WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Company Directive

STANDARD TECHNIQUE: OH4H/5

Relating to the Mounting of Auxiliary Equipment on Wood Poles

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Implementation Date: April 2014

Approved By:

Policy Manager

Date: 4 April 2014

Implementation Plan

Introduction

This Standard Technique gives guidance on standard techniques to be employed whilst designing and constructing Overhead Wood Pole Lines.

Main Changes

Section 10 (page 14) has been revised in order to include reference to the use of cable guards on 11kV pole terminations

Impact of Changes

No impact as the change brings the ST in line with current practice

Implementation Actions

No specific actions required as a result of this amendment

Implementation Timetable

This document can be issued immediately.

Document Revision & Review Table		
Date	**Comments**	**Author**
24.04.15	Section 10 (page 14) has been revised in order to allow the use of plastic cable guards on 11kV pole terminations	P. Hooper
09.12.14	Section 13 (page 27) has been added in order to provide requirements for to the installation of Radio Repeater Stations mounted on overhead poles. Section 15.7 (page 37) has been added to provide the earthing requirements for Radio Repeater Stations mounted on overhead poles.	P. Hooper
10.10.14	Section 16.4 - Amendment to include Item Code 60559 for 10m coil of 120mm Covered Conductor and the stripping tool item code 41479.	Mike Chapman
25.03.14	Section 10 - Introduction of surge arrestor adaptor plate and earthing pins. New Section 16 - General Arrangements for 33kV Point of Connection.	Mike Chapman
11.11.13	Section 11 has been revised in order to remove confusion. The table in Section 6 provides the minimum clearances between phases and phase to earth.	P. Hooper
29.11.12	Section 12 and 15 has been amended in order to include the use of hook stick operated 33kV ABSDs	P. Hooper
	Figures 16 and 17 have been added to show the general arrangement for hook stick operated 33kV ABSDs	P. Hooper
	All diagrams after figures 16 and 17 have been re-numbered and all references to these figures amended	P. Hooper

CONTENTS

1.0 SCOPE

This document specifies the methods of mounting auxiliary equipment on overhead lines and includes information on earthing requirements.

Included in this document are the mounting assembles for:

- Pole mounted transformers
- 11kV and 33kV Air Break Switch Disconnectors (ABSD, ABI,s)
- 11kV and 33kV Surge arresters
- 11kV Fusegear
- 11kV Pole Mounted Auto-Reclosers (PMAR)
- Cable Terminations

2.0 POLE SIZES

Medium class poles shall be used as a minimum. The size of pole required will depend on the total load imposed on the pole from:

- The strut loading imposed by HV stays
- The strut loading imposed by LV stays (assume fitted at the pole top)
- The weight of the auxiliary equipment

The pole size can be obtained from the Table of Permissible Strut loadings found within the relevant ENA Technical Specification (ENATS)

The wind load on small items such as 11kV fuses can be neglected. However where equipment such as transformers are to be erected, calculations must be carried out to determine the suitability of the supporting pole.

On new construction, the minimum size of transformer pole shall be a 10m medium.

Where a transformer weighing 400kg or more is to be erected on as single pole then the pole must have a back stay or a stout class pole must be used.

3.0 STAYS

All stays shall be fitted with stay insulators in accordance with ST:OH4L.

A minimum clearance of 450mm is recommended between the stay wire and any LV conductor and a 1 metre clearance to any HV jumpers. In order to maintain safe clearances care must be taken to ensure that the staywires are correctly tensioned and any unsupported jumpers are kept as short as possible.

Where broken jumpers or slack stays could cause a stay to become alive it may be necessary to increase the normal 1.8 metre distance from the stay insulator to the pole. This is to ensure the stay insulator will be below any likely point of contact with live metalwork.

4.0 ANTI-CLIMBING GUARDS

Supports that require precautions against access shall be fitted with a barbed wire anti-climbing device as detailed in ST:OH4M.

