). Frothing will also indicate the presence of moisture.
- (e) Should only a small number of bubbles appear on the surface of the oil, this is an indication of air bubbles on the paper and not moisture since the presence of moisture will result in a series of bubbles rising to the surface of the oil for a number of seconds, until all moisture has been removed.

8.2.4 The armouring shall be bonded to the main earth bar of the switchgear or transformer, but the bond shall be easily removable for testing purposes.

8.2.5 The lead sheath shall be wiped against the conical wiping gland.

8.2.6 All cut cable ends which will be exposed to the atmosphere for more than two hours shall be sealed and wiped to prevent penetration of moisture.

### 8.3 TERMINATION OF XLPE CABLES

8.3.1 These cables shall only be used in exceptional circumstances and only with the written permission of the Department.

8.3.2 Cross-linked polyethylene cables (XLPE) shall be terminated in accordance with the Department's standard specification for "CABLE TERMINATIONS AND JOINTS", Section C6 unless a pre-fabricated system based on pre-moulded slip-on EPR stress cones is used.

8.3.3 The copper tapes of the earth screen on the cable shall be bonded to the main earth bar of the switchgear or transformer, but the bond shall be easily removable for testing purposes.

8.3.4 The cable shall be firmly secured on the switchgear by means of a clamp to prevent mechanical stress on the cable and terminations.

### 8.4 TERMINATION OF PVC-INSULATED CABLES

8.4.1 Cable ends shall be terminated by means of adjustable glands in accordance with the Department's standard specification for "GLANDS FOR PVC-INSULATED CABLES", Section C5.

8.4.2 The glands shall be fitted in accordance with the cable and gland manufacturers instructions.

8.4.3 The correct size and type of gland shall be used for the particular cable and application.

### 8.5 CONNECTION OF CABLE CONDUCTORS

8.5.1 Suitable lugs shall be used, preferably solidly sweated to the cable conductor ends. Lugs may be crimped, using mechanical or pneumatic tools designed for this purpose, on condition that evidence is submitted that the method used complies with the performance requirements of BS 4579, Part 1 : "COMPRESSION JOINTS IN COPPER".

- 8.5.2 Contact surfaces shall be thoroughly cleaned and smoothed and fixing bolts shall match the hole size of the lug.
- 8.5.3 Cables that are connected to clamp type terminals where the clamping screws are not in direct contact with the conductor, need not be lugged but the correct terminal size shall be used.
- 8.5.4 Ferrules shall be used as far as possible where cable conductors are connected directly to equipment with screws against the conductor strands.
- 8.5.5 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.

## 8.6 JOINTS

- 8.6.1 Joints in cable runs will not be allowed unless specified in the Detail Technical Specification or authorised by the Department.
- 8.6.2 Jointing shall be carried out strictly in accordance with the manufacturer's instructions and by personnel competent in jointing the types of cables used.
- 8.6.3 During outdoor jointing operations, the joint bays shall be adequately covered by tents of waterproof material suitably supported. Where 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.
- 8.6.4 The joint shall not impair the anti-electrolysis characteristics of the cable.
- 8.6.5 The Contractor shall notify the Department 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 Department because of insufficient notice being given, shall be opened for inspection and redone at the discretion of the Department at the cost of the contractor.
- 8.6.6 HV cable joints on paper insulated cables shall be of the compound cast type and the compound used shall comply with the Department's standard specification for "CABLE END BOX FILLING COMPOUND", par. 2 of Section C8.
- 8.6.7 HV cable joints on XLPE-insulated cables shall be of the heat shrinkable type and shall comply with the Department's standard specification for "CABLE TERMINATIONS AND JOINTS" Section C6, or shall be based on a prefabricated system utilising pre-moulded slip-on stress cones.
- 8.6.8 LV cable joints shall be of the epoxy-resin type.
- 8.6.9 Joints shall be fully water and air tight and shall be free of voids and air pockets.
- 8.6.10 The crossing of cores in joints will not be permitted under any circumstances.

## 9. TESTING

- 9.1 Each cable shall be tested after installation in accordance SANS 1507 (up to 1 kV) and SANS 97 (up to 11 kV) as well as the requirements of the Local and Supply Authorities.
- 9.2 LV Cables shall be tested by means of a suitable megger at 1 kV and the insulation resistance shall be tabulated and certified.

TABLE B6.2

Cable Rating (kV)	TEST VOLTAGE (Applied for 15 minutes) (kV)				
	Paper-insulated cables				XLPE-insulated cables
6,6 11	Between conductors		Conductors to sheath		Conductors to screen
	AC (r.m.s)	DC	AC (r.m.s)	DC	DC
	12 20	18 30	12 20	18 30	11 18

\* High Voltage test with DC to 2kV for 1 minute only. Discharge cable slowly via discharge stick (1 minute). Clamp all conductors to earth for 24 hours.

- 9.3 HV Cables shall be high voltage tested in accordance with Table B6.2 and the exact leakage current shall be tabulated and certified.
- 9.4 The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The cost of testing shall have been included in the tender price.
- 9.5 The Contractor shall notify the Department timeously so that a representative of the Department may witness the tests.
- 9.6 On completion of the tests on any cable, the Contractor shall without delay, submit three copies of the certified Test Reports to the Department.

## 10. MEASUREMENTS

- 10.1 All measurements for payments shall be made jointly by the representatives of the Department and the Contractor and the Contractor shall obtain the signature of the Department's representative including approval of such measurements.
- 10.2 No allowance shall be made for the breaking away of the trench sides, other earth movements or for trenches excavated in excess of the stipulated dimensions. Refer also to par. 3.7.5 above.
- 10.3 The classification shall be as follows:

Very hard rock shall mean rock that can only be excavated by means of explosives.

Hard rock shall mean granite, quartzitic sandstone, slate and rock of similar or greater hardness, solid shale and boulders in general requiring the use of jack hammers and other mechanical means of excavations.

Soft rock and earth shall mean rock and earth that can be loosened and removed by hand-pick and shovel.

- 10.4 Where very hard rock and hard rock are encountered, the prior approval of the Department shall be obtained before proceeding with the excavation. This requirement is stipulated in order to afford the Department the opportunity to determine whether an alternative cable route is justified.
- 10.5 All cable lengths indicated in the Detail Technical Specification and/or shown in the cable route drawings shall be regarded as estimates and are given for tendering purposes only. The successful tenderer shall measure actual cable lengths on site before ordering.
- 10.6 The final price for the supply and installation of all cables will be adjusted, on the basis of the actual lengths of installed cables, in accordance with the unit rates quoted at the time of tendering. Cable lengths shall be measured on site to the nearest 500mm for this purpose and surplus cable will not be paid for.

**11. COMPLETION**

- 11.1 The Department 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 for completing the installation fully in accordance with the Contract Documents.
- 11.2 The Contractor shall carry out a final "as built" survey of the cable routes and present to the Department "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 :
- (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 to each joint, shall be used.
  - (c) Identification of each cable.
- 11.3 The works will be deemed to be incomplete until all tests have been conducted successfully and all "as built" drawings and schedules have been handed to the Department.

**SECTION B7****B.7 INSTALLATION OF LIGHT SWITCHES AND SOCKET-OUTLETS****1. GENERAL****1.1 STANDARDS**

Light switches and socket-outlets shall comply with the Department's quality specification for "LIGHT SWITCHES", Section C10 and UNSWITCHED AND SWITCHED SOCKET-OUTLETS", Section C11. Surface or flush mounted boxes and cover plates, complying with the Department's quality specification for "CONDUIT AND CONDUIT ACCESSORIES", Section C1, shall be provided.

**1.2 POSITION OF OUTLETS**

Switches and socket-outlets shall be accurately positioned in accordance with the drawings. It is the Contractor's responsibility to ensure that all outlets are installed level and square, at the correct height from the floor and at the correct position relative to building lines and equipment positions as specified. It is the Contractor's responsibility to determine the correct final floor level and ceiling level in conjunction with the Main Contractor.

**1.3 COVER PLATES**

All switches and socket-outlets shall be fitted with standard metal cover plates. The colour of cover plates shall be as specified or shall otherwise match the surrounding finishes as closely as possible. Unless specified to the contrary, ivory cover plates shall be installed on painted walls. Cover plates in the same area shall have the same colour. Flush mounted cover plates shall overlap the draw-box and edges of the recess. Cover plates shall under no circumstances be cut unless authorised by the Department.

**1.4 ESCUTCHEON PLATES**

Where flush mounted switches or socket-outlets are installed in special wall finishes e.g. wood or board panels, acoustic tiles or other cladding, etc. and where the wall finishes must be cut to accommodate the switch, it may be necessary to fix an escutcheon plate to the wall to cover the cut-outs. The escutcheon plate shall fit closely around the outlet boxes and shall be fixed independently of the boxes and cover plates. Bevelled cover plates shall be fixed to the outlet boxes and shall fit firmly against the escutcheon plate.

**1.5 APPEARANCE**

The sides of adjacent switches, plugs, push-buttons etc. shall be parallel or perpendicular to each other and uniformly spaced. A common escutcheon plate shall be placed around flush mounted outlets and accessories where the standard cover plates do not cover the cut-outs in the finishes.

**1.6 DEEP BOXES**

Where switch or socket-outlet boxes have been set deep, spiral type steel wire spacers shall be used to fix the yoke of the switch or socket.

**2. INSTALLATION OF SOCKET-OUTLETS****2.1 MOUNTING HEIGHT**

Unless specified to the contrary, socket-outlets shall be installed at the following heights above finished floor level, measured to the centre of the outlet:

Flush mounted in general:	300mm
Showrooms, shops, servants quarters:	1,4m
Domestic kitchens, tea kitchens:	1,05m
Commercial kitchens:	1,4m
Factories, workshops, garages:	1,4m

## 2.2 WALLS

In cases where socket-outlets must be mounted at a nominal height of 300mm and where the lower portion of the wall consists of face bricks and the upper portion is plastered, the outlets shall be installed in the plastered portion of the wall. If however the plastered portion of the wall commences 500mm or more above floor level the outlets shall be installed in the face bricks. Where a wall has different surface finishes the outlets shall be installed within the same finish and not in the dividing lines between the different wall finishes. All outlets shall be installed at least 150mm away from door frames.

## 3. INSTALLATION OF LIGHT SWITCHES

### 3.1 MOUNTING

Light switches shall be installed 1,4m above finished floor level unless specified to the contrary. Mounting heights given shall be measured from the finished floor level to the centre of the switch. All single switches shall be installed with the long side of the toggle vertical.

### 3.2 DOORS

Unless specified to the contrary, switches adjacent to doors shall be installed on the side containing the lock. If the position of the lock is not shown on the drawings, the position shall be verified before the switch-box is installed. Switch boxes in brick or concrete walls shall be installed 150mm from the door frame. Light switches installed in partitions or door frames shall be of the type designed for that purpose.

