



THE KENYA POWER
AND LIGHTING CO. LTD.

CODE OF PRACTICE

for

**CONSTRUCTION OF LOW VOLTAGE LINES
(OVERHEAD AND UNDERGROUND)**

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REVISION RECORD

| REVISION | DESCRIPTION OF REVISION | DATE | APPROVAL |
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| <i>0</i> | <i>1ST ISSUE</i> | <i>JANUARY 1998</i> | |
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CONSTRUCTION OF OVERHEAD AND UNDERGROUND L V LINES UP TO 433 VOLTS

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1. FOREWORD

- 1.1 This standard has been prepared by the Standards Department of the Technical Audit R&D Division, KPLC and lays down the recommendations for the construction of low voltage overhead and underground lines.
- 1.2 This standard is based on ESI-43-30 and is subject to revision as and when required. All construction work shall conform to this standard.
- 1.3 This standard supersedes all standards for construction of low voltage lines issued before the revision date.

2. SCOPE

- 2.1 This standard lays down the requirement for the design, erection and installation of overhead and underground low voltage electric power distribution lines of voltages up to 433 volts.
- 2.2 This standard covers the design and erection of
 - (i) Three phase, 4-wire and single phase, 2-wire low voltage overhead lines erected on wood poles, including constituent component parts.
 - (ii) Three phase, 4-core and single phase 2-core low voltage underground cables including service cables to buildings.

3. OVERHEAD LINES

3.1 MATERIAL AND CONSTRUCTION

3.1.1 LINE CONDUCTORS

- 3.1.1.1 The conductors used on the overhead lines shall be 50 sq. mm and 100 sq. mm All Aluminium stranded conductor bare and PVC covered, complying with the requirement of KPLC specification.

3.1.1.2 The conductor shall be arranged in vertical formation with 300 mm spacing. The normal arrangement from top to bottom on a three phase 4-wire shall be as follows

Red No.1
Yellow No.2
Blue No.3
Neutral No.4

Where a guard wire is required, this shall occupy position No.1, the phase and neutral conductors being placed in lower positions respectively. Where a 2-wire line is erected, the phase and neutral shall be arranged from top respectively.

Where street lighting is required, this shall occupy position No. 4, the neutral conductor being placed in a lower position i.e. No. 5

The neutral conductor and street lighting conductor if required shall be of the same size as the phase conductor.

3.1.1.3 All bare conductors shall be sagged in accordance with table 1 where insulated conductor is necessary the sag of all conductors shall be increased by 20%.

3.1.1.4 The conductor shall be bound in and made of using materials as set out below

(a) bare conductor

No 9 SWG bare aluminium binding wire

(b) PVC insulated conductor

(i) No.9SWG aluminium binding wire insulated with black PVC

alternatively

(ii) No.9 SWG bare aluminium binding wire and black PVC tape.

3.1.1.5 Mid-span joints are not permitted.

3.1.1.6 The minimum height of conductors above ground at the maximum temperature (75°C) shall be as follows

Road ways ---- 5.8m
Elsewhere ----- 5.2m

3.1.1.7 Spans of 50m shall be regarded as the normal span. Under favourable conditions, spans up to 70m without increases conductor spacing will be permitted.

3.1.2 SUPPORTS (POLES)

3.1.2.1 Poles shall be Eucalyptus saligna, complying with the requirement of KPLC specification.

3.1.2.2 Medium or light poles shall be used as detailed in table 2. Medium poles shall be used in all positions where a stay is required.

3.1.2.3 Poles shall be drilled (if not already drilled) to fig LV/01.

3.1.2.4 The insertion depths for poles upto and including 11.0m shall be 1.6m and for poles in excess of 11.0m shall be 1.8m.

3.1.3 INSULATORS

3.1.3.1 D-iron bracket and reel type insulator shall be used for all straight intermediate pole positions, all angles of deviation positions and terminal positions and shall be arranged in accordance with fig LV/02 to LV/07.

3.1.4 STAY

3.1.4.1 4/8 SWG galvanised stranded stay wire shall be used.

3.1.4.2 A sling type strain insulator shall be inserted in each stay, 1.6m from the top.

3.1.4.3 Stay rod shall be galvanised steel, size 6ft x 1/2 inch.

3.1.4.4 A reinforced concrete stay block buried to a depth of 1.4m shall be used as the stay anchor.

3.1.4.5 The number and spread of stays required for different angles of deviation and terminal positions shall be as stated in table 2.

3.1.5 SERVICE

3.1.5.1 The aerial service conductor shall be 16 sq. mm, 25 sq. mm and 35 sq. mm single core low voltage concentric Aluminium cable, PVC insulated.

3.1.5.2 The service cable shall be made off using No.9 SWG aluminium binding wire insulated with black PVC.

3.1.5.3 The service cable connection for aerial service lines shall be done by use of Aluminium line taps.

3.1.5.4 The maximum span length of service to buildings shall be 20m.

3.1.5.5 The lead in cable shall be 16 sq. mm, 25 sq. mm or 35 sq. mm single core low voltage concentric aluminium cable black PVC insulated and red PVC sheath and shall be secured to the building in accordance with fig LV/08. The same aerial service cable will be used as lead in cable where desired.

3.2 TELEPHONE LINE CROSSING

3.2.1 Where an overhead line crosses or is in proximity to an overhead telephone line, PVC insulated conductor shall be used and the overhead power line shall be above the telephone line with the recommended clearance.

3.2.2 Where a guard wire has to be erected, it shall consist of 1x50 sq. mm bare aluminium stranded conductor made off on reel insulators at each end of the crossing span. At each end, a tail of the aluminium conductor shall be jointed to a 25 sq. mm PVC insulated copper cable which shall then be carried down the pole to a 4ft earth rod.

The insulated cable shall be protected to a height of 1.8m above and 300mm below ground level by means of 1/2 inch PVC pipe. An "out of balance" stay shall be fitted to the pole and each guard wire termination.