When any auxiliary equipment is added to an existing support the existing guarding should be reviewed and replaced where required.

Anti-Climbing guards on Air Break Switch Disconnector poles shall not reduce the separation gap between the HV steelwork and operating handle earths. The position of the barbed wire shall, as far as practical follow fig 15. Barbed wire wrapped around the pole shall be clear of the operating rod and barbed wire on the operating rod must not touch the pole.

5.0 MOUNTING HEIGHT FOR AUXILIARY EQUIPMENT

Auxiliary equipment must be mounted such that any exposed metal work that may become alive or is alive is above 4.3 metres from the ground or any place accessible to unauthorised personnel.

6.0 JUMPER CONNECTIONS

HV Jumpers

Jumpers shall be of bare stranded overhead line conductor, of adequate rating for the equipment to be connected and compatible with the main line conductor.

The minimum size of a conductor that can be used shall be 25mm² copper or 50mm² AAAC or ACSR.

Connections to the main line shall be made with compression fittings or wedge taps.

All jumper connections shall be kept as short as possible and should not exceed 2.5 metres unless supported by pilot insulators. They should be moderately taut but not exert an undue force on the main line conductor.

LV Jumpers

LV equipment will normally be connected by PVC insulated and sheathed cable clipped to the support.

Minimum Clearances in Air

Jumpers shall be arranged in such a way as that a minimum clearance as shown in the table be maintained:-

Minimum Clearance in Air (mm)			
Arrangement	LV	11kV	33kV
Phase to Earth	150	200	390
Phase to Phase	150	250	440

Note:-

When positioning the jumpers, it will be necessary to take into account the possible movement of the jumpers etc. in order to ensure that the minimum clearance will be maintained under all conditions.

There is no requirement for minimum jumper clearances on LV for effectively insulated conductors

7.0 LV EQUIPMENT

LV equipment will normally be fixed above 3 metres from ground level. Where this is not the case it shall be locked in a durable weatherproof enclosure.

8.0 CONNECTIONS TO EQUIPMENT

Connections to equipment must be made using materials that are compatible with the equipment.

When an aluminium conductor is to be connected to an item of equipment with bronze or copper terminals this must be done by using a bi-metal lug or bi-metallic non-tension joint.

