



SPECIFICATION FOR LOW VOLTAGE UNDERGROUND CABLE

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SPECIFICATION FOR LOW VOLTAGE UNDERGROUND CABLE

1.0 GENERAL

This section of the Specification describes and specifies requirements for the supply, delivery, installation, testing, commissioning, handing over in approved working order and maintenance during the Defects Liability Period of the underground cabling work in accordance with the specifications, Supplementary Notes, Bill of Quantities, Conditions of Contracts, Drawing and other related documents.

2.0 TYPES OF CABLES

This specification shall cover the following types of cables: -

- (a) **PVC/SWA/PVC CABLE** - Cable shall be manufactured and tested in accordance with MS 274 or BS 6346 and shall have high conductivity plain copper stranded conductors insulated with PVC suitable for a voltage of 600/1000 V laid together and bedded with PVC, armoured with galvanised steel wires and sheathed with PVC.
- (b) **XLPE/SWA/PVC CABLE** - Cable shall be manufactured and tested in accordance to BS 5467 or IEC 60502 and shall have high conductivity plain copper stranded conductors, insulated with cross-linked polyethylene (XLPE), suitable for a voltage of 600/1000 V laid together and bedded with extruded PVC, armoured with galvanised steel wires and sheathed with PVC.
- (c) **XLPE/AWA/PVC CABLE** - Cable shall be manufactured and tested in accordance to BS 5467 or IEC 60502 and shall have high conductivity plain copper stranded conductors, insulated with cross-linked polyethylene (XLPE), suitable for a voltage of 600/1000 V laid together and bedded with extruded PVC, armoured with aluminium wires and sheathed with PVC.



- (d) **XLPE/PVC CABLE** - Cable shall be manufactured and tested in accordance to BS 5467 or IEC 60502 and shall have high conductivity plain copper stranded conductors, insulated with cross-linked polyethylene (XLPE), suitable for a voltage of 600/1000 V laid together and bedded with extruded PVC and sheathed with PVC.
- (e) **PILCDSTAS CABLE** - Cable shall be manufactured and tested in accordance with BS 6480 Part 1 and shall have high conductivity plain copper stranded conductors, insulated with strong long fibre paper, uniform in texture, free from metallic particles, mass impregnated with non-draining insulating oil compound suitable for a voltage of 600/1000 V, lead alloy sheathed, double steel type armoured and served.
- (f) **PILCDS CABLE** - Cable shall be manufactured and tested in accordance with BS 6480 Part 1 and shall have high conductivity plain copper stranded conductors, insulated with strong long fibre paper, uniform in texture, free from metallic particles, mass impregnated with non-draining insulating oil compound suitable for a voltage of 600/1000 V lead alloy sheathed and served.

3.0 CABLE ROUTES

Cable routes shown in the Drawings are for tendering purpose only. The Electrical Contractor shall submit shop drawings as required in 13.1 of the proposed routes and peg out the cable routes for the approval of the S.O.'s Representative prior to excavation of the cable trenches. The program of work for excavation of cable trenches, laying of cables, reinstatement of trenches etc. shall be submitted to the S.O.'s Representative for approval one week before execution of the work.

The Electrical Contractor shall make available all necessary insurance or guarantee, and shall also ensure all approvals are obtained from relevant authorities prior to commencing works. The Electrical Contractor shall be responsible in making good any damage to buildings, tarmacs, pavements,



concrete areas, slopes, drains, culverts, pipes etc. which had not been properly make good arising out of his work.

4.0 LENGTH OF CABLE

The length of cable each indicated in the Drawings and/or Bill of Quantities is for tendering purpose only. The Electrical Contractor shall ascertain the length of each cable required before ordering. Actual length of each cable installed shall be measured on site and the Electrical Contractor shall be paid according to the unit rate in the Contract. However, the rates quoted shall include wastage due to cutting to lengths, terminations etc..

5.0 CABLE TRENCH

Unless otherwise specified, cable trenches shall be 750 mm deep. The trenches shall be of sufficient width to enable provision of adequate spacing between cables but in any case shall not be less than 450 mm wide.

Trenches shall be kept as straight as possible and shall have vertical sides which shall be protected where necessary so as to avoid subsidence and damage. The bottom of the trenches shall be firm and of smooth contour and any other objects likely to damage the cable sheathing shall be removed. The material excavated from the trenches shall be placed or removed so as to prevent nuisance or damage to adjacent areas or buildings.