4. UNDERGROUND CABLES

4.1 MATERIALS

4.1.1 CABLES

4.1.1.1 The cables used in the installation of underground low voltage lines shall be as shown here below:

| Cable type | Conductor size (mm ²) | |
|------------|-----------------------------------|-------------|
| | Single Phase | Three Phase |
| Copper | 10 | |
| | 16 | |
| | 25 | |
| Aluminium | 16 | 25 |
| | 25 | 70 |
| | 35 | 120 |
| | 630 | 185 |
| | | 300 |

4.1.1.2 All cables conform to the appropriate KPLC standards specification for procurement.

4.2 INSTALLATION

4.2.1 In general, cables shall be handled and installed to this requirement and with minimum risk of cable damage.

4.2.2 POLE SUPPORT

Cables clamped to poles shall be secured at not more than one metre intervals. The cable shall be protected to a height of 1.8m above and 300m below ground level by means of PVC pipe of ample section. The pipe shall be clamped to the pole at top, middle and bottom.

The cable entry shall be affected at a radius greater than the prescribed minimum herein.

4.2.3 LAYING

4.2.3.1 Cables shall be laid in prepared bedding along the centre line of the trench without dragging or kinking.

4.2.3.2 Cables shall be bent to a radius larger than the minimum bending radius of the cable indicated herein.

4.2.3.3 Cables shall be laid as much as possible away from obstruction such as pipes, sewer and other existing cables.

If crossing of such obstructions are unavoidable, the cable shall be laid below such existing services with a minimum clearance of 300mm.

4.2.3.4 Trench excavation shall not be less than 200mm wide and 600mm deep.

4.2.3.5 Cables across roads shall be contained in a heavy duty pipe complying with KPLC specification.

4.2.3.6 Cables shall be covered with protective cable covers complying with KPLC specification.

4.2.3.7 Cable markers complying with KPLC specification shall be installed at the exit routes of buildings, at every change of direction of the cable route and at every point of crossing another service.

4.2.3.8 The service cable connection of aluminium to copper shall be done by use of bimetal connector.

TABLE 1 (A) SAGGING CHART FOR 50 SQ MM ALL ALUMINIUM CONDUCTOR

| SPAN (m) | TEMPERATURE | | | | | | | | | | | |
|-------------|----------------|------------|----------------|------------|----------------|------------|----------------|------------|----------------|------------|----------------|------------|
| | 50°C | | 45°C | | 40°C | | 35°C | | 30°C | | 25°C | |
| | Force (daN) | Sag (m) | Force (daN) | Sag (m) | Force (daN) | Sag (m) | Force (daN) | Sag (m) | Force (daN) | Sag (m) | Force (daN) | Sag (m) |
| 5 | 5 | 0.18 | 6 | 0.15 | 7 | 0.13 | 8 | 0.11 | 11 | 0.08 | 18 | 0.05 |
| 10 | 11 | 0.33 | 12 | 0.30 | 14 | 0.26 | 16 | 0.23 | 20 | 0.18 | 29 | 0.13 |
| 15 | 16 | 0.51 | 18 | 0.45 | 20 | 0.41 | 24 | 0.34 | 29 | 0.28 | 38 | 0.21 |
| 20 | 22 | 0.66 | 24 | 0.60 | 27 | 0.54 | 30 | 0.48 | 36 | 0.40 | 46 | 0.32 |
| 25 | 27 | 0.84 | 29 | 0.78 | 33 | 0.69 | 37 | 0.61 | 43 | 0.53 | 53 | 0.43 |
| 30 | 32 | 1.02 | 35 | 0.93 | 38 | 0.86 | 43 | 0.76 | 49 | 0.67 | 59 | 0.55 |
| 35 | 35 | 1.27 | 38 | 1.17 | 42 | 1.06 | 46 | 0.97 | 52 | 0.85 | 60 | 0.74 |
| 40 | 38 | 1.53 | 41 | 1.41 | 44 | 1.32 | 48 | 1.21 | 53 | 1.09 | 59 | 0.98 |
| 45 | 40 | 1.84 | 43 | 1.71 | 45 | 1.63 | 49 | 1.50 | 53 | 1.39 | 59 | 1.24 |
| 50 | 42 | 2.16 | 44 | 2.06 | 47 | 1.93 | 50 | 1.81 | 54 | 1.68 | 58 | 1.56 |
| 55 | 44 | 2.49 | 46 | 2.38 | 48 | 2.28 | 51 | 2.15 | 54 | 2.03 | 58 | 1.89 |
| 60 | 45 | 2.90 | 47 | 2.78 | 49 | 2.66 | 51 | 2.56 | 54 | 2.42 | 57 | 2.29 |
| 70 | 47 | 3.78 | 49 | 3.63 | 50 | 3.55 | 52 | 3.42 | 54 | 3.29 | 57 | 3.12 |
| 80 | 49 | 4.73 | 50 | 4.64 | 51 | 4.55 | 53 | 4.38 | 55 | 4.22 | 57 | 4.07 |
| 90 | 50 | 5.87 | 51 | 5.76 | 52 | 5.65 | 53 | 5.54 | 55 | 5.34 | 56 | 5.24 |
| 100 | 51 | 7.11 | 52 | 6.97 | 53 | 6.84 | 54 | 6.71 | 55 | 6.59 | 56 | 6.47 |