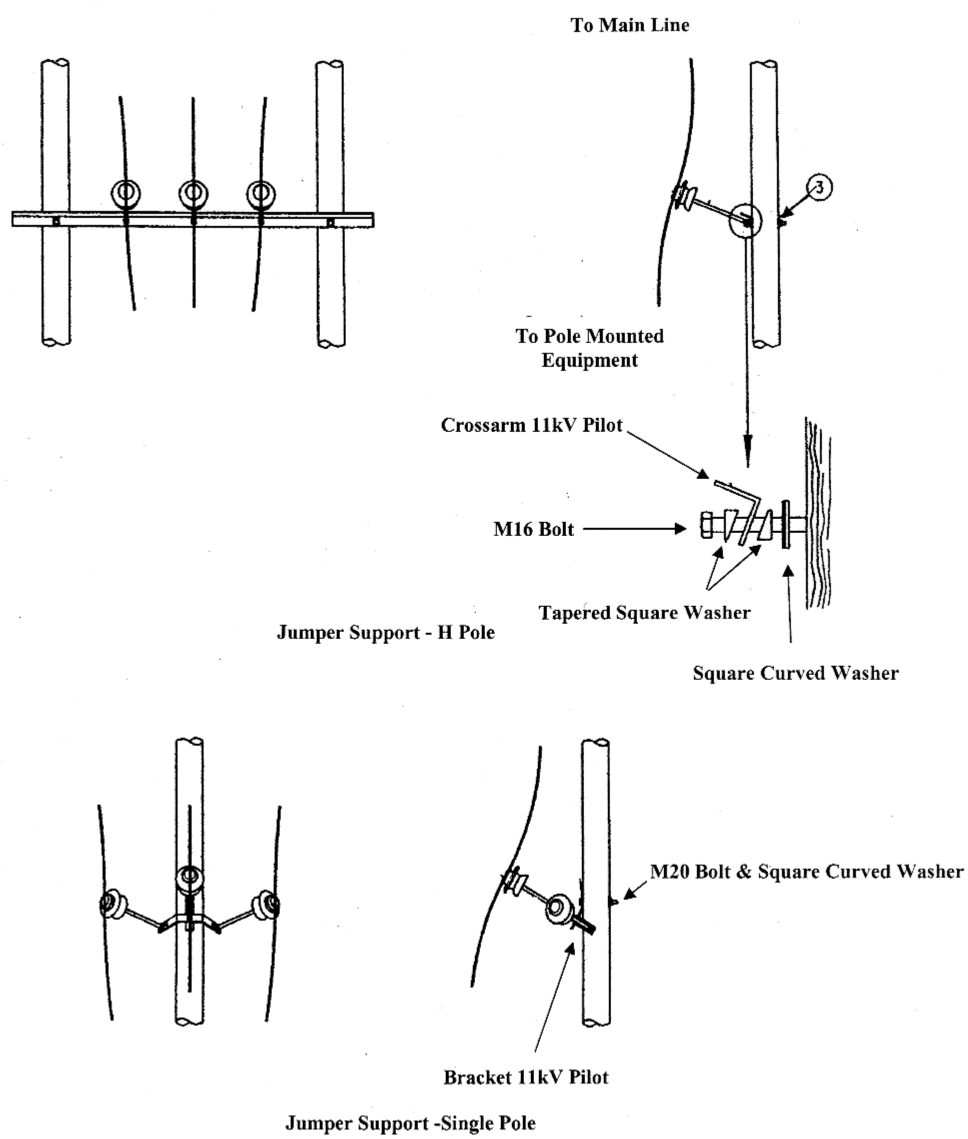

FIG 1
11kV JUMPER SUPPORT ARRANGEMENTS

9.0 POLE MOUNTED TRANSFORMERS

The minimum height to the base of the transformer shall be 4 metres providing that there is a minimum ground clearance of 4.3 metres to live metalwork.

The following arrangements shall be used to erect transformers

- A single transformer up to 50kVA can be mounted on a single bolt fixing as shown in fig 2.
- Transformers up to 100kVA and a maximum weight of 1000kg can be mounted on a single pole platform as shown in fig 3.
- Transformers up to 315kVA and a maximum weight of 1400kg shall be mounted on a 'H' pole platform as shown in fig 4 or on single pole with an additional pole (lazy leg) erected in a convenient position as shown in fig 5.
- Where a standard 'H' pole platform to is used on an existing 'H' pole structure with 5ft (1524mm) centres, the mounting steelwork will require two additional M22 holes to be drilled in order that the bracket can be mounted centrally. The platform should not be cut to length.

Notes for figures 2 to 5

1. Approved LV fuses that are fully insulated shall be mounted at height of not less than 3 metres above ground and no higher than the transformer base when mounted at the transformer position. The spacing between each fuse cut-out should be 380mm.
2. The leads connecting the fuses shall be PVC insulated and sheathed copper conductor or ABC leads and should be as short as possible.
3. LV line conductors shall maintain a minimum clearance of 1 metre from HV jumpers and 450mm from any stay wire.
4. All steelwork including transformer tank and stays (but excluding any LV insulator brackets) shall to be bonded to the HV steelwork earth leads.
5. The LV neutral earth shall be segregated from the HV steelwork earth unless the calculations have been carried out to confirm that the HV and LV earthing systems can be combined in accordance with ST:TP21D.