The trench excavation and filling in shall be so executed that all roads, walls, sewers, drains, pipes, cables, structures etc. shall be reasonably secured against risk of subsidence damage. Provision shall be made, during excavation and until interim restoration has been completed, for reasonable access of persons and vehicles to the areas of buildings adjacent to the trenches.

The Electrical Contractor shall provide pumps and other appliances for the



necessary pumping required for the disposal of water so as to prevent any risk of the cables and other materials to be laid in the trenches being detrimentally affected. Where necessary, bailing shall be provided.

Where trenches pass from a footway to a roadway or at other position where a change of level is necessary, the bottom of the trench shall rise or fall gradually.

6.0 CABLE DUCTS

At road crossings, sewerage pipe crossing, water pipe crossings, paved areas, concrete areas, concrete areas and where specified by the S.O.'s Representative cables shall be protected by galvanised steel pipes buried to a depth of 900 mm below finished ground level. The pipes shall be of heavy duty type, complying with BS 1387 and complete with screwed and socketed joints. Unless otherwise specified the pipes shall be 150 mm in diameter. Where it is necessary to cross drains, culverts or similar obstruction, which is too deep for the cables to be buried below, galvanised steel pipes as specified above shall be provided. The pipes shall be supported at each end in a concrete block and shall project through the blocks into the ground at a depth of at least 750 mm. All ducts shall be extended at least 600 mm beyond paved areas, concrete areas, drains, road crossing, pipe crossing etc.

Cable entering a building shall be protected by pitch fibre ducts complying with BS 4108 or heavy duty galvanised steel pipes complying with BS 1387 or uPVC pipes complying with MS 978 and MS 1063 as specified of 150 mm diameter completed with bend pieces, buried to a depth of 900 mm and encased with 75 mm of concrete all round. The ducts shall be installed with a gradient so as to drain away any water in the ducts. All ducts passing through walls shall be effectively sealed and made water-tight.

Unless otherwise approved by the S.O.'s Representative, the number of cables installed in each duct shall be such that the space factor shall not exceed 45%. A draw wire shall be provided for each duct.



Unless specified to be provided by others, the above galvanised steel pipes, pitch fibre ducts and/or uPVC pipes shall be provided by the Electrical Contractor whether they are shown in the Drawings or not.

7.0 TRAFFIC SAFETY AND CONTROL

When work is being carried out beside any public road or other existing road, appropriate warning signs shall be erected by the Electrical Contractor. The form, placing and light of the warning signs must comply with all local and national regulations and safety codes for road works.

Where it is necessary for any trench, pit or manhole to be left open overnight, ample flashing warning lamps shall be placed at each end and at intervals not greater than 10 metres. In built up areas barricades shall be erected along the length of the trench pit or manhole in addition to warning lamps.

Where necessary or as directed by the S.O.'s Representative, flag-men shall be stationed at strategic locations to control prevailing traffic.

8.0 CABLE LAYING AND INSTALLATION

All cables shall be handled, laid and installed according to this specification, BS 7671, cable manufacturer's recommendations and ERA Reports by using proper installation equipment and tools.

All cables shall be supplied in complete length to suit the circuits they serve, and no straight through joints shall be used. Straight through joints in the cable will only be permitted in very exceptional circumstances such as arising from unavoidable limitations in manufacturing length. If straight through joints or other approved joints is permitted by the S.O.'s Representative, the cost of such joints shall be borne by the Electrical Contractor. No joints in the cable will be allowed unless approved in writing by S.O.'s Representative.



The minimum internal bending radius of the cable shall be not less than 12 times the overall diameter of the cable. Wherever cables are cut, the ends shall be immediately sealed in an approved manner unless; it is intended to proceed with cable jointing for termination straight away.

For groups of more than one cables laid in the same trench, they shall be spaced by the horizontal clearance between adjacent cables of at least twice the overall diameter of the adjacent largest size cables.

Unless otherwise permitted by the S.O.'s Representative no cable shall be laid and covered up in the absence of the S.O.'s Representative.