TABLE 1 (B) SAGGING CHART FOR 100 SQ MM ALL ALUMINIUM CONDUCTOR

| SPAN (m) | TEMPERATURE | | | | | | | | | | | |
|-------------|----------------|------------|----------------|------------|----------------|------------|----------------|------------|----------------|------------|----------------|------------|
| | 50°C | | 45°C | | 40°C | | 35°C | | 30°C | | 25°C | |
| | Force (daN) | Sag (m) | Force (daN) | Sag (m) | Force (daN) | Sag (m) | Force (daN) | Sag (m) | Force (daN) | Sag (m) | Force (daN) | Sag (m) |
| 5 | 10 | 0.09 | 11 | 0.08 | 12 | 0.08 | 13 | 0.07 | 15 | 0.06 | 18 | 0.05 |
| 10 | 20 | 0.18 | 21 | 0.17 | 23 | 0.16 | 26 | 0.14 | 29 | 0.13 | 34 | 0.11 |
| 15 | 29 | 0.28 | 31 | 0.26 | 34 | 0.24 | 37 | 0.22 | 42 | 0.19 | 48 | 0.17 |
| 20 | 39 | 0.37 | 42 | 0.35 | 44 | 0.33 | 48 | 0.30 | 53 | 0.27 | 61 | 0.24 |
| 25 | 46 | 0.49 | 49 | 0.46 | 52 | 0.44 | 56 | 0.40 | 61 | 0.37 | 68 | 0.33 |
| 30 | 51 | 0.64 | 54 | 0.60 | 57 | 0.57 | 60 | 0.54 | 65 | 0.50 | 70 | 0.47 |
| 35 | 55 | 0.81 | 58 | 0.77 | 60 | 0.74 | 64 | 0.69 | 67 | 0.66 | 72 | 0.62 |
| 40 | 59 | 0.98 | 61 | 0.95 | 63 | 0.92 | 66 | 0.88 | 69 | 0.84 | 73 | 0.79 |
| 45 | 61 | 1.20 | 63 | 1.17 | 65 | 1.13 | 68 | 1.08 | 71 | 1.03 | 73 | 1.01 |
| 50 | 64 | 1.42 | 65 | 1.39 | 67 | 1.35 | 69 | 1.31 | 72 | 1.26 | 74 | 1.22 |
| 55 | 65 | 1.69 | 67 | 1.64 | 69 | 1.59 | 70 | 1.57 | 72 | 1.52 | 75 | 1.46 |
| 60 | 67 | 1.95 | 68 | 1.92 | 70 | 1.86 | 71 | 1.84 | 73 | 1.79 | 75 | 1.74 |
| 70 | 69 | 2.57 | 70 | 2.54 | 71 | 2.50 | 73 | 2.43 | 74 | 2.40 | 75 | 2.37 |
| 80 | 71 | 3.27 | 72 | 3.22 | 73 | 3.18 | 74 | 3.14 | 75 | 3.09 | 76 | 3.05 |
| 90 | 72 | 4.08 | 73 | 4.02 | 73 | 4.02 | 74 | 3.97 | 75 | 3.92 | 76 | 3.86 |
| 100 | 73 | 4.97 | 73 | 4.97 | 74 | 4.90 | 75 | 4.83 | 75 | 4.83 | 76 | 4.77 |

TABLE 2 POLE AND STAY REQUIREMENTS

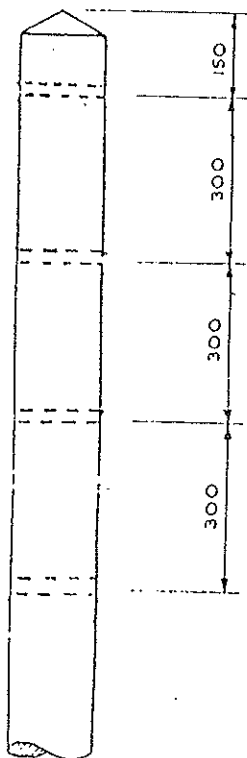
(A) 50 SQ MM CONDUCTOR

| POLE LENGTH | STRAIGHT LINE | | ANGLE OF DEVIATION | | | | | | | | | | Terminal | |
|-------------|---------------|-------------------|--------------------|-------------------|-----------|---------------|-----------|---------------|-----------|---------------|-----------|----------------|----------|-----|
| | | | 0° - 10° | | | 11° - 30° | | 30° - 60° | | > 60° | | | | |
| | Pole type | Angle of stay | Pole type | Angle of stay | Pole type | Angle of stay | Pole type | Angle of stay | Pole type | Angle of stay | Pole type | Angle of stay | | |
| | | | | | | | | | | | | | | |
| 8.5 m | Light | Stay not required | Light | Stay not required | Medium | 30° | Medium | 45° | Medium | 45° | Medium | 2 stays at 45° | Medium | 45° |
| 10.0 m | Light | Stay not required | Light | Stay not required | Medium | 30° | Medium | 45° | Medium | 45° | Medium | 2 stays at 45° | Medium | 45° |

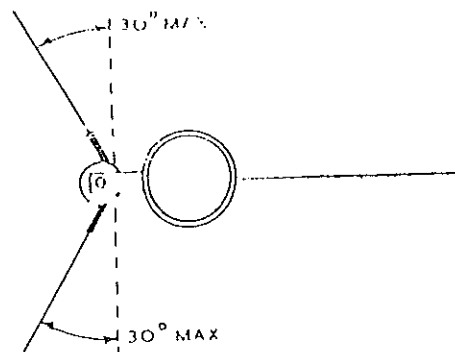
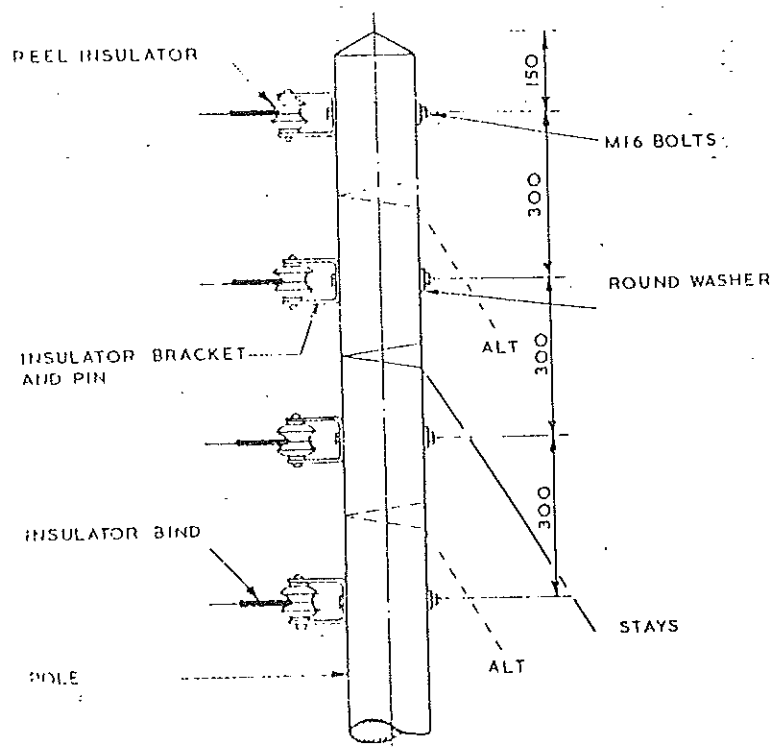
(B) 100 SQ MM CONDUCTOR