### 3.3 WALLS

Where the lower portion of a wall is face brick and the upper portion plastered, light switches shall be installed wholly in the plaster provided that the lower edge of the plaster is not higher than 1,6m above the finished floor level. In general where different wall finishes are used in the same area. Switches shall be installed within the same finish and not on the dividing lines between finishes.

### 3.4 PARTITIONS

Light switches installed in partitions shall preferably be of the type designed to be accommodated in the partition construction. Switches installed in the metal supports do not require switch boxes. Switches may not be flush mounted in partition walls without switch boxes.

### 3.5 WATERTIGHT SWITCHES

Switches that are exposed to the weather or are installed in damp areas, shall be of the watertight type complying with the Department's quality specification for "WATERTIGHT SWITCHES", par. 3 of Section C10.

### 3.6 MULTIPLE SWITCHES

Where several switches are required in one position, multi-lever switches in a common switch box shall be provided wherever possible. All circuits wired into this box shall be on the same phase in order that voltages in excess of 250 V are not present in the box. Where it is not possible or practical to do this, barriers shall be installed and a label shall be prominently displayed within the box stating that voltages in excess of 250 V are present.

**SECTION B8****B.8 PHOTO-ELECTRIC DAYLIGHT SENSITIVE SWITCH FOR OUTSIDE LIGHTING****1. INSTALLATION**

- 1.1 The outside lighting of each individual building i.e. light circuits marked "T" on the drawings, shall be controlled by photo-electric daylight sensitive switches.
- 1.2 The positions of the switches as indicated on the drawings are provisional and the exact positions shall be confirmed with the representative of the Department on site.
- 1.3 Individual outside lighting circuits on a building may be connected directly to the daylight sensitive switch.
- 1.4 Where two or more lighting circuits are to be controlled by a single daylight sensitive switch, a contactor actuated by the unit shall be provided in the switchboard.
- 1.5 A by-pass switch enabling the lights to be turned on at any time, shall be provided.
- 1.6 Standard control circuits are indicated in fig. B8.1 and B8.2.

**2. CONSTRUCTION**

- 2.1 The unit shall comprise a photo cell, thermal actuator and change-over switch. The cover of the unit shall be manufactured from a tough, durable material providing protection against tampering. The cover shall have good weathering properties. It shall be ultraviolet-resistant and shall not deteriorate when exposed to sunlight for prolonged periods.
- 2.2 The unit shall be of the wall mounting type and shall be supplied complete with a suitable bracket.
- 2.3 The operational level shall be factory preset for "ON" at a light level of approximately 54 lux and "OFF" at approximately 108 lux. Voltage variations shall not materially affect the operational levels.
- 2.4 A time delay of not less than 15 seconds shall be provided to prevent the unit from functioning due to short period changes in illumination.
- 2.5 The unit shall be effectively safeguarded against voltage surges by means of a suitable surge protector which shall preferably form an integral part of the unit.

**SECTION B9****B.9 INSTALLATION OF LUMINAIRES****1. POSITIONS**

The mounting positions of luminaires shall be verified on site. All luminaires shall be placed symmetrically with respect to ceiling panels, battens, beams, columns or other architectural features of the space unless otherwise indicated. The layout as shown in the Documents shall generally be adhered to but any discrepancies or clashes with structural or other features must be referred to the Department, before commencing erection of the installation.

**2. COVER PLATES**

Cover plates shall be fitted over all draw-boxes and outlets intended for luminaires that are not covered by the luminaires canopy, lamp-holder, ceiling rose or similar accessories.

**3. FIXING TO DRAW-BOXES**

Where an outlet box or draw-box provides the necessary support for a luminaires, all luminaires with the exception of fluorescent luminaires mounted against ceilings, shall be fixed directly to the box. Fluorescent luminaires and luminaires with a mass in excess of 10kg shall however be suspended independently of the outlet box.

**4. HANGERS AND SUPPORTS**

Where provision has not been made for the fixing of luminaires, the Contractor shall supply the necessary supports, hangers, conduit extensions, angle brackets or any other fixing method approved by the Department.

**5. SUSPENDED LUMINAIRES**

The necessary hangers shall be provided where luminaires which are of the non-suspension type have to be fixed below false ceilings or roof slabs. The use of 20mm conduits fixed to the roof slab or ceiling is preferred. Provision shall be made for adjustments to enable the levelling of luminaires. Suspended conduits shall be fixed to the ceiling by means of screwed dome lids, bolts and nuts. Ball-and-spigot type domelids shall be used where conduit lengths exceed 600mm. Wiring shall be installed in the conduit hangers.

**6. SUSPENDED WIRING CHANNELS**

Luminaires (especially fluorescent luminaires) may also be suspended from ceilings by means of suspended metal channels. The metal channel may be supported by conduits or threaded rods. Should metal rods be utilised, these shall be screwed to anchor bolts fixed in the roof slab. Wiring shall either be installed in conduits fixed to the metal channel or in the metal channels and covered with a suitable cover plate. Purpose-made clamps shall be used to fix the luminaires to the cable channel.

**7. CEILING BATTENS**

Where wooden blocks are used to suspend luminaires, ceiling battens shall not be cut. The wooden blocks shall be cut to fit around battens and shall be screwed to the ceiling. Battens may however be cut where fluorescent or incandescent luminaires with metal canopies have to be installed against a false ceiling.

**8. GLASS-BOWL LUMINAIRES**

Unless specified to the contrary, suspended glass-bowl luminaires shall be installed with the underside at least 2,1 m above finished floor level.

**9. FLUORESCENT LUMINAIRES FIXED TO CONCRETE SLABS**

Fluorescent luminaires to be installed directly against concrete slabs or walls shall be securely fixed to the outlet box and at two additional points. Shot-fired fixings are not acceptable. Where approved, fluorescent luminaires may be installed against metal wiring channels in which the wiring is housed. The channel fixing may in this case be shot-fired. Purpose-made fluorescent fixing adaptors shall be used to fix luminaires to cable channels.

**10. FLUORESCENT LUMINAIRES FIXED TO CEILINGS**

- 10.1 In all cases where luminaires are fixed to false ceilings, the Contractor shall ensure that the ceiling is capable of carrying the weight of the luminaires before commencing installation. Should any doubt exist in this regard, the matter shall be referred to the Department.
- 10.2 In cases where the weight of the luminaire is not carried by the ceiling but by a support or other suspension method, provision shall be made to prevent relative movement between the ceiling and luminaire, ceiling rose or connection point.
- 10.3 Surface mounted fluorescent luminaires shall fit firmly against the ceiling branderling without leaving gaps between luminaire and ceiling. The luminaire shall be fixed directly to the ceiling by means of brass plated round-head wood screws and washers.
- 10.4 In the case of tiled ceilings with exposed or concealed T-section supports, surface mounted luminaires shall be fixed only to the tiles by means of butterfly screws or bolts with nuts and washers. The tiles shall be suitably reinforced.
- 10.5 Luminaires may alternatively be fixed to metal cross-pieces resting in the ceiling tees.
- 10.6 Drilling of holes in ceiling tees to support luminaires will not be allowed.
- 10.7 Luminaires shall be fixed in neat relation to the ceiling lay-out.

**11. CONTINUOUS ROWS OF LUMINAIRES**

In cases where fluorescent luminaires are installed in tandem, only one connection outlet need be supplied per circuit. All luminaires shall be coupled to one another by means of nipples or brass bushes and locknuts to ensure that wiring is not exposed and that earth continuity is maintained. Luminaires on the same circuit may be wired through the channel formed by the luminaire bodies. In this case silicon-rubber insulated conductors shall be used and internal connections shall be made at porcelain terminal blocks. "SCREW-IT" or similar connectors may only be used if prior permission is obtained from the Department. The wiring for any other circuits or outlets, even though these may be in the same row, may not be installed through the luminaire bodies. The Contractor shall ensure that continuous rows are straight and parallel to the relevant building lines.

**12. RECESSED LUMINAIRES**

- 12.1 Where recessed luminaires are specified, the Contractor shall maintain close liaison with the ceiling Contractor. In the case of tiled ceilings, the luminaires shall preferably be installed while the metal supports are being installed and before the tiles are placed in position. The Electrical Contractor shall be responsible for the co-ordination of the cutting of ceiling tiles with the other contractors concerned.
- 12.2 All mounting rings and other accessories shall fit closely into cut-outs to ensure a proper finish.
- 12.3 In all false ceilings where wiring channels are used, recessed luminaires shall be connected to the wiring channels by means of unswitched 5 A socket-outlets.
- 12.4 The following requirements shall be adhered to:
  - (a) Socket-outlets used shall comply with the Department's quality specification for "UNSWITCHED AND SWITCHED SOCKET-OUTLETS", par. 4 of Section 11 and shall be of 5 A minimum rating.

- (b) The connector cord attached to the luminaire may not exceed 3m in length and shall consist of 1,5mm<sup>2</sup> minimum, 3-core, PVC-insulated flexible cord.
- (c) The 5A socket-outlets shall be positioned such that they are not more than 600mm above the false ceiling.

### **13. SPECIAL CEILINGS**

In cases where special ceilings e.g. aluminium strips, decorative glass, metal leaves, etc. are to be installed, the Contractor and the Manufacturer of the ceiling shall agree upon the method of fixing of luminaires in the ceiling.

### **14. BULKHEAD LUMINAIRES**

Surface mounted bulkhead luminaires shall not be screwed directly to conduit ends. The conduit shall terminate in a round draw-box at the top or rear of the luminaire. The PVC-insulated conductors shall terminate in a porcelain terminal strip in the draw-box. Silicon-rubber-insulated conductors shall be installed from the terminal strip to the luminaire lamp-holder. "SCREW-IT" or similar connectors may only be used if prior permission is obtained from the Department.

### **15. TYPE OF CONDUCTOR**

PVC-insulated conductors, unless protected by an approved heat-resistant sheathing, shall not be used where the temperature of the insulation is likely to exceed 70°C. In unventilated luminaires or luminaires capable of housing incandescent lamps over 60W, the interconnecting wiring from the lamp-holder to the circuit wiring shall consist of silicon-rubber insulated conductors. Silicon-rubber insulated conductors shall be used exclusively in the case of high bay fittings. Refer also to the provisions of SANS 10142.

### **16. WIRING OF LAMP HOLDERS**

The central terminal of Edison Screw (E.S.-type) LAMP-HOLDERS shall be connected to the phase conductor and the screwed housing to the neutral conductor.

### **17. HIGH BAY LUMINAIRES**

- 17.1 High bay luminaires shall be securely suspended from the roof structure.
- 17.2 The luminaires may be fixed to suspended wiring channels containing the wiring on condition that:
  - (a) rigid channels with a maximum width of 42 mm be used,
  - (b) the channels are supported at intervals that will prevent sag or warp and
  - (c) the channels are large enough to accommodate the wiring.
- 17.3 Luminaires may be suspended from metal roof trusses with the aid of "CADDY" or similar fasteners.
- 17.4 Luminaires shall preferably be connected to unswitched 5A socket outlets. Silicon-rubber insulated flexible cord shall be used exclusively to connect the luminaire to the outlet.
- 17.5 A safety chain to keep the luminaire from falling when loosened shall be provided.