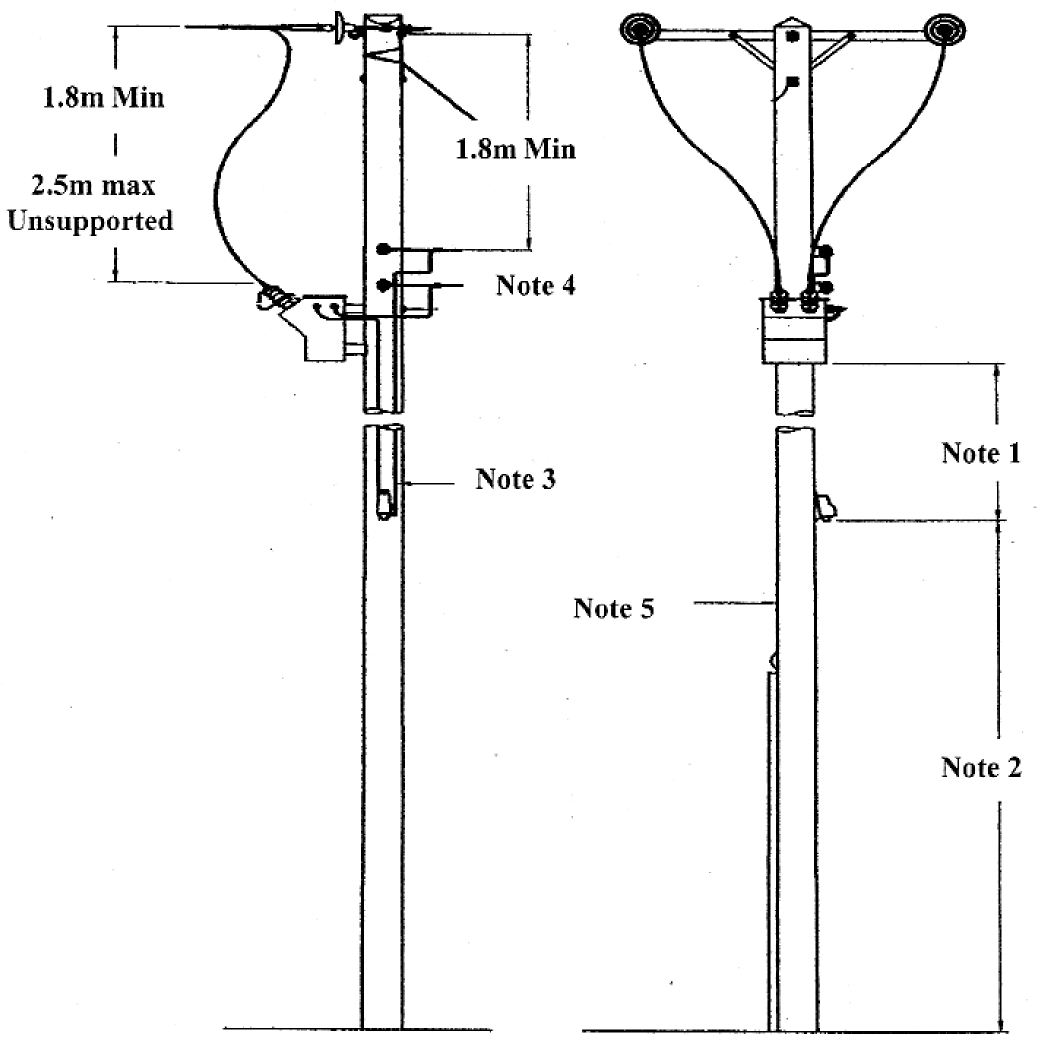

FIG 2
POLE MOUNTED TRANSFORMER SINGLE BOLT FIXING

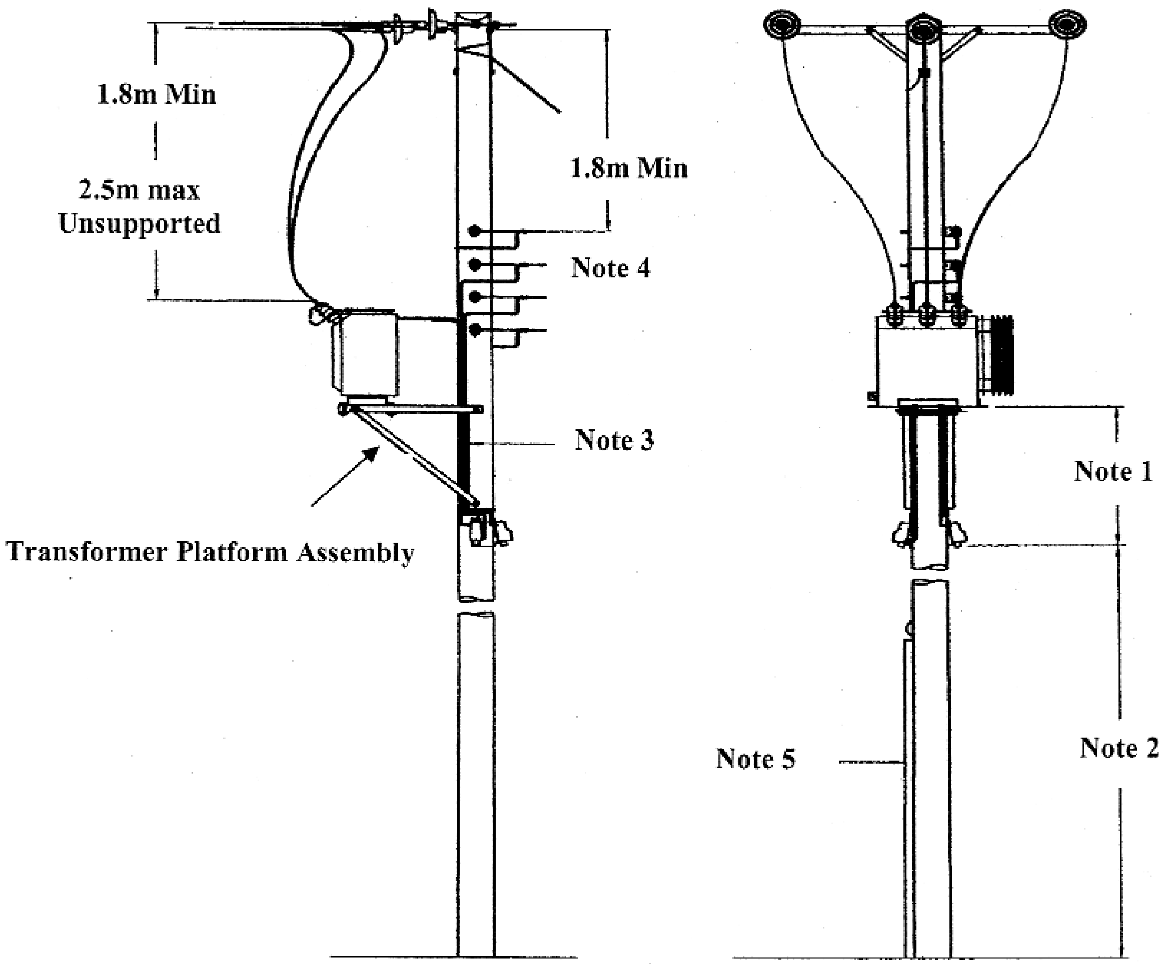

FIG 3
POLE MOUNTED TRANSFORMER SINGLE POLE PLATFORM

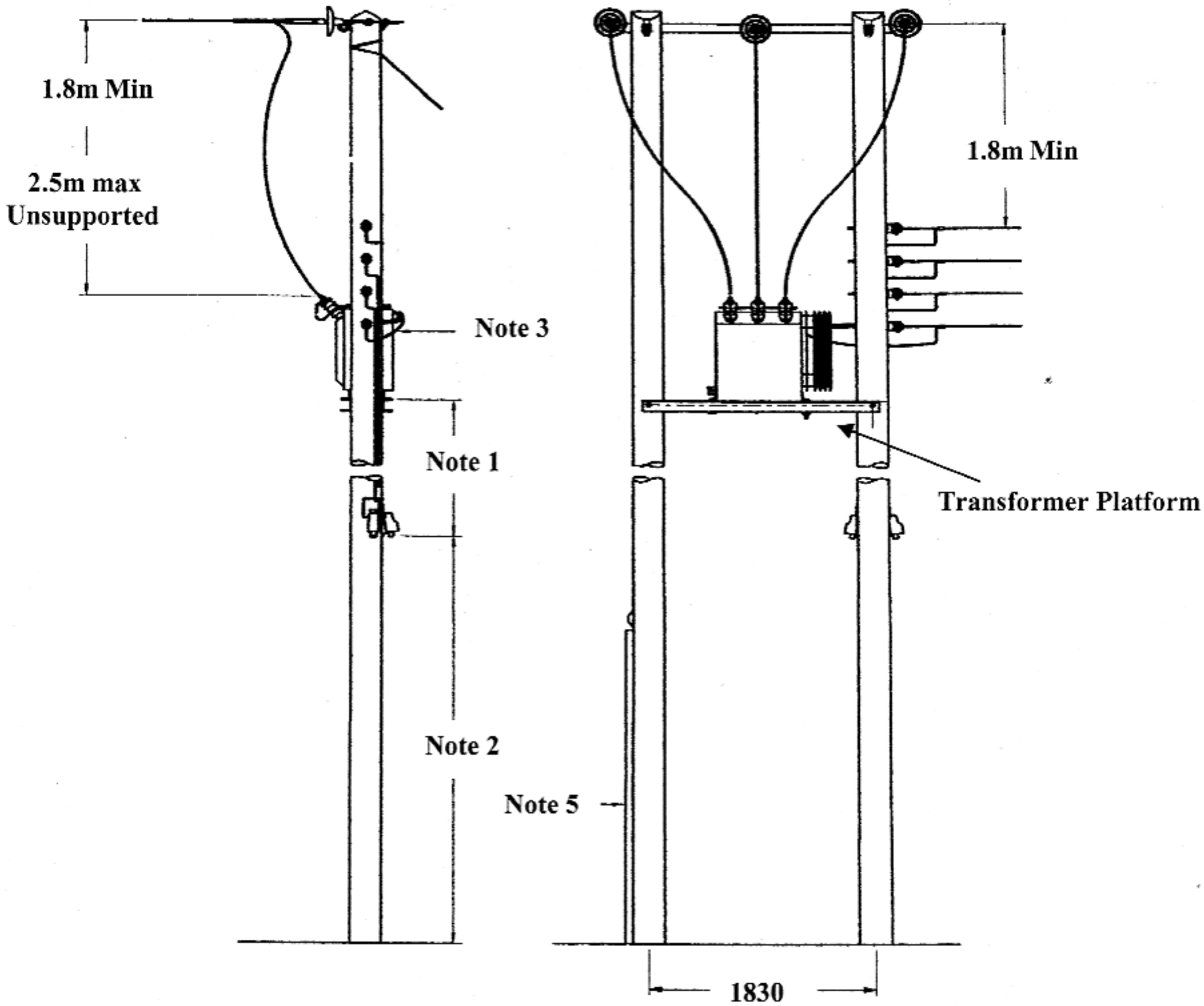