| POLE LENGTH | STRAIGHT LINE | | ANGLE OF DEVIATION | | | | | | | | Terminal | |
|-------------|---------------|-------------------|--------------------|-------------------|-----------|---------------|-----------|----------------|-----------|----------------|-----------|---------------|
| | | | 0° - 10° | | 11° - 30° | | 30° - 60° | | > 60° | | | |
| | Pole type | Angle of stay | Pole type | Angle of stay | Pole type | Angle of stay | Pole type | Angle of stay | Pole type | Angle of stay | Pole type | Angle of stay |
| | | | | | | | | | | | | |
| 8.5 m | Medium | Stay not required | Medium | Stay not required | Medium | 45° | Medium | 2 stays at 45° | Medium | 2 stays at 45° | Medium | 45° |
| 10.0 m | Medium | Stay not required | Medium | Stay not required | Medium | 45° | Medium | 2 stays at 45° | Medium | 2 stays at 45° | Medium | 45° |

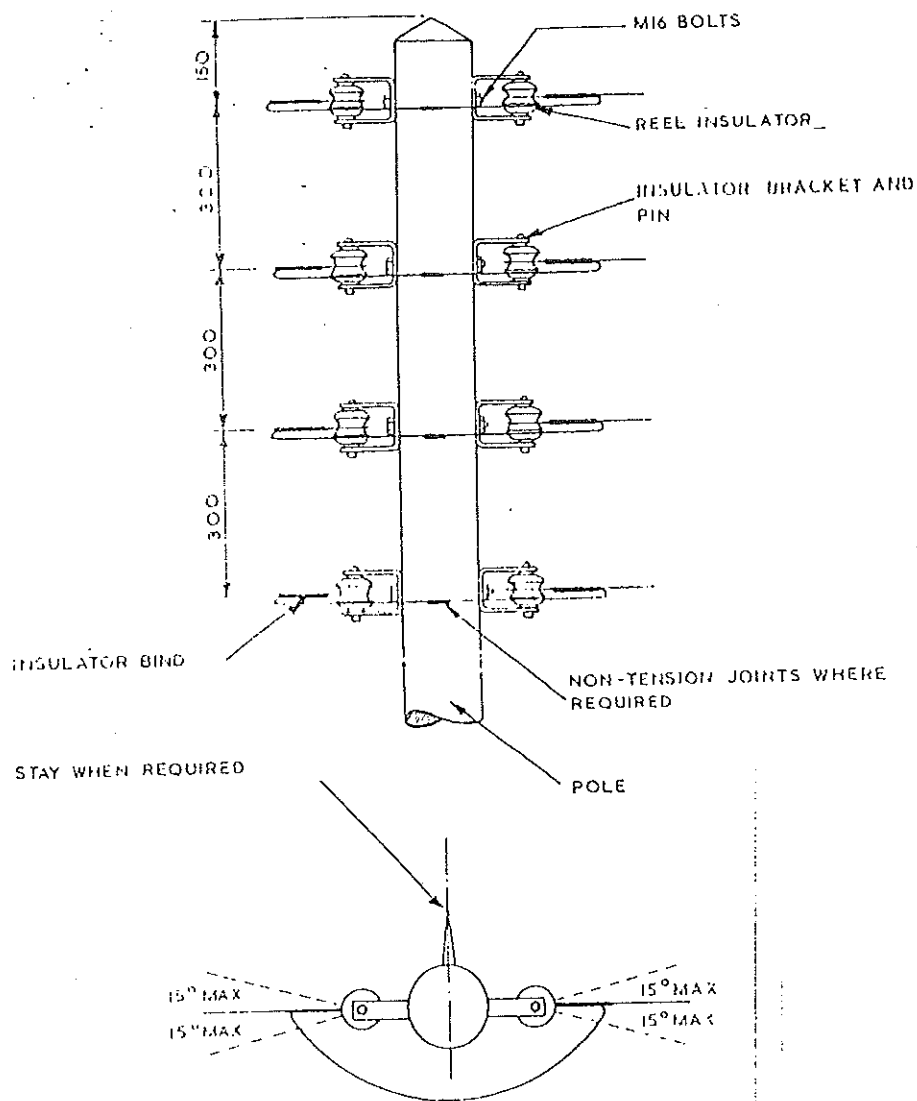
DRAWINGS



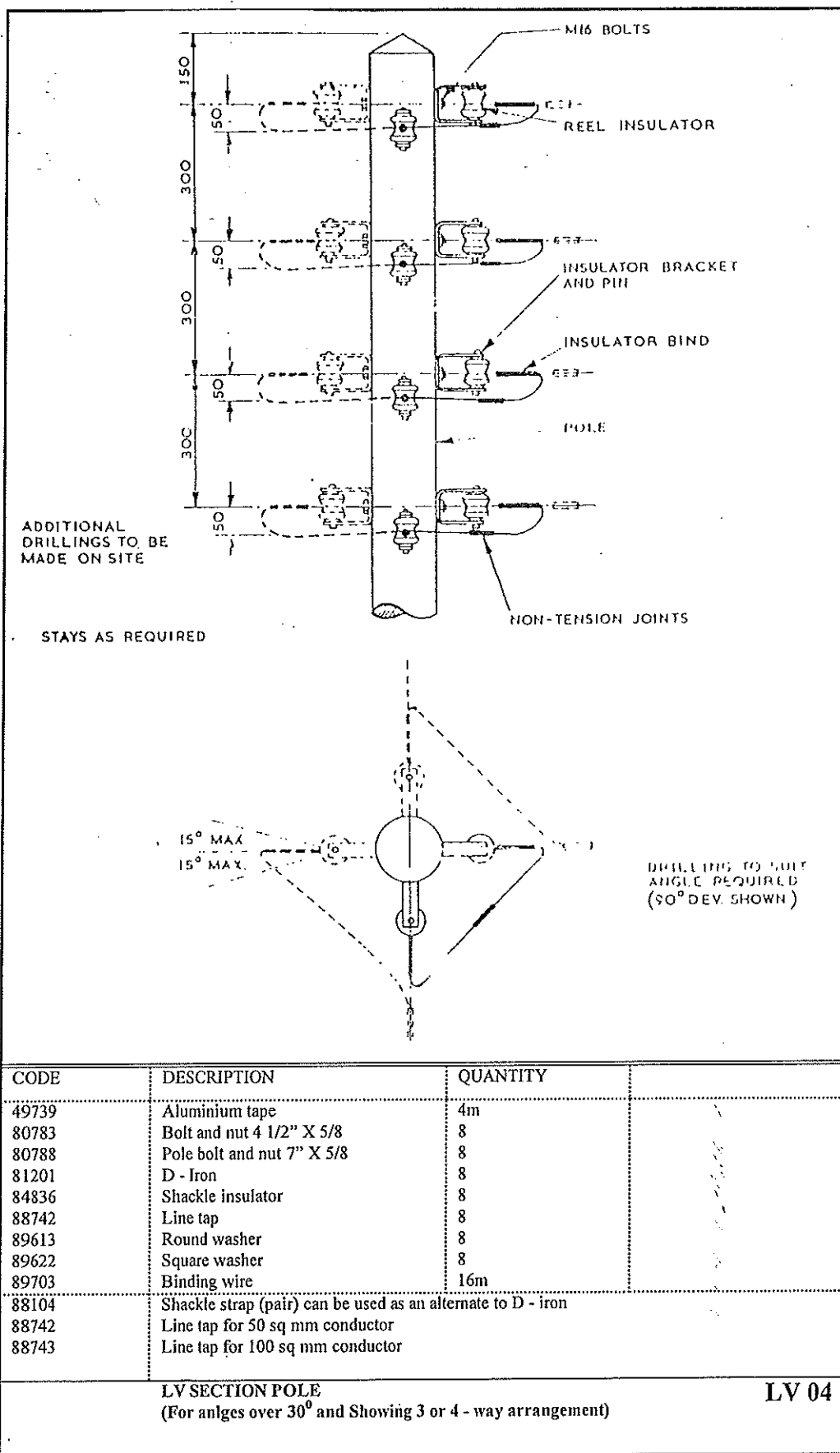
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| | | | |
| | | | |
| STANDARD LV POLE DRILLING | | | LV 01 |