8.1 CABLE LAID DIRECT IN GROUND

Before cable is laid, the trench shall be thoroughly inspected and any debris and sharp objects shall be removed. The bottom of the trench shall be covered with a layer of 75 mm of clean sand. The cables shall then be laid on this bedding in an orderly manner without overlapping and crossing each other. After laying the cables, a layer of 75 mm of clean sand shall cover the cables and carefully spread over the trench before placing the cable protective covers.

Unless otherwise specified, the cable protective covers shall be of clay bricks. The bricks shall be new, well burnt and in complete pieces. They shall be laid length wise from end to end along the entire route of the underground cable if the cable size is more than 120 sq. mm. For cable size more than 120 sq. mm., more than one row of the bricks shall be laid. Each cable shall be separately protected by these bricks and the cover shall have at least 25 mm overhang on each side of the cable.

If uPVC cable protective covers are specified, the covers shall be of polyvinylchloride without plasticiser type with specific density between 1.37 g/cm^3 to 1.42 g/cm^3 as shown in Appendix A approved by the S.O.'s Representative. The uPVC cover shall be resistant to aggressive soils and of dimension 150 mm wide and 1000 mm long. The covers shall be single coloured orange and top side shall be embossed with standard danger sign and bold letters "BAHAYA! KABEL ELEKTRIK DI BAWAH". The covers shall be provided with male and female interlocking device. The



covers are laid together lengthwise from end to end along the entire cable route and they are held together tightly by the interlocking device. At least 25 mm overhang on each side of the cable shall be provided to protect the cable underneath.

The trench shall then be backfilled with earth and shall be consolidated after every 150 mm of backfilling using a mechanical rammer. An orange coloured, multi-strand nylon rope of minimum 6 mm diameter shall be laid at a depth of 300 mm along the trench to identify the cable route. At every 10 metres interval, an extra 2 metres length of nylon rope shall be coiled and laid. The finished surface shall be left proud by 50 mm to allow for subsidence and the Electrical Contractor shall be responsible for the removal of any surplus to a position indicated by the S.O.'s Representative.

The surface of the refilled trench shall be temporarily reinstated and maintained in a thoroughly safe condition until complete consolidation of the soil is achieved. As soon as the soil has consolidated, the trenches shall be made good to the original conditions to the satisfaction of the S.O.'s Representative.

8.2 CABLE INSTALLED IN PRE-CAST CONCRETE TRENCHES

Method of installation of cables in pre-cast concrete trenches shall be in accordance with Method 12, 18, 19 or 20 of Table 4A BS 7671. However, if the method is not specified, the cables shall be installed in accordance with Method 18 and/or as directed by the S.O.'s Representative.

Cables laid at the bottom of the trenches shall be in accordance with Method 18 of Table 4A BS 7671. Cables installed on the trench wall shall be in accordance with Method 12, 19 or 20 of Table 4A BS 7671 and the cables shall be secured on the cable tray by means of saddles at suitable intervals. In the case of single core cable, non ferrous saddle shall be used.

The cable trays shall be fabricated from perforated hot dipped galvanised sheet. The minimum thickness of the sheet steel used shall be 1.5 mm for cable tray with width up to 300 mm and shall be 2.0 mm for width exceeding 300 mm. The cable tray shall be supported at least 25 mm from



the trench wall by mild steel brackets at 600 mm intervals. The bracket shall be hot dipped galvanised. All brackets shall be securely fastened with steel raw bolts and nuts. Samples of cable tray and bracket shall be submitted to the S.O.'s Representative for approval prior to installation.

To provide electrical continuity, all cable tray joints shall be bridged by means of tinned copper tape of dimension not less than 25 mm x 3 mm. All saddles for cables on cable trays shall be installed by bolts, washers and nuts. All cable tray tees, intersection units, adaptor units etc. shall be factory manufactured.

The trenches inside the buildings shall be filled with clean sand up to a level above the cable ducts.

8.3 CABLE RUN ON WALLS AND UNDER FLOOR SLABS

Cable run on walls and under floor slabs shall be mounted on perforated hot dipped galvanised sheet steel cable trays. Method of installation of the cables shall be in accordance with Method 11 and 12 of Table 4A BS 7671. The construction and finished of the cable trays and the way of installation of the cables on the cable trays shall be as described in 8.2 above.

The cable trays shall be suspended from floor slabs by hangers or mounted on wall by brackets at 600 mm interval. The material and finishes of the hangers, brackets and other suspending and supporting structures shall be as that described for brackets in 8.2 above.