FIG 4
POLE MOUNTED TRANSFORMER H POLE PLATFORM

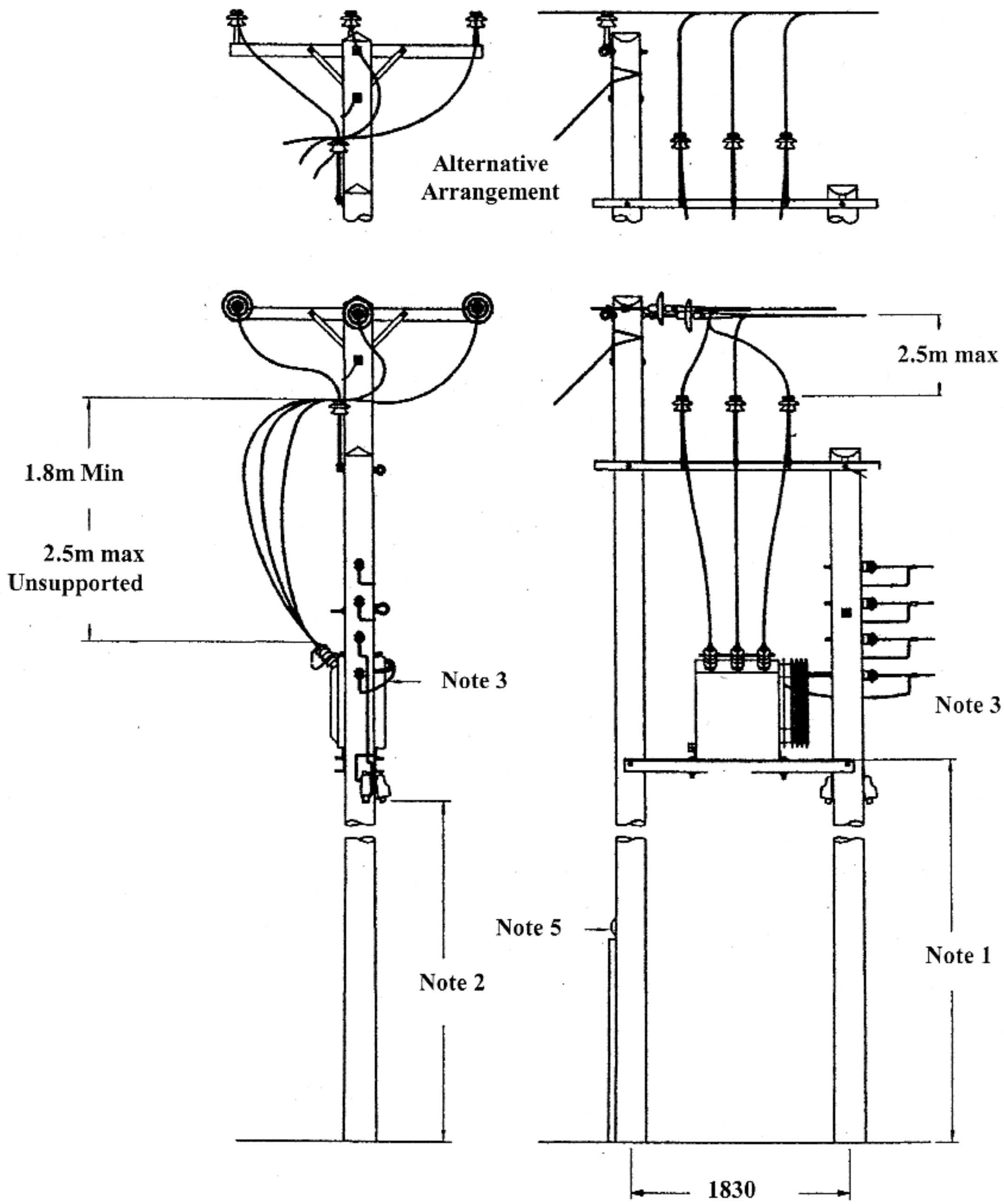

FIG 5
POLE MOUNTED TRANSFORMER LAZY LEG H POLE

10.0 CABLE TERMINATIONS

Heat shrink terminations shall be used on LV mains cable poles as detailed in ST: CA1G/2.

11kV cables shall be terminated on poles using polymeric terminations as shown in fig 6.

The arrangement for pole mounted 33kV cable termination is shown in fig 7 & 8.

All cable terminations shall be protected by surge arresters.

All cables shall be secured to the supports using the appropriate cleats.

33kV Cables shall be protected using troughing (see figs 7& 8) to at least 3 metres from ground level.