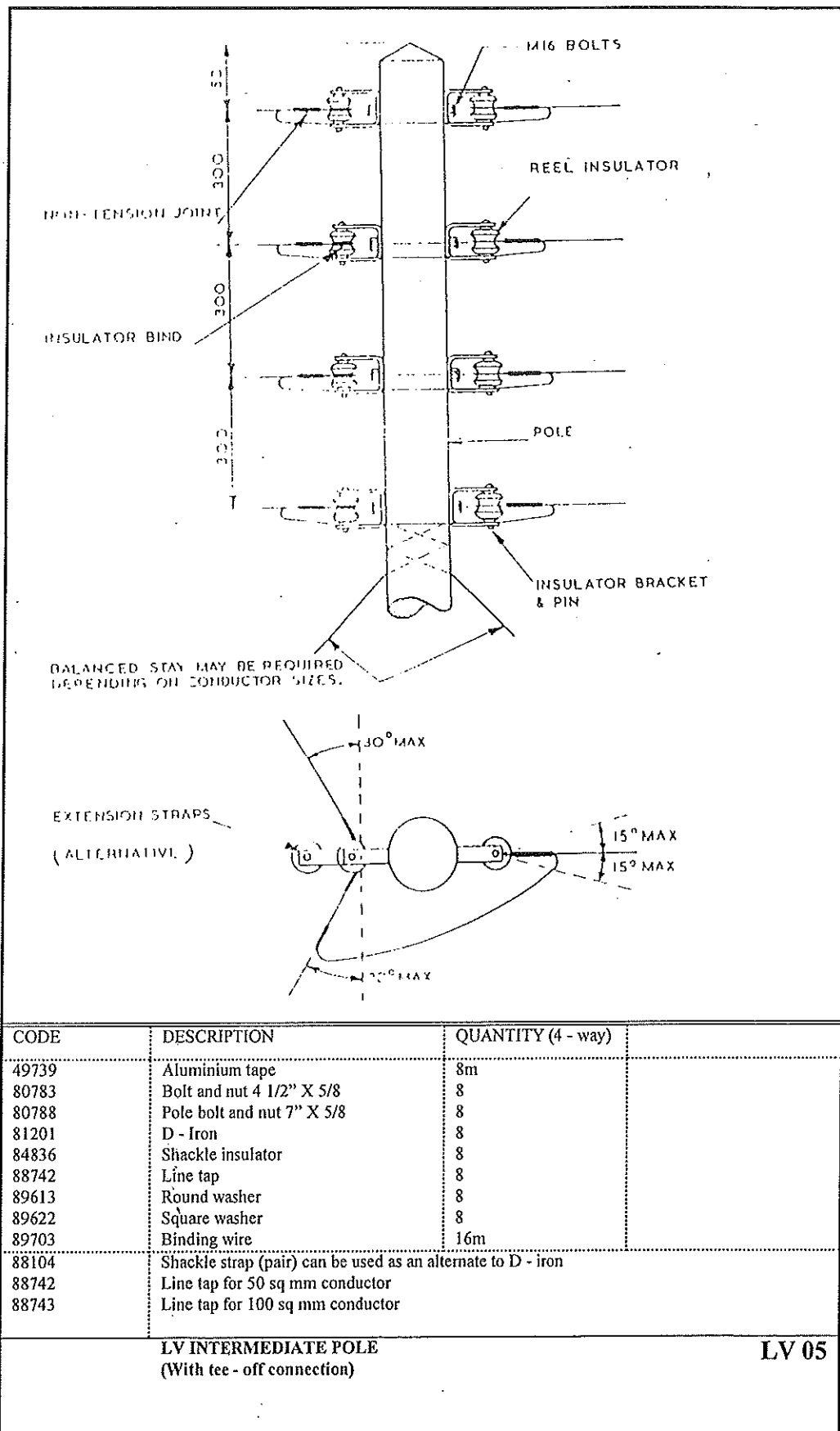


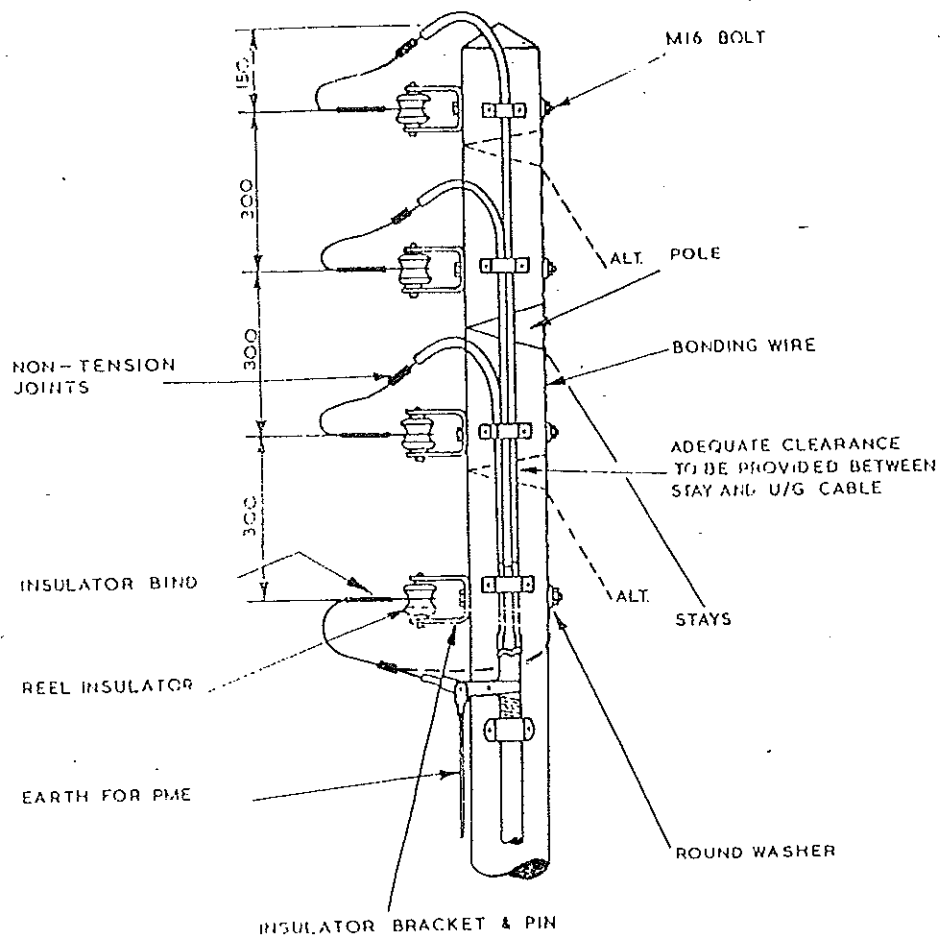
| CODE | DESCRIPTION | QUANTITY | |
|--|--|----------|-------|
| 49739 | Aluminium tape | 4m | |
| 80783 | Bolt and nut 4 1/2" X 5/8 | 4 | |
| 80788 | Pole bolt and nut 7" X 3/8 | 4 | |
| 81201 | D - Iron | 4 | |
| 84836 | Shackle insulator | 4 | |
| 88742 | Line tap | 4 | |
| 89613 | Round washer | 4 | |
| 89622 | Square washer | 4 | |
| 89703 | Binding wire | 8m | |
| 88104 | Shackle strap (pair) can be used as an alternate to D - iron | | |
| 88742 | Line tap for 50 sq mm conductor | | |
| 88743 | Line tap for 100 sq mm conductor | | |
| LV INTERMEDIATE POLE (For angles up to 60°) | | | LV 02 |