Where cable trays pass through floors or fire resistant walls, the surrounding hole shall be sealed to full thickness of the floor or wall with non-hygroscopic fire-resisting material of minimum 2-hour fire rating approved by Jabatan Bomba Dan Penyelamat Malaysia.

9.0 CABLE TERMINATION AND JOINTING

Unless otherwise permitted, all cable termination and jointing works shall



only be carried out in the presence of the S.O.'s Representative. A plastic laminated plate engraved with details such as size of cable, number of core, date of commissioning, date of jointing, length of cable, distance of cable joint etc. shall be securely fixed near the termination. All cable terminations and jointing shall be undertaken by competent persons as prescribed in Electricity Regulations 1994.

9.1 TERMINATION OF PVC INSULATED ARMOURED CABLE

PVC/SWA/PVC, XLPE/SWA/PVC, XLPE/AWA/PVC, and XLPE/PVC cable shall be provided with compression cable gland for termination. The cable gland shall be of gunmetal or brass type and shall grip both the inner and outer PVC sheath of the cable and so designed that any strain on the cable is taken by the steel wire armouring which shall be effectively sealed between the gland itself and the outer cable sheath. If so directed by the S.O.'s Representative, termination by heat shrinkable method shall be used as described in 9.2 hereafter.

9.2 TERMINATION OF PAPER INSULATED CABLE

Paper insulated cables, unless otherwise specified, shall be terminated by the heat shrinkable method.

The cables shall be tested for moisture before termination is commenced. Samples of paper both from the layer nearest to and furthest from the conductor shall be immersed in transformer oil or paraffin wax, heated to a temperature of approximately 115 °C. If any residual moisture is present this will be immediately detected by bubbling. Samples of paper should be tested singly and should not be touched by hand but gripped in a pair of tweezers. Phasing and insulation resistance tests shall be taken on each length of cable laid before termination is commenced.

The heat shrinkable termination materials used shall be supplied in a complete kit to suit various sizes of cable and to provide stress control, non-tracking and environmentally sealed termination. It shall consist of high permittivity, high resistivity, heat shrinkable, stress control, UV stable, non-tracking polymeric materials and heat activated sealant to



prevent ingress of moisture and contamination. The termination shall meet the performance test of IEC 60112, and identification of conductors by colour shall comply with IEC 60446. It shall also have the following performance characteristics: -

- (a) Voltage withstand for 15 minutes, 50 Hz : 4 KV phase to earth.
- (b) Voltage withstand for 4 hours, 50 Hz : 3 KV phase to earth.
- (c) Impulse voltage withstand positive and 10 negative, micro seconds : 8 KV peak phase to earth.
- (d) Continuous a.c.voltage : 1.5 KV phase to earth.
- (e) Insulation resistance between phase conductor and ground : 1000 Megaohms or greater.

9.3 CABLE JOINTING

The type of cable boxes, compound and jointing materials used shall be factory manufactured. Unless otherwise specified cast iron joint boxes shall be used, and all jointing kits shall be approved by the S.O.'s Representative before joints being carried out. Every cable joint shall be started and finished on the same day. Whenever cables are to be jointed in the open during wet weather conditions, the Electrical Contractor shall take all necessary precautions to prevent moisture getting into the cables. When cable sheaths is used as earth continuity conductor, the glands must have necessary contact surfaces to provide a low resistance path under fault conditions. Phasing and insulation resistance tests shall be taken before jointing is commenced.

Core numbers printed on the papers shall be observed when jointing and whenever possible such numbers shall be maintained throughout the



system. Core number '0', '1', '2' and '3' shall denote as neutral, red, yellow and blue phases respectively. In the case of two core cable, number '1' shall denote the phase conductor and '0' the neutral. Crossing of core in the boxes shall be avoided wherever possible but connections shall be consistent with the foregoing requirements. The jointing of cables shall be undertaken only by competent cable jointer as prescribed in Electricity Regulations 1994.

10.0 CABLE MARKERS

Cable marker with lettering and sign as shown in Appendix B1 and Appendix B2 shall be provided by the Electrical Contractor at every change in direction of underground cable routes and at every 15 m on straight run. Cable markers shall be of heavy duty reinforced concrete construction and approved by the S.O.'s Representative.