**SECTION B10****B.10 CONNECTIONS TO EQUIPMENT****1. GENERAL**

This section covers the final electrical connections to switchboards and various equipment in general electrical installations under normal environmental conditions for system voltages up to 600 V. Refer also to the Department's standard specifications for "WIRING", Section B5 and "INSTALLATION OF CABLES", Section B6.

**2. CONNECTIONS TO SWITCHBOARDS****2.1 CONDUIT ENTRIES**

2.1.1 Where sufficient space for conduit entries as well as adequate space for future conduit entries is available, conduits may be terminated directly on the switchboard.

2.1.2 Alternatively, conduits connected to switchboards shall terminate in a common fabricated sheet steel draw-box installed in the vicinity of the switchboard. In open roof spaces this draw-box shall be placed in a roof space of not less than 900mm clearance.

2.1.3 Lighting and socket-outlet circuits may be separately grouped in common conduits or metal ducts (trunking) from the distribution board to the draw-box. The drawbox shall be of sheet steel with a minimum thickness of 1,6mm and shall be fitted with a removable cover plate.

**2.2 FLUSH MOUNTED SWITCHBOARDS**

Where flush mounted switchboards are required, the recessed switchboard tray shall be built into the brick or concrete wall. All conduits from the floor or roof shall be fully recessed and shall be bonded directly to the tray by means of locknuts on both sides and the ends of the conduits fitted with a brass bush.

**2.3 SURFACE MOUNTED SWITCHBOARDS**

Where surface mounted switchboards are specified but where the conduits can be fully recessed, the conduit shall be connected to a recessed connection box installed behind the switchboard. An opening with the same dimensions as the connection box shall be cut in the back of the switchboard and fitted with a suitable grommet.

**2.4 SPARE CONDUITS**

Where conduits from a switchboard run into a false ceiling space above the board, a minimum of two 25mm and two 20mm spare conduits shall be installed into the ceiling space immediately above the board.

**2.5 CABLE CONNECTIONS**

2.5.1 Where underground cables are to be connected to switchboards, it shall be the responsibility of the Contractor to ensure that metal, earthenware, asbestos-cement or other approved sleeves are built in correctly to enable installation and connection of the cable to the switchboard.

2.5.2 PVC or pitch fibre sleeves are not acceptable - refer to par. 3.10 of the Department's standard specification for "INSTALLATION OF CABLES", Section B6.

2.5.3 Sleeves shall be installed with a fall from inside to outside of the building to facilitate drainage. The sleeves shall be sealed with a non-hardening compound after installation of the cables to render the installation vermin proof and waterproof.

2.5.4 A metal cable channel with removable metal cover plate shall be installed by the Contractor and shall extend from the switchboard to the floor or into the ceiling void as required. The channel shall

coincide with the position of sleeves. The channel shall be flush mounted except in the case of surface mounted switchboards and then only with the permission of the Department's representative.

2.5.5 The cable channel shall be large enough to permit the installation of cable glands and future cables, particularly where spare sleeves have been provided.

2.5.6 The colour of the channel cover shall match that of the associated switchboard.

## 2.6 CABLE TRENCHES

Where cables in floor trenches have to be connected to wall mounted switchboards, approved sleeves or conduits shall be installed from the side of the trench to the bottom of the switchboard. These sleeves shall be positioned and fixed before the concrete is cast.

## 3. CONNECTIONS TO MOTOR DRIVEN EQUIPMENT.

3.1 An isolator or starter containing an isolator shall be installed within 2m of motor driven equipment. The requirements of SANS 10142 shall be met. If this isolator cannot be installed on a wall, switchboard or other suitable place, an approved free-standing pedestal shall be provided. The pedestal shall be 1m high and outside normal walkways, access routes, etc.

3.2 The connection to the equipment shall be carried out as follows:

(a) Metal reinforced plastic or PVC-covered flexible metal conduits with individual conductors or a multi-core PVC insulated cable and separate bare earth conductor installed inside the conduit may be used. The flexible conduit shall not exceed 600mm. Screwed conduit shall be used from the end of the flexible conduit to the isolator and/or starter. Refer to the department's standard specification for "FLEXIBLE CONDUIT", Section B1, par. 5.

(b) Multi-core armoured PVC- or rubber-insulated cable and earth conductor. The installation and termination of the cables shall comply with the Department's specification for "INSTALLATION OF CABLES, Section B6.

(c) Cables and flexible conduits shall be provided with sufficient slack to allow positional adjustment of the equipment.

3.3 Supply cables to equipment may not be installed across floors which are for general use.

## 4. CONNECTIONS TO WATER HEATERS

4.1 Each water heater shall be connected to a separate circuit with a separate earth conductor.

4.2 The conduit from the switchboard to the water heater shall terminate in a draw-box within 1 m of the water heater terminals. The connection from the draw-box shall be conductors in conduit or PVC-insulated cable. Only in instances where heaters are mounted out of normal reach may flexible conduit and round boxes with dome lids be used for the final connection.

4.3 Three-phase supplies to fixed storage water heaters shall be in accordance with the wiring diagram, Fig. B10.1.

4.4 The mounting of the water heater and the provision of the water connections will be undertaken by others. The Contractor shall ensure that the elements and thermostats can easily be replaced.

4.5 Before testing a water heater, the Contractor shall confirm with the Plumbing Contractor that the unit is filled with water.

4.6 Unless otherwise specified in the Detail Technical Specification, the wiring of hot water heater circuits not exceeding 4 kW shall consist of 4mm<sup>2</sup> conductors and 2,5mm<sup>2</sup> earth conductor.

- 4.7 Unless it is specified that isolators for water heaters shall be provided in the switchboard, a local isolator shall be provided for each water heater. In the case of water heaters not exceeding 4 kW, a 30 A double-pole metal-clad isolator shall be surface mounted over the flush conduit outlet box.

## **5. CONNECTIONS TO HEATERS, FANS AND AIRCONDITIONING UNITS**

### **5.1 ISOLATORS**

A flush mounted suitably rated double-pole isolator shall be provided within 1m of the unit. Where the equipment is mounted out of reach, the isolator shall be installed at 1,5m above floor level. Only where units are mounted in easily accessible positions and where an isolating switch is incorporated in the unit, may this isolator be omitted. Where flush isolators are used, flush conduit shall be installed to link with the equipment outlet point. Flexible cords of sufficient rating may be used for the final connection to the equipment.

### **5.2 WIRING**

The minimum conductor size to be used shall be 4 mm<sup>2</sup>. Each fan, heater or air-conditioning unit shall be on a separate circuit.

### **5.3 FLUSH MOUNTED CONVECTION HEATERS**

The heater frame or tray shall be built or cast into the wall at a height such that the underside of the heater is at 250mm above floor level. Conduits shall terminate on the frame near the terminals.

### **5.4 SURFACE MOUNTED EQUIPMENT**

5.4.1 Connections to surface mounted equipment shall consist of a draw-box located in the vicinity of the terminals of the unit. In workshops and industrial areas the connections shall be made by means of flexible conduit connected to dome lids on the draw-box. Conductors shall be connected directly to the unit.

5.4.2 In non-industrial applications PVC-insulated 3-core flexible cables may be used for the connection.

5.4.3 Where flexible cables are used, a bush shall be provided at the rear of the unit for cable entry and a bush and clamp (or gripper gland) at the draw-box. The clamp shall tightly grip the outer insulation of the cable to prevent tension on the connections between cable and conductors in the draw-box.

5.4.4 Where heaters or air-conditioning units are situated above power skirting, the isolator shall be installed in the power skirting and the flexible cable or cord to the unit shall be installed in the power skirting through a gripper or compression gland. The cable shall be made as short as practical and shall be neatly saddled to the surface of the wall.

### **5.5 RADIANT HEATERS**

The installation of radiant heaters and asbestos heaters, where specified, shall comply with the requirements of paragraph 5.4, with the exception that they shall be mounted on spacers, 25mm away from the mounting surface.

### **5.6 FAN HEATERS**

5.6.1 The contractor shall allow for the supply, installation and electrical connection of the fan heaters as indicated on the drawings. The fan heaters shall be rated at 3 kW and shall be complete with control units.

5.6.2 The heaters shall be secured by means of approved expansion bolts at 2,4m above floor level in positions as shown, with the control units at 1,5m above floor level, directly below the unit.

5.6.3 The fan heater shall be installed on a box directly behind the unit.

5.6.4 Each connection shall be protected by means of a single-pole circuit-breaker on the associated switchboard.

- 5.6.5 Brass bushes shall be provided to protect the wiring at the rear cable entries to the control unit and fan connection box.

## **6. CONNECTIONS TO UNDERFLOOR HEATING**

- 6.1 Where underfloor heating cable is specified, the Contractor shall supply the cable and thermostats which shall be purchased from a specialist supplier. The cable shall be laid by the specialist supplier and connected by the Contractor. The Contractor shall also be responsible for testing of the cables prior to their being covered by the screed and immediately thereafter. Details of circuit wiring and control of underfloor heating will be specified in the Detail Technical Specification.
- 6.2 PVC-insulated heating cable with a rating of not higher than 13 W per linear metre shall be used. Thermal insulation will be provided by the Builder.
- 6.3 The capacity of the heating cable shall be sufficient to give a 20°C temperature rise with an outside ambient temperature of 5°C.
- 6.4 The total heating load shall, however, not be more than 135 W/m<sup>2</sup>.

## **7. CONNECTIONS TO INCINERATORS**

### **7.1 GENERAL**

This section covers connections to incinerators used for domestic purposes in buildings. Unless specified to the contrary, the supply and installation of incinerators will form part of the electrical installation and shall comply with the Department's quality specification, "INCINERATORS", SECTION C14.

### **7.2 FLUSH MOUNTED INCINERATORS**

Where flush mounted incinerators have been specified, the Contractor shall supply the mounting tray to the Builder in good time for it to be built into the structure.

### **7.3 MOUNTING HEIGHT**

Unless specified to the contrary, incinerators shall be installed with the bottom 1m above finished floor level.

### **7.4 ISOLATOR**

A flush mounted 30 A double-pole isolator shall be installed approximately 1,5m above the finished floor level adjacent to each incinerator. The isolator cover plate shall wholly fall within either the tiled or plastered surface of the wall. Unless specified to the contrary, the cover plate shall be finished in white baked enamel. An engraved label shall be provided at each isolator marked as follows:

"SWITCH OFF TO CLEAN AND REMOVE ASH"  
"SKAKEL AF VIR SKOONMAAK EN ASVERWYDERING"

### **7.5 FLUES**

The Contractor shall supply flue pipes to the Builder for installation. Two bends and an "H" piece exhaust canopy shall be allowed for each flue pipe.