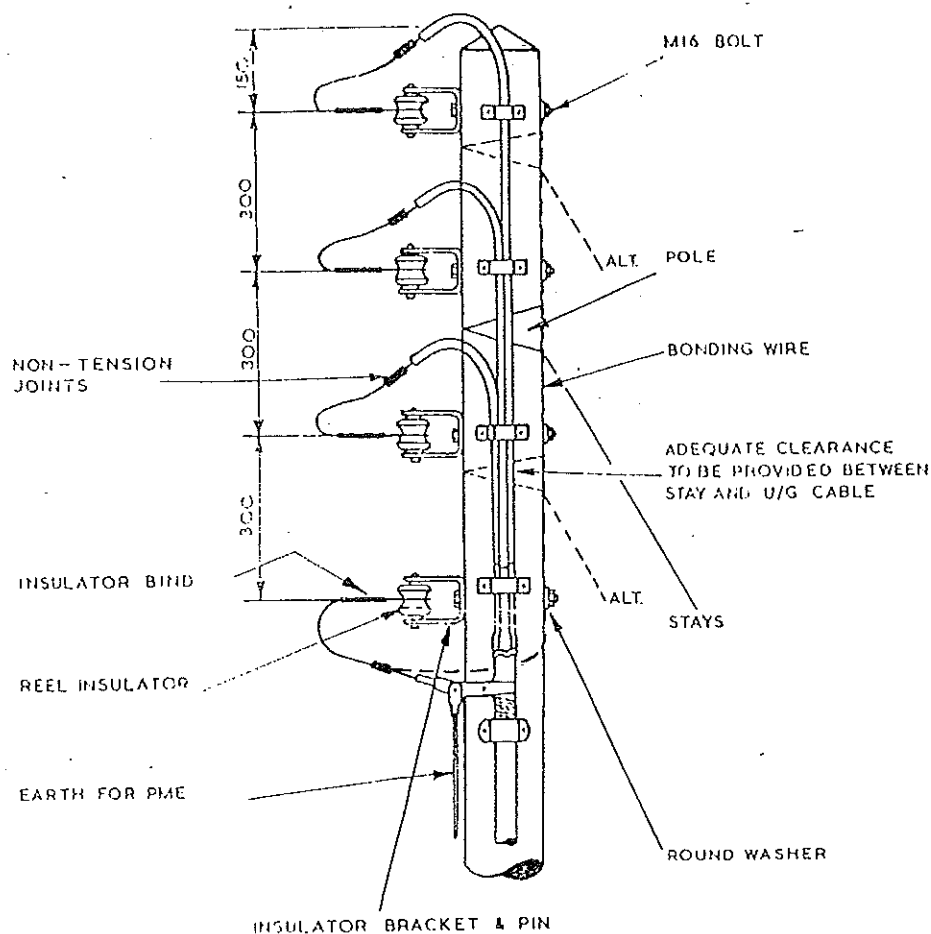
| CODE | DESCRIPTION | QUANTITY | |
|---|--|----------|-------|
| 49739 | Aluminium tape | 4m | |
| 80783 | Bolt and nut 4 1/2" X 5/8" | 8 | |
| 80788 | Pole bolt and nut 7" X 3/8" | 8 | |
| 81201 | D - Iron | 8 | |
| 84836 | Shackle insulator | 8 | |
| 88742 | Line tap | 4 | |
| 89613 | Round washer | 8 | |
| 89622 | Square washer | 8 | |
| 89703 | Binding wire | 16m | |
| 88104 | Shackle strap (pair) can be used as an alternate to D - iron | | |
| 88742 | Line tap for 50 sq mm conductor | | |
| 88743 | Line tap for 100 sq mm conductor | | |
| LV SECTION POLE (For angles up to 30°) | | | LV 03 |