The cable marker shall be of trapezoidal block with 100 mm square top face, 150 mm square bottom face and 400 mm in height as shown in Appendix B3. The top face shall be indented with bold lettering 'L.V.' and directional sign indicating the direction/directions of the cable route. The cable marker shall be fully painted orange using standard road paint. The cable marker shall be buried to a depth of 300 mm. Cable joint marker of similar construction but with the lettering and sign as shown in Appendix B3 shall be provided and installed at every cable joint in the similar manner.

11.0 TESTING AND COMMISSIONING

The Electrical Contractor shall be responsible for the testing of the cables. Tests shall include continuity, phasing out and insulation resistance between conductors and between conductors and sheath by employing a 500 volts insulation tester. A copy of test results certified by competent person shall be submitted to the S.O.'s Representative. The date of commissioning shall be agreed by the S.O.'s Representative and the Electrical Contractor shall ensure that the installation is safe before the



cable is energised.

The S.O.'s Representative reserves the right to be present at all tests and the Electrical Contractor shall give at least one week notice in writing to the S.O.'s Representative for this purpose. In any case, no test shall be carried out without prior approval of the S.O.'s Representative. Copies of all the test certificates together with as-installed Drawings properly bound and titled shall be submitted to the S.O.'s Representative within one week after the completion of the testing.

12.0 MAINTENANCE

During the Defects Liability Period the Electrical Contractor shall perform maintenance work for the complete cabling and associated work. All work labour, materials, tools and parts necessary to rectify the defects due to manufacturing or installation fault shall be supplied and/or executed at no extra cost to the Government. The maintenance work shall be carried out as soon as the Electrical Contractor has been informed by S.O.'s Representative.

The work to be performed shall include but not limited to the following: -

- (a) Replace or make good any defective cables, cable joints and cable terminations;
- (b) Replace any broken or defective cable markers;
- (c) Making good any damage to building, concrete areas, slopes, drains, culverts, existing cables, pipes etc. which had not been properly made good arising out of his work;
- (d) Any other work deemed necessary by the S.O.'s Representative.



13.0 SHOP DRAWINGS AND AS INSTALLED DRAWINGS

13.1 SHOP DRAWINGS

Two sets of prints of shop drawings for cable installation shall be submitted to the S.O.'s Representative for approval. The Electrical Contractor shall prepare and submit shop drawings for the whole work or parts of the work at least two weeks before the work begins. If the shop drawings submitted are not acceptable by the S.O.'s Representative, the Electrical Contractor shall amend and re-submit the shop drawings within two weeks from the date of return of the shop drawings.

The shop drawings shall include and show the following:

- (a) The dimensioned general arrangements, layouts and positions of cable trenches and cable ducts;
- (b) The dimensioned general arrangements, layouts and routes of cable trays;
- (c) The dimensioned layouts and positions of all holes and cut-through in the walls and floors for the lateral and vertical cable mains and/or submains;
- (d) The dimensioned layouts and positions of cable routes for all cables laid underground, in ducts and trenches;
- (e) The dimensioned general arrangements, layout and positions of cable joints.

The cost of all these shop drawings, whether or not provided in the Bill of Quantities, is deemed to be included in the Contract.

13.2 AS INSTALLED DRAWINGS

Within three calendar months after the practical completion of the contract, one set of true to scale negatives (110/115 gm/sq. m) and four



set of prints showing the cable routes with reference to easily recognisable buildings and structures, size and type of cables, location and type of joint etc shall be submitted. The drawing size shall be AO or A1 unless otherwise approved by S.O.'s Representative.

These drawings shall be properly stencilled and shall have at the lower right hand corner the Electrical Contractor's name and address, date of commissioning, scale, drawing number, title and any other particulars as required by the S.O.'s Representative and the following particulars: -

JABATAN KERJA RAYA
CAWANGAN ELEKTRIK
CONTRACT NO:
TENDER NO:

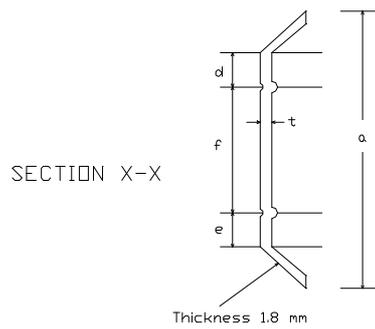
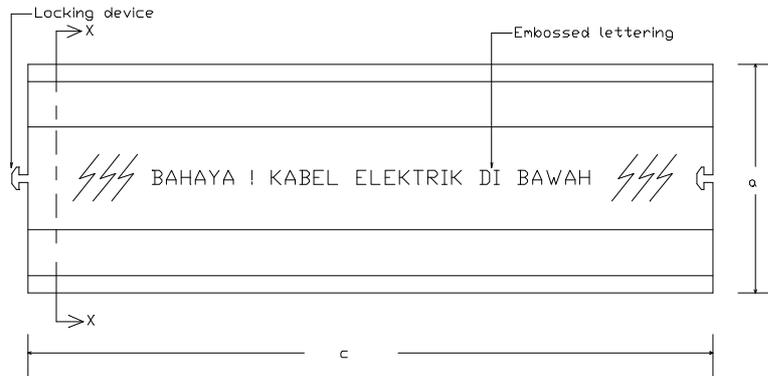
The numbers for these drawings shall be obtained from the S.O.'s Representative.

If the drawings submitted are not acceptable to the S.O.'s Representative the Electrical Contractor shall amend and re-submit the drawings within two weeks from the date of return of the drawings.

If required and specified elsewhere, in addition to the aforesaid negatives and prints, as installed drawings shall be stored in electronic media or any other media as specified. For electronic media they shall be either in floppy disks format or CD rewritable (CD-RW) optical disks format as specified which can be easily retrieved by computer. The software programme shall be AutoCAD of latest release. Two sets or copies in either format as specified appropriately titled and stored in container or casing shall be submitted.

In addition to the above, one set of the drawing shall be properly framed up in the switchroom.

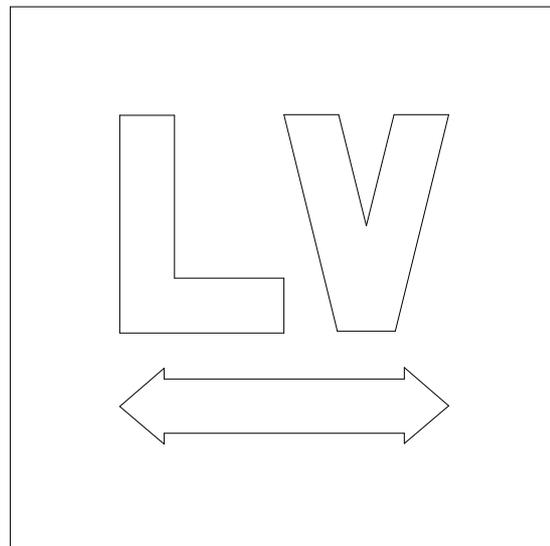
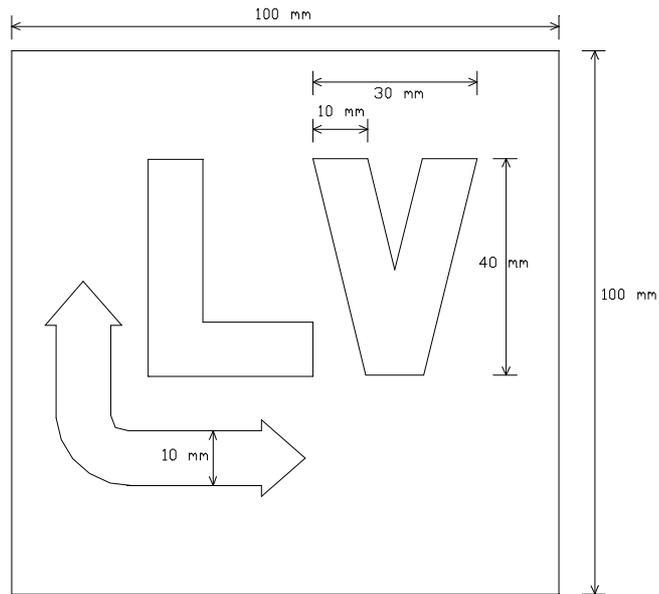
Appendix A : uPVC Cable Protective Cover



SIZE(mm)	a	c	t	d	e	f
170/1000	170	1000	1.8	35	35	50
250/1000	250	1000	1.8	60	60	100