### **7.6 EXHAUST FANS**

Where more than 5 incinerators are connected to the same flue or where more than two 90° bends are used in the flue, an exhaust fan shall be installed at the flue outlet. In addition a small fan must be provided at each incinerator.

### **7.7 WIRING**

Single incinerators shall be connected by means of 2 x 4mm<sup>2</sup> PVC insulated conductors and a 2,5mm<sup>2</sup> bare copper earth conductor in a 20mm conduit. Each incinerator shall be connected to a separate circuit where a common exhaust fan is not used. Where a common exhaust fan is needed, the following applies:

- (a) All fans and incinerators connected to the same flue shall be on the same circuit.
- (b) The current rating of the circuit-breaker shall be sufficient to allow the simultaneous operation of all the fans and 50 % of the incinerators.
- (c) A 30 A double-pole isolator shall be flush mounted adjacent to each incinerator as described in paragraph 7.4. However if the current rating of the circuit-breaker protecting the circuit is larger than 15A, a 15A fuse and fuse holder shall be installed at each incinerator in addition to the isolator. The draw-box and cover plate for the isolator shall be large enough to accommodate the isolator and fuse. Alternatively, a 15A circuit-breaker may be installed adjacent to each incinerator in lieu of the isolator and fuse.
- (d) The circuitry shall be arranged to ensure that all the fans will operate when any one of the incinerators is switched on.
- (e) Earth leakage protection shall be installed on all incinerator circuits.

## **8. CONNECTIONS TO COOKING APPLIANCES**

- 8.1 Unless specified to the contrary, the circuit connection to each cooking appliance shall consist of:
- (a) 2 x 10mm<sup>2</sup> PVC-insulated conductors and 6mm<sup>2</sup> bare copper earth conductor for single phase connections, or
  - (b) 4 x 4mm<sup>2</sup> PVC-insulated conductors and 2,5mm<sup>2</sup> bare copper earth conductor for three phase connections.
- 8.2 A 60A double pole or 30A triple pole micro-gap isolator flush mounted in a wall outlet box, shall be installed 1,5m above floor level to the left or right of the appliance in accordance with SANS 10142. A white baked enamel cover plate shall be provided, situated wholly on the tiled or plastered surface as applicable.
- 8.3 The conduit shall terminate 450mm above floor level behind the appliance position. The conduit end shall be approximately 75mm long and shall face downwards. Connections from the conduit end to the appliance shall be installed in accordance with SANS 10142. Sufficient slack shall be provided in the flexible connection to move the appliance 600mm away from its normal position for cleaning or maintenance.
- 8.4 Alternatively a 45A, 3-pin socket-outlet may be mounted on a round draw-box 450mm above floor level. The connection to the appliance shall consist of a plug and 10mm<sup>2</sup>, rubber-insulated and sheathed cable in accordance with SANS 1520. The cable shall be long enough to enable the appliance to be moved 600mm from its normal position for cleaning or maintenance.
- 8.5 Crimped or soldered lugs shall be provided on all conductors intended for connection to cooking appliances.
- 8.6 Each appliance shall be connected to a separate circuit. A separate earth wire shall be provided for each appliance.

## **SECTION B11**

### **B.11 EARTHING**

This section covers the earthing of electrical installations in buildings or other structures. The total earthing system of any electrical installation shall be in complete accordance with SANS 10142.

#### **1. GENERAL RECOMMENDATIONS ON THE PRACTICAL INSTALLATION OF EARTH ELECTRODES**

##### **1.1 REQUIREMENTS OF AN EFFECTIVE EARTH**

1.1.1 An effective earth must prevent dangerous over voltages arising between metallic structures, frames, supports or enclosures of electrical equipment and the ground during fault conditions.

1.1.2 An effective earth must be able to permit fault currents of sufficient magnitude to flow so as to operate protective devices to isolate the fault before damage can occur.

1.1.3 The ohmic resistance of an effective earth must be low enough to ensure that the step potential on the ground in the vicinity of the earthing point is within safe limits under fault conditions i.e. a voltage gradient not exceeding 40 V/m for fault durations exceeding 1s.

##### **1.2 TYPES OF EARTH ELECTRODES**

Three types of earth electrodes are suitable:

###### **1.2.1 Trench Earths**

Trench earths comprise a bare copper or galvanised iron conductor laid at a minimum of 800mm below ground level, usually when underground cables are installed. This type of earth electrode provides a relatively large contact area between electrode and surrounding ground, makes contact with a variety of types of soil and soils of varying moisture content en route and is economical to install.

###### **1.2.2 Spike Earths**

Spike earths comprise rods of bare copper, copper-coated steel, stainless steel or galvanised steel designed for the purpose of penetrating ground to depths of up to several metres. A low resistance earth may sometimes be obtained by driving multiple spikes at some distance from each other in order to provide parallel paths.

In hard or rocky ground, it is usually necessary to drill holes into which earth spikes are inserted and then packed with soft soil.

###### **1.2.3 Foundation Earths**

Foundation earths comprise bare copper or galvanised iron conductors laid under the foundations of buildings, miniature substations, distribution pillars, bases of wooden, concrete or steel poles and structures. Because soil under foundations usually retains moisture, foundation earths are located to take advantage of this favourable condition. Furthermore, they are economical to install.

##### **1.3 MATERIALS FOR EARTH ELECTRODES**

1.3.1 Bare copper, either in stranded, strip or rod form, is considered the most suitable general purpose material for earth electrodes. Its main disadvantage is its cost and susceptibility to theft.

1.3.2 Bare galvanised iron and steel, either in stranded, strip or rod form, has a satisfactory record of survival in non-aggressive soils and is more economical than copper.

1.3.3 Bare aluminium is unsuitable as electrode material.

## 1.4 CORROSION

Because galvanised ferrous metals corrode sacrificially to copper, galvanised iron and steel electrodes should not be buried in close proximity to bare copper.

## 2. TECHNICAL REQUIREMENTS OF NEUTRAL EARTHING

The following relevant aspects have been extracted from the "AMEU CODE OF PRACTICE FOR THE APPLICATION OF NEUTRAL EARTHING ON LOW VOLTAGE DISTRIBUTION SYSTEMS."

### 2.1 DISTRIBUTION SYSTEMS

Multiple Earthed Neutral (MEN) and Protective Multiple Earthing (PME) systems.

Distribution equipment associated with transformer substations that are either ground mounted or pole mounted and fed by underground cable or overhead line, with or without an earth continuity conductor, (ECC), should be installed, connected and earthed in accordance with the following requirements:

- (a) Where the resistance to earth of the HV equipment earth is 1 ohm or less, it is permissible to earth the LV neutral to the HV earth electrode.
- (b) Where the HV equipment earth exceeds 1 ohm the LV neutral shall be earthed at a minimum distance of 6m from the HV equipment earth (i.e. 6m from the HV electrode/s and also from any earthed metalwork connected thereto).
- (c) Notwithstanding the requirements of (a) above, where transformers are associated with HV overhead lines, it is considered good practice to separate the HV and LV earth electrodes. The minimum earth separation should be 6m or one LV span.
- (d) The overall resistance to earth of the neutral of an LV distributor or distribution system must not exceed 10 ohms.
- (e) The LV neutral may be connected to other supply neutrals, earth electrodes, cable sheaths and armouring and these connections used to obtain the required earthing value of 10 ohms or less specified in par. (d). above.
- (f) The neutral of underground and overhead LV distributors must be earthed at the remote ends of each distributor.
- (g) Where the overall resistance to earth of the neutral of the distribution system exceeds 10 OHMS, the neutral shall be earthed at intermediate positions on the distributor/s to reduce its resistance to earth to below this limit.
- (h) The cross-sectional area of the neutral of all LV distributors must not be less than that of a phase conductor.
- (i) No circuit-breakers, isolators, fuses, switches or removable links shall be installed in the neutral between the transformer star point and the remote end of any LV distributor or service connection.
- (j) All metallic sheathing and armouring of cables and all metalwork associated with meter cabinets, fuse pillars, etc., supporting or enclosing LV cables shall be bonded to the distributor neutral conductor.
- (k) Where a Separate Neutral Earth (SNE) cable is part of an MEN or PME system, the armouring and/or metallic sheath and any ECC shall be bonded to the neutral at the supply end of the cable.
- (l) To ensure the integrity of the neutral, it is recommended that all connections and joints on or to overhead line conductors be made by compression fittings or, alternatively double bolted connectors.
- (m) MEN or PME may be applied to any single LV distributor without alterations to other LV distributors supplied from the same transformer.

## 2.2 PROTECTIVE NEUTRAL BONDING (PNB) SYSTEM

Since the neutral is earthed at one point only, the question of multiple earthing does not arise and there is therefore no necessity to meet the MEN/PME technical requirements.

## 2.3 SERVICE CONNECTIONS

### 2.3.1 MEN System

The following conditions apply to consumers' service connections as well as service connections to traffic signals, road signs, street lighting and other power-consuming equipment installed in public places:

- (a) All service connections must be by means of cable with an insulated phase, an insulated neutral conductor and an ECC.
- (b) A single phase service connection comprises a live, a neutral and an ECC.
- (c) A polyphase service connection comprises two or three phase conductors, a neutral and an ECC.
- (d) The service neutral and ECC must be solidly and separately connected to the distributor neutral at the tee-off point.
- (e) The consumer's earthing lead is connected to the Supply Authority's earth terminal which is in turn connected to the ECC in the service cable at the consumer's supply point.
- (f) The neutral must not be connected to earth at the consumer's supply point.
- (g) If required by the Supply Authority, an earth electrode must be installed at the consumer's supply point.
- (h) In a service connection to traffic signals, street light and other power-consuming equipment installed in public places, such equipment is earthed to the ECC of the service connection.

### 2.3.2 PME System

- (a) All service connections must be by means of a cable with an insulated phase and an insulated neutral conductor.
- (b) A single phase service comprises a live conductor and a neutral.
- (c) A polyphase service connection comprises two or three phase conductors and a neutral.
- (d) The consumer's earthing lead is connected to the supplier's neutral and to a mandatory earth electrode at the consumer's supply point.
- (e) A label must be attached at the consumer's supply point on his premises indicating that the installation is part of a PME system.

Note: It is not recommended that the PME system be applied to supply traffic signals, street signs or other power-consuming equipment installed in public places, because the PME system is inherently unsafe under "broken-neutral" conditions.

## 3. SUBSTATION EARTHING

In order to comply with the requirements of par. 1 and 2 above, an earth resistivity measurement shall be undertaken at the site of a new substation or miniature substation, preferably by a specialist firm. The contractor shall then submit to the Department details of a proposed substation earth indicating whether a trench earth, spike earth or foundation earth is intended and the proposed interconnections with the installation.