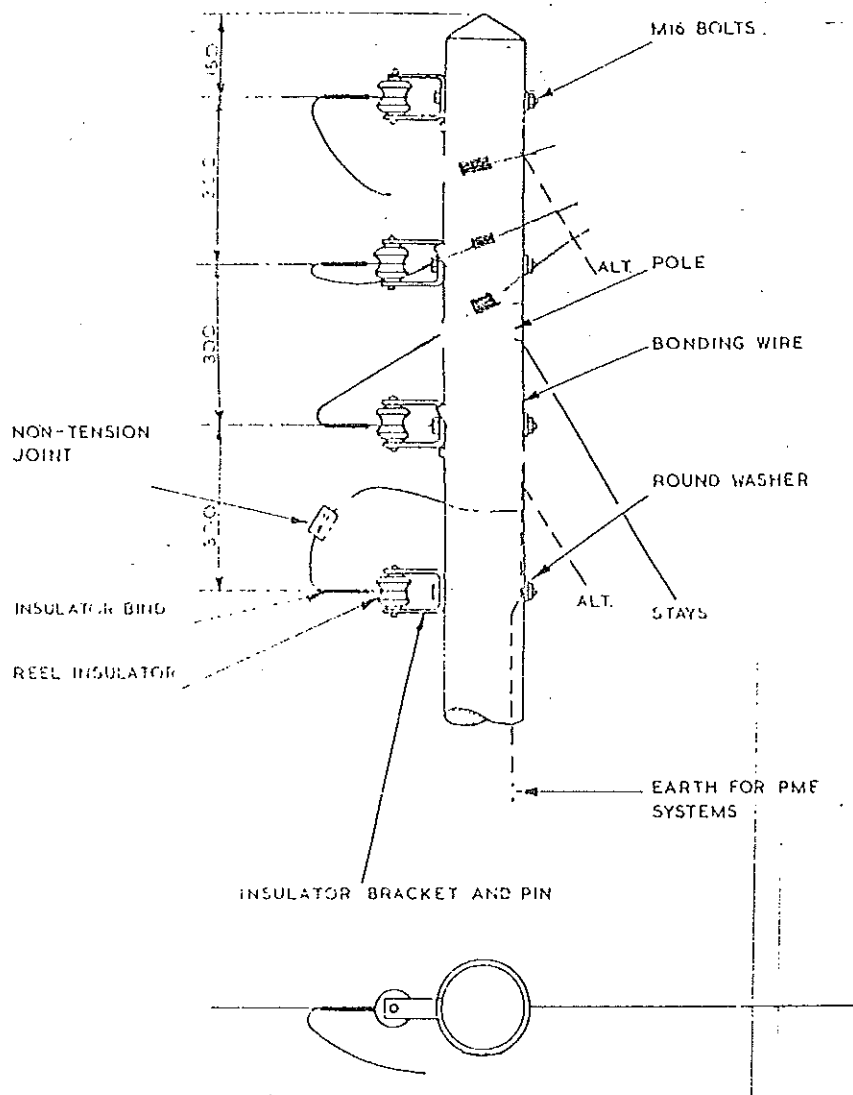




| CODE | DESCRIPTION | QUANTITY | |
|---|--|----------|-------|
| 49739 | Aluminium tape | 4m | |
| 80783 | Bolt and nut 4 1/2" X 5/8 | 4 | |
| 80788 | Pole bolt and nut 7" X 5/8 | 4 | |
| 81201 | D - Iron | 4 | |
| 84836 | Shackle insulator | 4 | |
| 88742 | Line tap | 4 | |
| 89613 | Round washer | 4 | |
| 89622 | Square washer | 4 | |
| 89703 | Binding wire | 8m | |
| 88104 | Shackle strap (pair) can be used as an alternate to D - iron | | |
| 88742 | Line tap for 50 sq mm conductor | | |
| 88743 | Line tap for 100 sq mm conductor | | |
| LV TERMINAL POLE (With underground cable connection) | | | LV 06 |

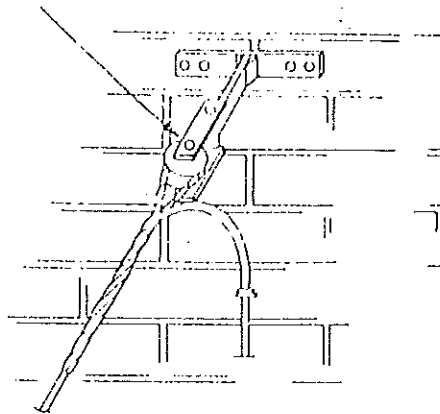


| CODE | DESCRIPTION | QUANTITY | |
|---|--|----------|-------|
| 49739 | Aluminium tape | 4m | |
| 80783 | Bolt and nut 4 1/2" X 5/8 | 4 | |
| 80788 | Pole bolt and nut 7" X 5/8 | 4 | |
| 81201 | D - Iron | 4 | |
| 84836 | Shackle insulator | 4 | |
| 88742 | Line tap | 4 | |
| 89613 | Round washer | 4 | |
| 89622 | Square washer | 4 | |
| 89703 | Binding wire | 8m | |
| 88104 | Shackle strap (pair) can be used as an alternate to D - iron | | |
| 88742 | Line tap for 50 sq mm conductor | | |
| 88743 | Line tap for 100 sq mm conductor | | |
| LV TERMINAL POLE (With underground cable connection) | | | LV 06 |