Appendix B1 : Cable Marker - Directional Sign & Lettering

Dimension as indicated
Lettering: 40mm (H) x 30mm (L) x 10mm (W) x 5mm (D)

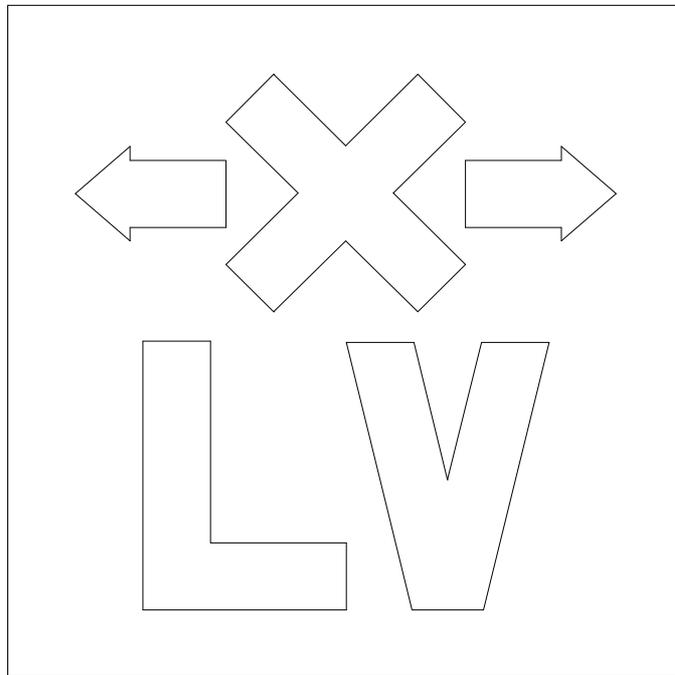


Dimension as above

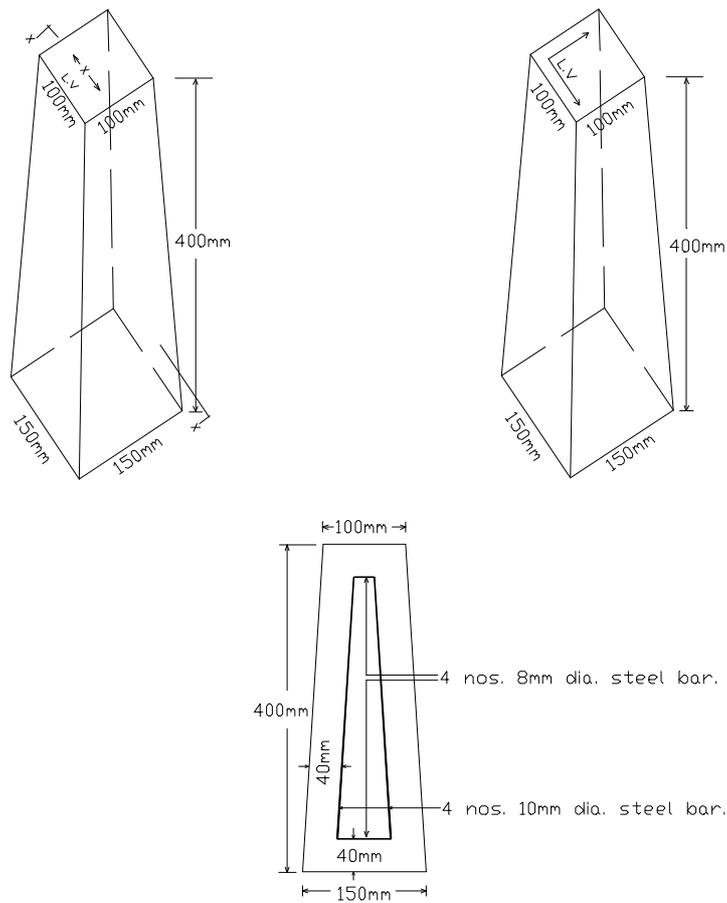
Appendix B2 : Cable Marker - Joint Sign & Lettering

Dimension as Appendix B1

Lettering: 40mm (H) x 30mm (L) x 10mm (W) x 5mm (D)



Appendix B3: Cable Marker - Construction



SECTION X-X

NOTE:

1. ALL COVERS TO BE 40mm
2. GRADE 20 (1:2:4) CONCRETE 20mm (3/4) AGGREGATE