#### 4. FENCES OF OUTDOOR SUBSTATIONS

In cases where substations contain transformers or switchgear installed outdoors, the compulsory fence shall be earthed as follows, if no other method is specified :

- (a) A 70mm<sup>2</sup> earth wire shall be installed 400mm below ground level and 500mm from the fence on the outside of the sub-station along the entire length of the fence. This earth wire shall be earthed at each corner by means of a 1,8m earth rod and the rod and earth wire bonded to the fence. The earth wire shall also be bonded, at least at two points, to the main earthing system.
- (b) A 70mm<sup>2</sup> earth wire shall also be buried at a depth of 400mm around each transformer and switch and bonded to the main earthing system.

#### 5. EARTHING OF A GENERAL ELECTRICAL INSTALLATION

##### 5.1 GENERAL

All earth conductors shall be stranded copper with or without green PVC insulation. The conductors shall comply with the Department's quality specification for "PVC-INSULATED CABLES", Section C4. All earth conductor sizes shall be determined in accordance with SANS 10142, par. 4.6 where the earth does not form an integral part of the cable.

##### 5.2 SWITCHBOARDS

A separate earth connection shall be supplied between the earth busbar of the main switchboard and the earth busbar of every sub-switchboard. These connections shall consist of bare or insulated stranded copper conductors installed along the same routes as the supply cables or in the same conduit as the supply conductors. Alternatively armoured cables with earth continuity conductors included in the armouring may be utilised.

##### 5.3 SUB-CIRCUITS

The earth conductors of all sub-circuits shall be connected to the earth busbar in the supply switchboard in accordance with SANS 10142.

##### 5.4 RING MAINS

Common earth conductors may be used where various circuits are installed in the same wiring channel in accordance with SANS 10142. In such instances the sizes of earth conductors shall be specifically approved by the Department. Earth conductors for individual circuits branching from the ring main shall be connected to the common earth conductor with T-ferrules or soldered. The common earth shall not be broken.

##### 5.5 CONNECTIONS

Under no circumstances shall connection points, bolts, screws, etc. used for earthing be utilised for any other purpose. It will be the responsibility of the Contractor to supply and fit earth terminals or clamps on equipment and materials that must be earthed where these are not provided. Unless earth conductors are connected to proper terminals, the ends shall be tinned and lugged. Lugs may be crimped, using mechanical or pneumatic tools designed for this purpose, on condition that evidence is submitted that the method used complies with the performance requirements of BS 4579, Part 1: "COMPRESSION JOINTS IN COPPER."

##### 5.6 NON-METALLIC CONDUIT

Where non-metallic conduit is specified or allowed, stranded copper earth conductors shall be installed in the conduits and fixed securely to all metal appliances and equipment, including switch boxes, socket-outlet boxes, draw-boxes, switchboards, luminaries, etc. The securing of earth conductors by means of self-threading screws will not be permitted.

### 5.7 FLEXIBLE CONDUIT

An earth conductor shall be installed in all non-metallic flexible conduit. This earth conductor shall not be installed external to the flexible conduit but within the conduit with the other conductors. The earth conductor shall be connected to the earth terminals at both ends of the circuit.

### 5.8 WATER PIPES

Metal cold water mains shall be bonded to the earth busbar in the Main Switchboard by solid 15 x 2mm copper strapping. All other hot and cold water pipes shall be connected by 12 x 0,8mm perforated or solid copper strapping (not conductors) to the nearest switchboard. The strapping shall be fixed to the pipe work by brass nuts and bolts and against walls be brass screws at 150mm centres. In all cases where metal water pipes, down pipes, flues, etc. are positioned within 1,6 m of switchboards, an earth connection consisting of copper strapping shall be installed between the pipe work and the board. In vertical building ducts accommodating both metal water pipes and electrical cables, all the pipes shall be earthed at each switchboard.

### 5.9 ROOFS

Where service connections consist of overhead conductors, all metal parts of roofs, gutters and down pipes shall be earthed. One bare 10mm<sup>2</sup> copper conductor shall be installed over the full length of the ceiling void, fixed to the top purlin and connected to the main earth conductor of each switchboard. The roof and gutters shall be connected at 15m intervals to this conductor by means of 12 x 0,8mm copper strapping (not conductors) and galvanised bolts and nuts. Self-tapping screws are not acceptable. Where service connections consist of underground supplies, the above requirements are not applicable.

**SECTION B12****B.12 PROVISION FOR TELEPHONE INSTALLATION****1. CONTRACTOR'S RESPONSIBILITY**

The Contractor shall only supply and install outlet points, wiring channels and/or conduits for telephones. The telephone installation will be carried out by others.

**2. REGULATIONS**

All provisions for telephones in buildings shall comply with the latest issue of "FACILITIES FOR TELECOMMUNICATION SERVICES IN BUILDINGS" as issued by the Department of Posts and Telecommunications.

**3. SEPARATION OF SERVICES**

3.1 Cables or conductors for telephone services shall be separated from all other services by:

- (a) providing separate metal channels or conduits, or
- (b) installing power cables, conductors and accessories at a minimum distance of 300mm from routes reserved for telephone cables, or
- (c) an earthed metal barrier installed in such a manner to ensure that the minimum distance through free air space between the telephone cables and other services is at least 300mm.

3.2 In cases where high voltage cable runs are parallel to telephone cable runs for more than 50m, the correct spacing shall be determined by conferring with the Department of Posts and Telecommunications.

3.3 Conduits or wiring channels provided for telephone services may not be used for any other purpose. Where non-metallic channels are used, the separation stated in par. 3.1 (b) shall be maintained throughout the installation.

**4. MAIN TELEPHONE DISTRIBUTION BOARD**

4.1 The size and position of the Main Telephone Distribution Board, where required, shall be in accordance with the requirements of the Detail Technical Specification.

4.2 The board shall consist of a metal tray, architrave frame and hinged doors and shall be flush mounted in the position shown on the drawing(s).

4.3 A 20mm thick soft wooden panel (fine grade pine to SANS 1359, without knots) shall be installed in the main telephone distribution board and shall cover the entire back of the board. Chipboard or similar materials are not acceptable.

4.4 All conduits and sleeves to telephone outlets or sub-distribution boards in the buildings or on the site as well as the main incoming sleeves, shall terminate at the main telephone distribution board as indicated on the drawing(s).

4.5 Where 100 x 100 x 50mm draw-boxes are specified as main or sub-distribution boards, the boxes shall be flush mounted and provided with a cover plate. A wooden panel need not be provided in these cases.

**5. VERTICAL BUILDING (SERVICE) DUCTS**

5.1 If the telephone cables are to be installed in the same duct as power cables the separation of services described in par. 3 shall be maintained.

- 5.2 Conduits and metal channels to and from building duct(s) shall be installed from the section containing the telephone cables to obviate telephone cables crossing power cables or other services in the duct.
- 5.3 Where more than one vertical building duct is provided in the structure, the ducts shall be interconnected by at least 2 x 32mm dia. conduits at each floor level unless otherwise specified or indicated on the drawings.

## **6. TELEPHONE OUTLETS**

- 6.1 Blank cover plates shall be fitted to all telephone outlets.
- 6.2 Telephone outlets in walls shall consist of flush mounted 100 x 100 x 50mm draw-boxes.
- 6.3 Telephone outlets in floors shall be of the same type as floor outlets for power socket-outlets. These provisions also apply to underfloor ducting. If the type of floor outlet is not specified, 100 x 100 x 50mm flush mounted draw-boxes shall be provided in the floor at the positions indicated on the drawings. The cover plates for these draw-boxes shall be of the diecast type.
- 6.4 Where twin underfloor ducts are provided and where the one duct is intended for telephone cables, the separation between the ducts shall be maintained throughout the underfloor ducting installation.
- 6.5 Where power skirting is specified for telephone installations, the Contractor need only install the skirting with covers since the telephone socket will be fixed directly to the cover. Where multiple power skirting is provided containing other services, no other cables may be installed in the section intended for telephone cables and the separation between the sections shall be maintained throughout the installation.
- 6.6 Refer also to the Department's standard specification for the "INSTALLATION OF WIRING CHANNELS, UNDERFLOOR DUCTING AND POWER SKIRTING", Section B2.

## **7. CONNECTION OF TELEPHONE OUTLETS**

- 7.1 Telephone outlets shall be inter-connected and connected to the telephone distribution boards as shown on the drawings.
- 7.2 If the inter-connecting conduits are not specified, conduit sizes shall be determined as follows:
- Inter-connection of 10 outlets maximum - 25mm dia. conduit.
- Inter-connection of 20 outlets maximum - 32mm dia. conduit.
- 7.3 Metal channels or power skirting installed on the same floor level on opposite walls of the same area as well as parallel runs of underfloor ducting intended for the installation of telephone cables, shall be interconnected at intervals of 6m. Conduit may be used for these inter-connections.
- 7.4 All conduits and all ducts or channels which do not have removable covers, shall be provided with galvanised steel draw-wires.
- 7.5 Conduit connections to power skirting or surface mounted metal channels, shall consist of a 100 x 100 x 50mm draw-box which is flush mounted immediately behind the duct or channel in which the telephone cables are to be installed. A hole shall be cut in the back of the duct or channel, immediately opposite the draw-box. The edges of the hole shall be grommeted. The draw-box shall be accessible from the front when the cover is removed.
- 7.6 Purpose-made accessories for the connection of conduits to underfloor ducts shall be used. Where these are not available, a 100 x 100 x 50mm draw-box shall be installed below the underfloor duct opposite a floor telephone outlet. Inter-connecting conduits shall terminate at the draw-box. The edges of the hole shall be grommeted. The draw-box shall be accessible from the top via the floor outlet.

- 7.7 Exposed conduit ends intended for future extensions shall be terminated by means of a coupling and screwed brass plug. Only galvanised conduit shall be used in these instances.

**SECTION B13****B.13 SUBSTATIONS SWITCH ROOMS AND GENERATOR ROOMS**

This section covers the general building arrangement and special requirements for high and low voltage switch rooms, transformer rooms and generator rooms.

**1. STANDARD BUILDINGS**

The following list indicates the standard substation designs and corresponding standard departmental drawing number which are available.

- 1.1 High voltage room, transformer room for one transformer up to 800kVA, low voltage room and a generator room for one emergency generator set from 200 to 500kVA ..... EE/136/131A.
- 1.2 High voltage room, transformer room for one transformer up to 800kVA, low voltage room and a generator room for one emergency generator set from 80 to 200kVA ..... EE3/136/131B.
- 1.3 High voltage room, transformer room for one transformer up to 800kVA, low voltage room and a generator room for one emergency generator set up to 30kVA ..... EE3/136/131C.
- 1.4 High voltage room, transformer room for one transformer up to 800kVA and low voltage room ..... EE3/136/131D.
- 1.5 High voltage room, transformer room for one transformer up to 800kVA, low voltage room and a generator room for two emergency generators up to 200kVA each ..... EE3/136/131E.
- 1.6 Large high voltage room, transformer room for one transformer up to 800kVA and low voltage room..... EE3/136/131F.
- 1.7 High voltage room, transformer room for two transformers of up to 800kVA each, large low voltage room and a store room ..... EE3/136/131G.
- 1.8 Emergency generator buildings..... EE3/136/118.