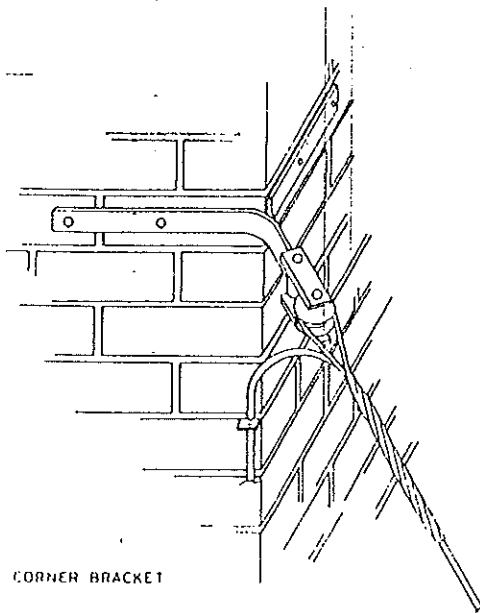


| CODE | DESCRIPTION | QUANTITY | |
|--|--|----------|-------|
| 49739 | Aluminium tape | 4m | |
| 80783 | Bolt and nut 4 1/2" X 5/8 | 4 | |
| 80788 | Pole bolt and nut 7" X 5/8 | 4 | |
| 81201 | D - Iron | 4 | |
| 84836 | Shackle insulator | 4 | |
| 88742 | Line tap | 4 | |
| 89613 | Round washer | 4 | |
| 89622 | Square washer | 4 | |
| 89703 | Binding wire | 8m | |
| 88104 | Shackle strap (pair) can be used as an alternate to D - iron | | |
| 88742 | Line tap for 50 sq mm conductor | | |
| 88743 | Line tap for 100 sq mm conductor | | |
| LV TERMINAL POLE (With Aerial cable connection) | | | LV 07 |

M16 x 130 BOLTS

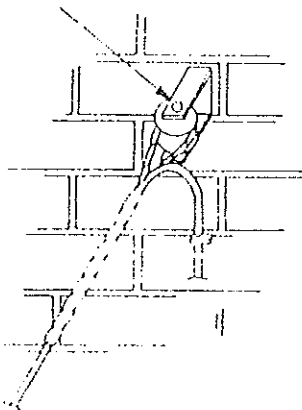


FLAT BRACKET WITH EXTENSION STRAPS

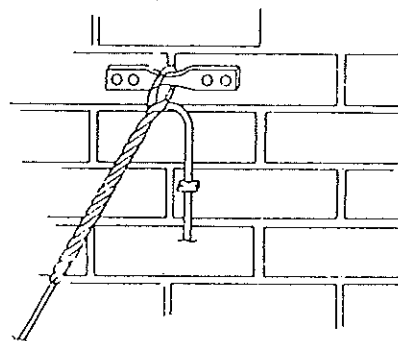


CORNER BRACKET

M16 x 130 BOLTS

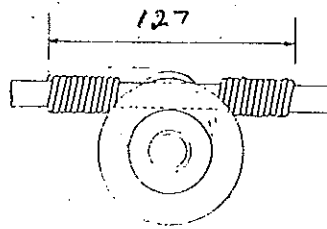


INSULATOR BRACKET

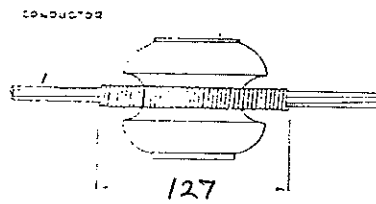
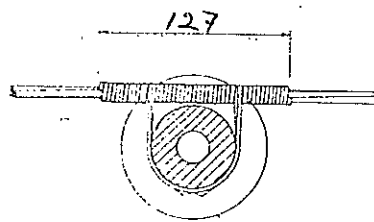


BRACKET

| CODE | DESCRIPTION | QUANTITY | |
|---|--|----------|-------|
| 05409 | Rawl bolt 8" X 1/2 | 4m | |
| 80790 | Bolt 8" X 5/8 (alternate to rawl bolt) | 4 | |
| 80803 | Bolt and nut 14" X 5/8 | 4 | |
| 81213 | Wall bracket 3 phase | 4 | |
| 81218 | Roof bracket 3 phase (alternate to wall bracket) | 4 | |
| 84836 | Shackle insulator | 4 | |
| 87209 | Line tap shroud | 4 | |
| 88742 | Line tap | 4 | |
| 89703 | Binding wire | 8m | |
| 89705 | Binding wire PVC | | |
| 89204 | Porcelain lead in tube | | |
| 88742 | Line tap for 50 sq mm conductor | | |
| 88743 | Line tap for 100 sq mm conductor | | |
| HOUSE TERMINATION (Aerial attachment to buildings) | | | LV 08 |

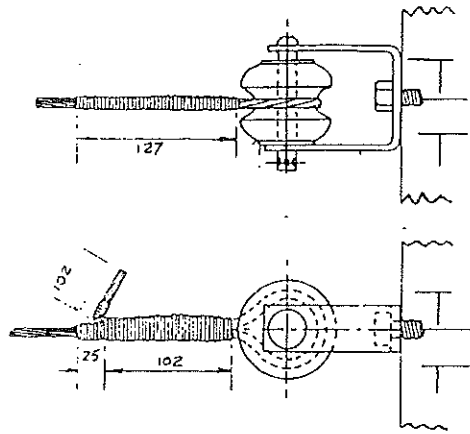


Alternatively



BINDING - IN ARRANGEMENT
FOR THROUGH CONDUCTORS

LV 09



TERMINATION FOR SERVICE CABLE

LV 10