**2. OTHER BUILDINGS**

If the standard buildings cannot accommodate the equipment required, suitable substation rooms complying with the following constructional details shall be provided:

- 2.1 The rooms shall have a ceiling height of at least 2,8 m above finished floor level.
- 2.2 A concrete roof slab shall be provided or alternatively a roof consisting of corrugated iron, or clay or cement tiles with an asbestos ceiling.
- 2.3 The rooms shall be waterproof, vermin proof and fireproof.
- 2.4 Door openings shall be 1,85 m wide by 2,5 m high with steel louvered ventilation openings over at least 60 % of the door area. Doors shall open outwards and it shall be possible to readily open them from the inside. Provision shall be made for a night latch and a padlock.
- 2.5 The floor and transformer base shall be on the same level. Each transformer base shall be able to support a mass of 5 tons on castors.
- 2.6 Vermin proof steel louvered ventilation openings shall be provided with an area of at least 20 % of the total floor area for transformer and generator rooms and 10 % for switch rooms if not specified to the contrary. 50 % of the ventilation openings shall be installed in the lower part of the walls, not more than 300 mm above floor level and the other 50 % of the ventilation openings shall be installed in the upper part of the walls, not more than 300 mm below ceiling level to achieve good cross and

convection ventilation. Louver's contained in the doors can normally be considered to provide the 50 % required in one of the walls.

- 2.7 Where possible, windows with an area equal to 5 % of the floor area shall be included to provide natural lighting. It shall not be possible to open these windows. The windows shall be in the upper portion of the walls, as high as possible.
- 2.8 Corners of transformer bases and cable ducts shall be cut off at an angle of 45° with the splay at least 100mm wide.
- 2.9 Cable entrance openings shall be at least 600mm wide x 500mm deep and level with the bottom of the cable trenches. Alternatively a separate sleeve for each cable and at least one spare sleeve, shall be provided.
- 2.10 Cable trenches shall be 600mm wide and 800mm deep unless specified to the contrary.
- 2.11 The floors of cable trenches shall have a fall of 1:100 to make provision for the natural draining of water.
- 2.12 At least one light with a switch adjacent to the entrance and one standard 16A 3-pin earth leakage protected socket outlet shall be provided in each room. The illumination level in the substations shall not be less than 200 lux. If a battery supply is available one incandescent light per substation room shall be connected to this supply and the switch in the circuit marked "EMERGENCY LIGHT"/"NOODLIG".
- 2.13 The floors shall be floated to a smooth finish with a steel trowel.
- 2.14 Any one of the following interior wall finishes is acceptable:
  - (a) Plastered and painted white.
  - (b) Unpainted face brick (preferably light colour brick).
  - (c) Off-shutter concrete painted white.

### **3. NOTICES**

The following notices in both official languages shall be exhibited at all entrances to and suitable places within premises in which are situated generating plant and transforming, switching or linking apparatus:

A notice showing the "Lightning" sign with the wording: Danger-Ingozi-Gevaar.

- 3.1 A notice prohibiting unauthorised persons from entering such premises.
- 3.2 A notice prohibiting any unauthorised persons from handling or interfering with electrical apparatus.
- 3.3 A notice detailing procedure in case of fire.
- 3.4 A notice containing directions for resuscitation of persons suffering from the effects of electric shock.

### **4. HIGH VOLTAGE SWITCH ROOMS (ABOVE 1 KV)**

- 4.1 The equipment shall be installed and secured to the floor in accordance with the manufacturer's specification.
- 4.2 Sufficient space shall be provided between the switchboard and the walls of the switch room to allow for the installation, maintenance and operation of the switchboard.
- 4.3 In the case of switchboards with uninsulated conductors accessible from the back, a clear space of at least 1,2 m shall be provided between the back and sides of the board and the wall.

- 4.4 In the case of switchboards which are of a totally enclosed construction the minimum clear space between the back and sides of the board and the wall shall be at least 900mm.
- 4.5 A space of at least 1,2 m shall be provided in front of a switchboard for operating and maintenance personnel. If the circuit breakers are of the withdrawable carriage type this space shall be at least 900 mm when the breaker carriages are in the fully withdrawn position.
- 4.6 The access door into the room shall be in front of the switchboard.
- 4.7 The tools and earthing and operating devices for the switchgear shall be contained in a purpose-made sheet metal cupboard secured to the wall of the substation.
- 4.8 A reticulation diagram displaying sufficient detail to be able to assess problems and trace faults (both on the HV and LV sides of the system) shall be mounted against a wall in the HV switch room behind clear plastic.

## **5. LOW VOLTAGE SWITCH ROOMS (BELOW 1 KV)**

- 5.1 The equipment shall be installed and secured firmly to the floor or wall of the switch room.
- 5.2 Sufficient space shall be provided between the switchboard and the walls of the switch room to allow for the installation, maintenance and operation of the switchgear. In general this space shall be 900mm at the back and sides of the board and 1,2 m in front of the switchboard.
- 5.3 In the case of switchboards with uninsulated conductors which are exposed and accessible from the back a clear space of at least 1,2 m shall be provided at the back.
- 5.4 A LV reticulation diagram displaying sufficient detail of at least the main LV reticulation in order to be able to assess problems shall be mounted against a wall in the LV switch room behind clear plastic.

## **6. TRANSFORMER ROOMS OTHER THAN IN STANDARD BUILDINGS**

- 6.1 Transformer rooms shall be large enough to accommodate the transformer with a 900mm clear space between the walls and the transformer. The minimum dimensions of a transformer room shall in any case be not less than 3,5m wide and 4,0m long.
- 6.2 The dimensions of the room shall be determined by using the transformer dimensions of TABLE 2 of SANS 780.
- 6.3 Where natural cross ventilation of the transformer room is not possible, adequate forced ventilation shall be provided to dispose of the transformer's losses and to prevent the air temperature in the transformer room from exceeding 40 C.
- 6.4 The cable entrances to the transformer room shall be sealed off after the cables have been installed.

## **7. GENERATOR ROOMS OTHER THAN IN STANDARD BUILDINGS**

- 7.1 The ventilation of generator rooms shall be sufficient to dispose of the heat radiated from the engine while delivering full power.
- 7.2 The heat from the radiator shall be released outside the building via a ventilation duct or an external heat exchanger.
- 7.3 The exhaust emission shall be released outside the building and shall comply with the local environmental control regulations.
- 7.4 The fuel storage tank shall be installed in compliance with SANS 10131 and the position shall be approved by the local Fire Department. When the storage tank must be located outdoors, it should be underground to insulate the fuel from severe temperature variations which may impede fuel flow.
- 7.5 An electrical schematic diagram indicating mains supply and change-over arrangement as well as all standby plant electrical control circuitry, shall be mounted on a wall behind clear plastic.

- 7.6 An emergency light with automatically rechargeable Nickel-Cadmium batteries shall be installed above the generator set to facilitate manual starting or fault tracing in the event that the set does not start during a power failure.

**8. CABLES**

- 8.1 Cables shall be installed in cable trenches which shall be provided for this purpose. The installation shall comply with the Department's standard specification for "INSTALLATION OF CABLES", par. 5 of Section B6.
- 8.2 Under normal circumstances cables shall not be installed directly on the floor.

**9. COVERING AND SEALING OF CABLE TRENCHES**

- 9.1 All the cable trenches shall be covered with steel chequer plate or a compound wood, bound with a water resistant binder, or an approved fibreglass grating. The following types of compound wood coverings are acceptable:
- (a) Five ply marine ply, 12 mm thick.
  - (b) Exterior grade particle board, 22mm thick.
  - (c) Tempered hardboard, 12,7mm thick.
- 9.2 The trench coverings shall be ridged and shall not sag more than 5 mm with two normal persons standing on one section.
- 9.3 The trench covering shall be in sections not exceeding 1,25 m.
- 9.4 The trench coverings shall be provided with holes or recessed handles to make it possible to remove and replace the covers easily.
- 9.5 The trench coverings shall be neatly cut where necessary to accommodate cables.
- 9.6 The covers shall overlap the trench on both sides and shall be recessed to fit flush with the surface of the floor.
- 9.7 The cable entrances in the trenches of the switch rooms, transformer rooms and generator rooms shall be closed and sealed after the cables have been installed to prevent the backfill material and water from entering the trenches in the building.
- 9.8 The cable entrances shall be closed with bricks, without mortar, in such a way as to prevent the weight of the bricks from resting on the cables. These bricks shall be plastered on the inside with a 10:1 ratio of sand and cement.
- 9.9 If the cables enter the trenches via sleeves, these sleeves shall be plugged on both sides with weak mortar, an asbestos and cement mixture or a non-hardening compound.

**SECTION B14****B.14 OVERHEAD ELECTRICAL TRANSMISSION LINES****1 GENERAL**

- 1.1 This section covers the supply, delivery, erection and commissioning of overhead transmission lines up to 22 kV on wooden poles.
- 1.2 An overhead line shall comprise the wooden poles, cross-arms, stays, conductors, insulators, isolators, fuse-links, transformers, lightning arrestors and any other auxiliary equipment specified.
- 1.3 All materials and fittings used shall be new and of high quality.
- 1.4 Overhead lines shall be erected in accordance with the "CODE OF PRACTICE FOR OVERHEAD POWER LINES FOR CONDITIONS PREVAILING IN SOUTH AFRICA", issued by the S.A. Institute of Electrical Engineers.

**2. STATUTORY REQUIREMENTS**

- 2.1 Occupational Health and Safety act. (1993) Act 85 of 1993 and subsequent amendments and regulations issued thereunder.
- 2.2 The Post Office Act, No. 44 of 1958 and the Postmaster General's Requirements issued in terms of that Act.
- 2.3 The Mines and Works Act, No. 27 of 1956 and subsequent amendments and regulations issued thereunder.
- 2.4 The Electricity Act, (1994) Act 41 of 1984.
- 2.5 The Fencing Act, No. 31 of 1963.
- 2.6 The Forest Act, Article 34 of Act No. 72 of 1968.
- 2.7 The Advertising on Roads and Ribbon Development Act, No. 21 of 1940 and No. 16 of 1962.
- 2.8 The Air Navigation Regulations promulgated in terms of the Aviation Act, No. 74 of 1962.
- 2.9 Explosives Act, No. 26 of 1956.
- 2.10 The South African Transport Services Safety Regulations.

**3. RELEVANT SANS SPECIFICATIONS**

- 3.1 SANS 182 : Conductors for overhead electrical transmission lines.  
PART3 : Aluminium Conductors, Steel Reinforced.
- 3.2 SANS 60383 : Ceramic and glass insulators for overhead lines of nominal voltage greater than 1000V.
- 3.3 SANS 61284 : Non-current-carrying line fittings for overhead power lines.
- 3.4 SANS 753 : Wooden power transmission poles and cross-arms.
- 3.5 SANS 470 : Concrete poles for telegraph, telephone, power and lighting purposes (reinforced and prestressed types).
- 3.6 SANS 61643 : Low voltage lightning arresters.

#### 4. STANDARD DEPARTMENTAL SPECIFICATIONS

- 4.1 INSULATORS AND FITTINGS FOR OVERHEAD LINES, Section C38.
- 4.2 DISTRIBUTION TRANSFORMERS, Section C36.
- 4.3 INSTALLATION OF CABLES, par.3.13, Section B6.
- 4.4 EARTHING, Section B11.

#### 5. NOTICES AND PRECAUTIONS

- 5.1 The Contractor shall issue all notices and make the necessary arrangements with Supply Authorities, the Postmaster-General (TELKOM), Transnet, S.A. Transport Services, Provincial or National Road Authorities and other authorities as may be required with respect to the installation of overhead lines.
- 5.2 The Contractor shall take all the necessary precautions and provide the necessary warning signs and/or lights to ensure that the public and/or employees are not endangered.
- 5.3 The Contractor shall acquaint himself with the position of all existing services and infrastructure prior to commencing the installation.
- 5.4 The Contractor will be held responsible for damage to any existing services brought to his attention by the relevant authorities and will be responsible for the cost of repairs.

#### 6. PEGGING THE ROUTE

- 6.1 The Contractor shall peg out the route for the overhead line but shall maintain close liaison with the Department's representative.
- 6.2 Should the proposed position of poles appear unsatisfactory due to obstructions, poor soil conditions, rock, etc., the Department's representative shall be consulted and a ruling obtained.
- 6.3 The Department reserves the right to alter the line route at any time prior to the installation of the overhead wires. Payment in respect of any additional or wasted work involved shall be at the documented rates.
- 6.4 The removal of obstructions along the route shall be subject to the approval of the Department.

#### 7. LINE IMPULSE LEVEL

The line Basic Impulse Level (B.I.L.) shall be maintained at the full voltage, namely:

Line Voltage (kV)	Impulse Voltage withstand level (kV)
Up to 6,6	75
11	95
22	150

#### 8. LINE CONFIGURATION

- 8.1 Lines shall generally be configured as indicated in the drawings included in this specification, Fig. B14.1 - B14.7.
- 8.2 Alternate arrangements shall be submitted to the Department for approval.

**9. POLES**

- 9.1 The line configuration and support structure shall be suitable for the proposed route. Refer also to the Occupational Health and Safety Act.
- 9.2 Wooden poles shall normally be used and shall comply with SANS 753, Group strength "A" and shall bear the SANS mark of approval.
- 9.3 Preservatives of the poles shall comply with the requirements for Type AI of SANS 1290 and the impregnation shall be carried out in accordance with SANS 10005 using the empty-cell pressure process.
- 9.4 Poles shall be LOOP TENSION banded at both ends.
- 9.5 Concrete poles where specified shall comply with SANS 470 and the Detail Technical Specification.
- 9.6 If the spacing of poles is not more than 80m specified in the Detail Technical Specification, poles for 11 kV and 22 kV lines shall be spaced not more than 80m apart and poles for LV lines shall be spaced not more than 45m apart. The spacing of LV lines in suburban areas shall be arranged to suite the requirements of city blocks and street lighting.
- 9.7 All the poles shall be installed with the marking tags facing the roadside where applicable or shall face in the same direction where a road does not exist alongside the overhead line.
- 9.8 The pole minimum dimensions listed in the table below shall be used. Poles not complying with these dimensions shall be removed from site.

Length (m)	Minimum top dia (mm)
9,0	160
10,2	160
12,0	180
13,0	180
16,0	200

- 9.9 Templates shall be used for drilling holes required to fix cross-arms, brackets, insulators, etc. to the poles. After drilling, the holes shall be coated with a mixture of creosote and tar.
- 9.10 The poles shall be planted at the following minimum depths :

Length	Planting depth (m)
9,0	1,7
10,0	1,8
12,0	2,0
13,0	2,2
16,0	2,6

- 9.11 Kicking blocks shall be provided where ground with poor bearing qualities is encountered.
- 9.12 Poles shall be planted vertically plumb and in line and sufficiently stayed to maintain that position.

**10. CROSS-ARMS**

- 10.1 Cross-arms shall be of wood. Steel cross-arms shall only be used when clearly specified in the Detail Technical Specification. Wooden cross-arms are preferred due to their higher electrical resistance and better lightning performance of the line.
- 10.2 Steel cross-arms where specified shall be manufactured from standard steel sections complying with BS 4360.

- 10.3 Wooden cross-arms shall comply with SANS 753, Group Strength "A" and shall be straight in grain. Preservatives shall comply with par. 9.2. above. The minimum diameter of cross-arms shall be as follows:

Length (m)	Diameter (mm)	
	min.	Max.
2,4	140	160
3,0	140	160
3,6	160	185
4,5	160	185

- 10.4 Cross-arms shall be LOOP TENSION banded at both ends.
- 10.5 Tie straps shall be manufactured of mild steel to Grade 43 of BS 4360.
- 10.6 Cross-arms shall be long enough to accommodate the insulator spacing specified below.
- 10.7 Cross-arms and tie straps shall be bolted to poles using galvanised bolts, nuts and washers. Curved wood pole washers shall be fitted between bolt heads and the poles and between cross-arms and the poles. Back straps and U-bolts may be used to attach wooden cross-arms to the poles.
- 10.8 Curved wood pole washers shall be galvanised malleable cast iron or mild steel with a minimum thickness of 6 mm and shall have a minimum square outside dimension of 63 mm.

## 11. INSULATORS AND FITTINGS

- 11.1 Insulators shall be chosen to provide the mechanical strength and insulation level required by the line at every point in accordance with the Department's standard specification for "INSULATORS AND FITTINGS FOR OVERHEAD LINES", Section C38.
- 11.2 Insulators shall be spaced to provide the conductor clearance required.
- 11.3 Pin insulators and their pins complying with SANS 60383 shall be used in straight line intermediate positions only.
- 11.4 Disc insulators shall be used in all strain, tension or angle positions, Clevis-and-tongue or ball-and-socket type insulators complying with SANS 60383 shall be used. Disc insulators may be of glass or porcelain.
- 11.5 Curved wood pole washers shall be fitted between the collars of insulator pins and the cross-arm or pole and between the pin nut and the cross-arm or the pole, The washers shall comply with par. 10.8 above.
- 11.6 Insulator hooks shall be of an approved pattern and shall be manufactured from BS 4360 grade 43 mild steel or forged.
- 11.7 Terminating and yoke straps shall be manufactured from BS 4360 grade 43 steel or forged to a design approved by the Department.
- 11.8 All steel or ironwork i.e., fittings, cross-arms, bolts, nuts, washers, etc., shall be hot dip galvanised to SANS 32 & 121.

## 12. CONDUCTORS

- 12.1 Steel reinforced aluminium conductors to SANS 182, Part 3 shall be used for overhead lines. Should copper conductors be specified, they shall comply with SANS 182, Part 1. The cross-sectional area shall comply with the Detail Technical Specification.

- 12.2 The spacing between phase conductors shall be increased by 20 % over the spacing determined according to the formula in par. 4.7.5 of the "Code of Practice for Overhead Power lines" to compensate for stay movement and other factors and to maintain the B.I.L. of par. 7 above.

The minimum conductor spacing are :

Pole Spacing (m)	SUPPLY VOLTAGE		
	Up to 6,6 kV	11 kV	22 kV
	CONDUCTOR SPACING (mm)		
60	575	635	790
70	635	700	850
80	700	750	910
90	750	810	975

- 12.3 Manufacturer's stringing and tensioning charts shall be used to erect conductors. Conductors shall not be tensioned to more than 25 % of the breaking strength of the conductor at -5,5°C with no wind.
- 12.4 Conductor running blocks shall be installed on all pole positions to run out the conductors. Conductors shall not be dragged along the ground. The three conductors shall be tensioned simultaneously using suitably rated chain-ratchet pullers and "come along" specially designed for the particular conductor.
- 12.5 The minimum conductor to ground clearances as stipulated in Occupational Health and Safety Act shall be closely observed. Allowance shall be made for conductor creepage and subsequent increased sag after a period.
- 12.6 Conductors shall be prestressed for not less than one hour before binding in.
- 12.7 Mid span joints shall be kept to a minimum and where unavoidable, shall be made with approved full tension line splices.
- 12.8 Conductor joints at non-tension points shall be made with two bolt parallel groove clamps of a type approved by the Department. The current carrying capacity of the clamps shall be at least equal to that of the conductor.

Non-oxidising conducting paste shall be liberally applied to the inside of these clamps.

- 12.9 Where aluminium to copper connections are made, suitable bimetal clamps shall be used.

### 13. CONDUCTOR TERMINATIONS

- 13.1 Cold compression, bolted snail clamps or preformed terminations shall be used. Suitable thimble clamps shall be used with the preformed terminations.
- 13.2 The conductor shall be bound in at pin insulators by a single stirrup and binding. A chafer tape of soft aluminium shall be wrapped around the conductor at the insulator contact area. The conductor shall be bound to the stirrup for a distance of 50mm on either side of the insulator. 5mm diameter hard drawn aluminium wire shall be used for binding.
- 13.3 Suitably sized preformed wrap lock ties with pads may be used as an alternative method to par. 13.2 above.
- 13.4 Trails and bridge wires must be neatly disposed and connected with clamps or line taps with a minimum of two per connection or by means of other approved mechanical connectors.

**14. STAYS**

- 14.1 The position of stays may or may not be indicated in the instructions for the service, but it is the responsibility of the Contractor to provide staying adequate to maintain correct tension of the line and the verticality of every pole in the line, with or without the additional use of kicking blocks as he may decide.
- 14.2 Wind stays must also be provided for straight lines in exposed positions. Struts shall not be used if this can be avoided by the use of aerial stays and pillar stays.
- 14.3 Stay wires shall be spliced and bound in, in the accepted manner. Approved preformed materials may also be used.
- 14.4 The angle between the stay and the pole must be between 35° and 45°. The stay must be made off on the pole, as near as practicable to the point of resultant stress, with one and a half complete turns around the pole, supported by a suitable clamp.
- 14.5 For terminal poles of vertical line arrangements, at least two stays shall be used to prevent deformation of the pole, with the stay plates buried at least 1,8 m apart.
- 14.6 Stay holes shall be vertical, not less than 1,5 m deep and no wider than necessary to accommodate the baseplate, with a narrow side channel cut to embed the rod at the correct angle.
- The baseplate and portion of rod within the stay pole shall be firmly packed with hard material or concrete where necessary.
- 14.7 Stay pillars shall be concreted into the ground with top and bottom kicking blocks where required by the nature of the soil.
- 14.8 Porcelain stay insulators shall be installed in one stay wire as high as possible above ground level but far enough away from the structure to ensure that the portion of the stay below the insulator does not become alive.
- 14.9 Stay wire shall be of galvanised steel and the individual steel strands shall have a breaking stress of not less than 695 MPA and shall comply with BS 183 or SANS 182, Part 5. Stay wire make-offs shall be painted with bitumastic paint on completion.
- 14.10 Stay rods shall comply with BS Pattern 2 and shall be of circular section with tubular type turn buckles. Heavy duty construction, deep contoured type thimbles shall be used.
- 14.11 Galvanised steel stay plates shall be used.
- 14.12 Stay guards are required in the vicinity of public paths and roadways.

**15. EARTHING OF STRUCTURES**

- 15.1 Earthing requirements for service connections are specified in the Department's standard specification for "EARTHING", Section B11.
- 15.2 Protective overhead earth wires shall only be provided where specified in the Detail Technical Specification. In cases where overhead earth wires are specified, a low impedance earth as determined by the Basic Impulse Level of the line shall be provided at every pole along the line.
- 15.3 An earth connection is not required at every pole along a line with wooden poles and without overhead earth wires. Lines with metal poles shall be earthed at every pole.
- 15.4 Steelwork on wooden poles shall generally not be earthed except at structures for transformers, isolators, fuse-links, cable boxes, lightning arresters or other equipment which impairs the impulse flashover value of the insulation provided by the wooden structure.

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- 15.5 All metalwork to be earthed, shall be bonded together with 1 mm<sup>2</sup> bare copper conductors. These common bonds shall be connected to a 35mm<sup>2</sup> bare stranded or solid copper earth down lead conductor.
- 15.6 The connection between the overhead conductors and lightning arrestors and between the arrestors and the earth down lead shall consist of bare copper conductors of not less than 25mm<sup>2</sup>. The connecting leads shall have smooth bends and shall follow the shortest possible route.
- 15.7 The earth down lead conductor shall be stapled to the pole at intervals not exceeding 1m. Where atmospheric conditions are likely to cause galvanic action, staples shall be of non-ferrous metal and an earth clip used where possible.
- 15.8 The earth conductor shall be threaded through a black polyethylene sleeve for at least 2m above the ground.
- 15.9 The earth conductor shall not be installed in steel conduit nor shall the conductor be wrapped around the pole at any point since this will increase the reactance of the down lead.
- 15.10 A trench earth shall be installed at earthed structures carrying equipment such as transformers, fuse-links, lightning arresters, etc. extending 10 m on four sides of the structure in the form of a cross. The ends of the earth wires shall be bonded to four earth electrodes of at least 1,8m in length driven into the ground.
- 15.11 Intermediate earthing for overhead earth wires may consist of wrapping the earth wire 5 - 6 times around the pole below ground level.
- 15.12 The earth resistance shall be determined following the installation of the trench earth. Earth resistance values specified or required by protective devices shall be checked. The earth resistance values required to maintain the B.I.L. of the line as specified in par. 7 (assuming an average lightning current value of 25 kA), are as follows:

	Impulse Level (kV)	Earth Resistance (ohm)
Up to 6,6	75	3,0
11	95	3,8
22	150	6,0

- 15.13 Should the earth resistance be higher than specified or required, additional earthing shall be provided. Trench earths shall not exceed 50m. Proprietary clays may be used for soil treatment to improve the earth resistance.

### 16. EARTH WIRE ON LV SYSTEMS

- 16.1 Where specified, a continuous earth wire shall be installed along LV (up to 660 V) overhead lines in order to provide earth continuity between installations served by the line (ECC).
- 16.2 The earth wire shall be connected to every earth along the route in addition to the substation earth. Refer also to par. 4 of the Department's standard specification for "EARTHING", Section B11.
- 16.3 All metalwork and the top positions of stay wires shall be bonded to the earth wire.
- 16.4 The earth wire shall be above the conductors.

### 17. LIGHTNING ARRESTERS

- 17.1 Lightning arresters shall be of a type approved by the Department.
- 17.2 Lightning arresters shall be installed at all points where the steelwork has to be earthed and where specified.
- 17.3 The arresters shall be connected to the overhead conductors by 25mm<sup>2</sup> (minimum) copper conductors minimum and suitable parallel groove clamps.

- 17.4 Lightning arresters shall be placed on all the phase conductors at the following points in addition to those specified in the Detail Technical Specification :
- (a) As near as possible to the transformer terminals on the transformer side of the fused protection where applicable.
  - (b) At each termination of a cable on the overhead line.
  - (c) At every line sectionaliser or recloser.
  - (d) At each connection point to secondary lines.
- 17.5 Lightning arresters shall be mounted below the overhead conductors in order to reduce the length of the discharge path.
- 17.6 An earth shall be supplied and installed at each point where lightning arresters are installed in accordance with par. 15 above.

## **18. FUSE-LINKS**

- 18.1 Fuse-links shall be of a type approved by the Department.
- 18.2 Details of fixing methods and mounting shall be submitted to the Department for approval.
- 18.3 Fuse-links shall be installed at all transformers and where specified.

## **19. TRANSFORMER MOUNTINGS**

- 19.1 Transformers shall comply with the Department's standard specification for "DISTRIBUTION TRANSFORMERS", Section C36.
- 19.2 Transformers with a maximum power rating of 25kVA may be mounted on a single pole with the mounting brackets as specified in SANS 780.
- 19.3 Transformers with a power rating in excess of 25kVA and with a maximum of 200kVA shall be mounted on a platform between two poles.
- 19.4 The transformer platform for pole mounting shall consist of galvanised steel channels bolted to the two poles. The platforms shall be manufactured and installed in accordance with fig. B14.5 and B14.6.
- 19.5 All steelwork as well as the bolts, nuts and washers shall be galvanised to SANS 32 & 121.
- 19.6 An earth wire shall be installed against each pole of the structure and must extend for at least 500mm above the poles. These earth wires shall be bonded across at the top of the poles to shield the transformer.
- 19.7 Earthing in accordance with par. 15 shall be provided.

## **20. SUBSTATION EARTH**

Substation earths and earths at transformers along the route intended for earth continuity connections to installations served by the line, shall be provided in accordance with the Department's standard specification for "EARTHING", Section B11.

## **21. ANTI-CLIMBING DEVICES**

- 21.1 Anti-climbing devices shall be fitted to all poles carrying transformers or mechanically operated fuses or switchgear.

- 21.2 Galvanised barbed wire wound around the poles for at least 1m at a height of 2m above ground may be employed for this purpose.

## 22. CRADLES

Where HV overhead lines cross roadways, railways and other supply lines, important communication lines and where an HV line is run above an LV line, an earthed cradle shall be installed. The longitudinal wires of the cradle shall not be less than 7,2mm<sup>2</sup> and the cross-lacing not less than 4mm<sup>2</sup>.

## 23. DANGER NOTICES (LIGHTNING SIGN)

Danger notices with the wording "DANGER-GEVAAR-INGOZI" shall be fitted to all structures with transformers, mechanically operated switchgear and fuses.

## 24. EXCAVATIONS

- 24.1 Excavations for poles, stays and trench earths shall remain open for as short a period as possible. The Contractor shall erect and maintain guards, warning notices and lights at open excavations and soil heaps.

- 24.2 Excavations shall be classified as follows:-

Very hard rock shall mean rock that can only be excavated by means of explosives.

Hard rock shall mean granite, quartzitic sandstone, slate and rock of similar or greater hardness, solid shale and boulders in general requiring the use of jack hammers and other mechanical means of excavation.

Soft rock and earth shall mean rock and earth that can be loosened and removed by hand-pick and shovel.

- 24.3 After poles and stays have been planted, the holes shall be backfilled and well compacted. Compaction shall be executed in layers of not more than 300mm to obtain a high compaction density.
- 24.4 The following dimensions shall be used when calculating the cubic capacity of excavations:
- (a) Pole holes: 1,2m x 0,6m x depth
  - (b) Stay holes: 1,2m x 0,6m x 1,8m
  - (c) Trench earths: 0,5m x 0,6m x length
- 24.5 Poles shall be installed in accordance with the Detail Technical Specification of the installation.
- 24.6 Poles shall not be installed in clayey soil or in swampy conditions without the necessary precautions to stabilise the installation.
- 24.7 If unsatisfactory conditions for the installation of poles and stays are encountered during the excavations, the Department shall be informed without delay in order to facilitate alteration of the foundation design or alteration of the route of the line.
- 24.8 Poles and stays shall be installed in undisturbed soil.
- 24.9 If wooden poles are installed in a concrete or other water retaining foundation, the pole shall protrude through the concrete to ensure adequate natural drainage to prevent rotting of the wooden pole in the foundation due to the accumulation of water between the pole and the foundation.

## 25. SAMPLES

Samples of equipment, materials and SANS Test Reports proposed for the installation shall be submitted to the Department on request.

**SECTION B15****B.15 INSPECTIONS, TESTING, COMMISSIONING AND HANDING OVER****1. PHYSICAL INSPECTION PROCEDURE**

- 1.1 Once the Contractor has completed the installation, written notice shall be given to the Department in order that a mutually acceptable date can be arranged for a joint inspection.
- 1.2 During the course of the inspection, the representative of the Department will compile a list of items (if any) requiring further attention. A copy of this list will be provided to the Contractor who will have a period of 7 days in which to rectify the offending items of the installation.
- 1.3 The Contractor shall then provide written notice that he is ready for an inspection of the remedial work to the offending items.
- 1.4 This procedure will continue until the entire installation has been correctly completed to the satisfaction of the Department.

**2. TESTING AND OPERATIONAL INSPECTION PROCEDURE**

- 2.1 In addition to the above the Contractor shall have the complete installation tested and approved by the local authorities where applicable.
- 2.2 Subsequent to the above testing and approval, the Contractor shall in the presence of the representative of the Department test all circuits with respect to:
  - (a) Phase balance.
  - (b) Insulation level.
  - (c) Polarity.
- 2.3 Upon completion of the installation and within 3 months of the handover date, the Contractor shall provide and make available a recording voltmeter to record the voltage at three locations in the complex over a period of 48 hours each. These locations will be nominated by the Department.

**3. "AS BUILT" DRAWINGS**

- 3.1 As each portion of the work is completed, the Contractor shall provide the Department with as-built drawings showing the exact location measured from fixed points of all cables, transmission lines, each outlet point, etc.
- 3.2 In addition a complete reticulation diagram showing all supply cables and switchboards shall be provided behind a plastic cover in the substation or adjacent to the Main Switchboard if not located in a substation.
- 3.3 The installation will not be regarded as complete until all of the above requirements listed in 1, 2 and 3 above have been met.