11kV Cables shall be protected using a suitable cable guard (see fig 6) or troughing to at least 3 metres from ground level.

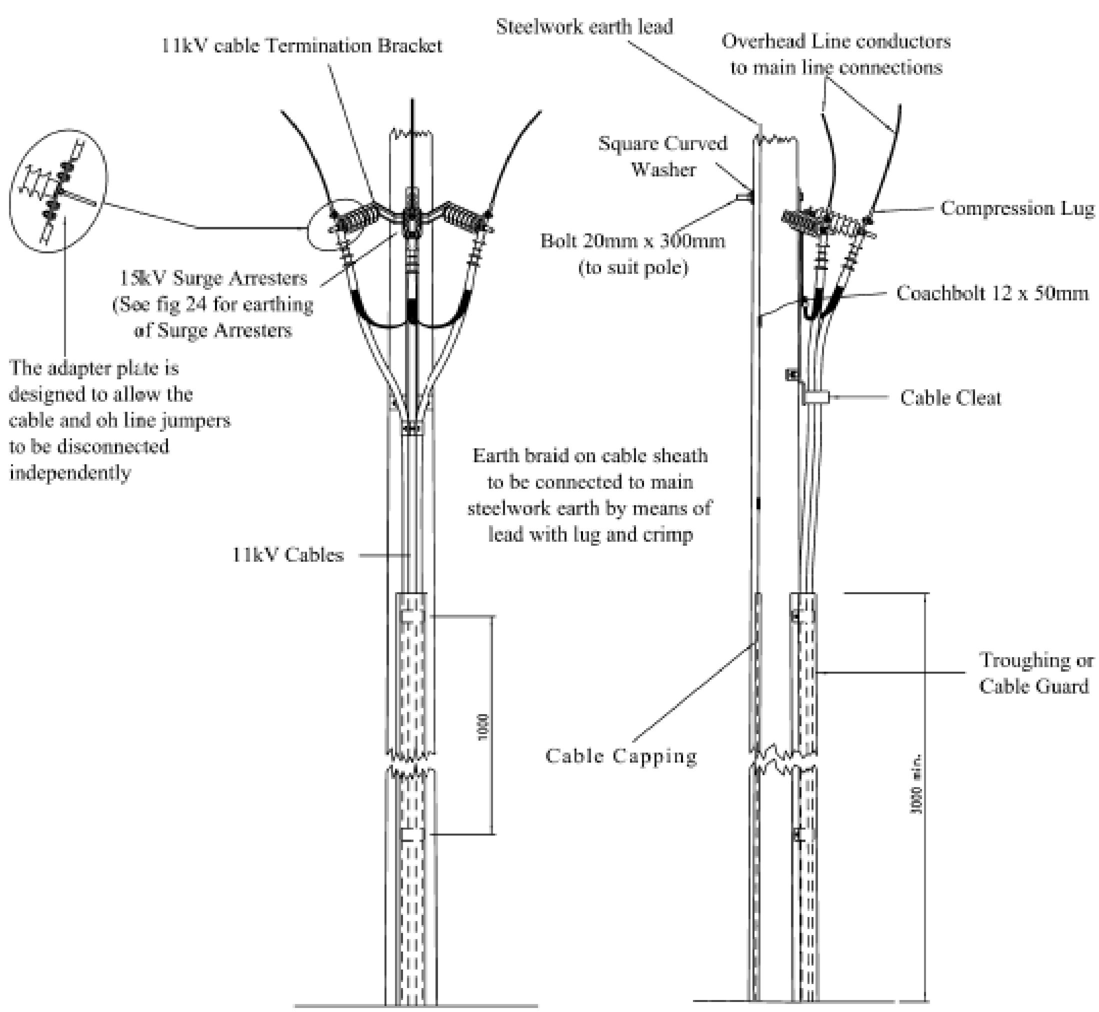

FIG 6
11kV TERMINATION ARRANGEMENT

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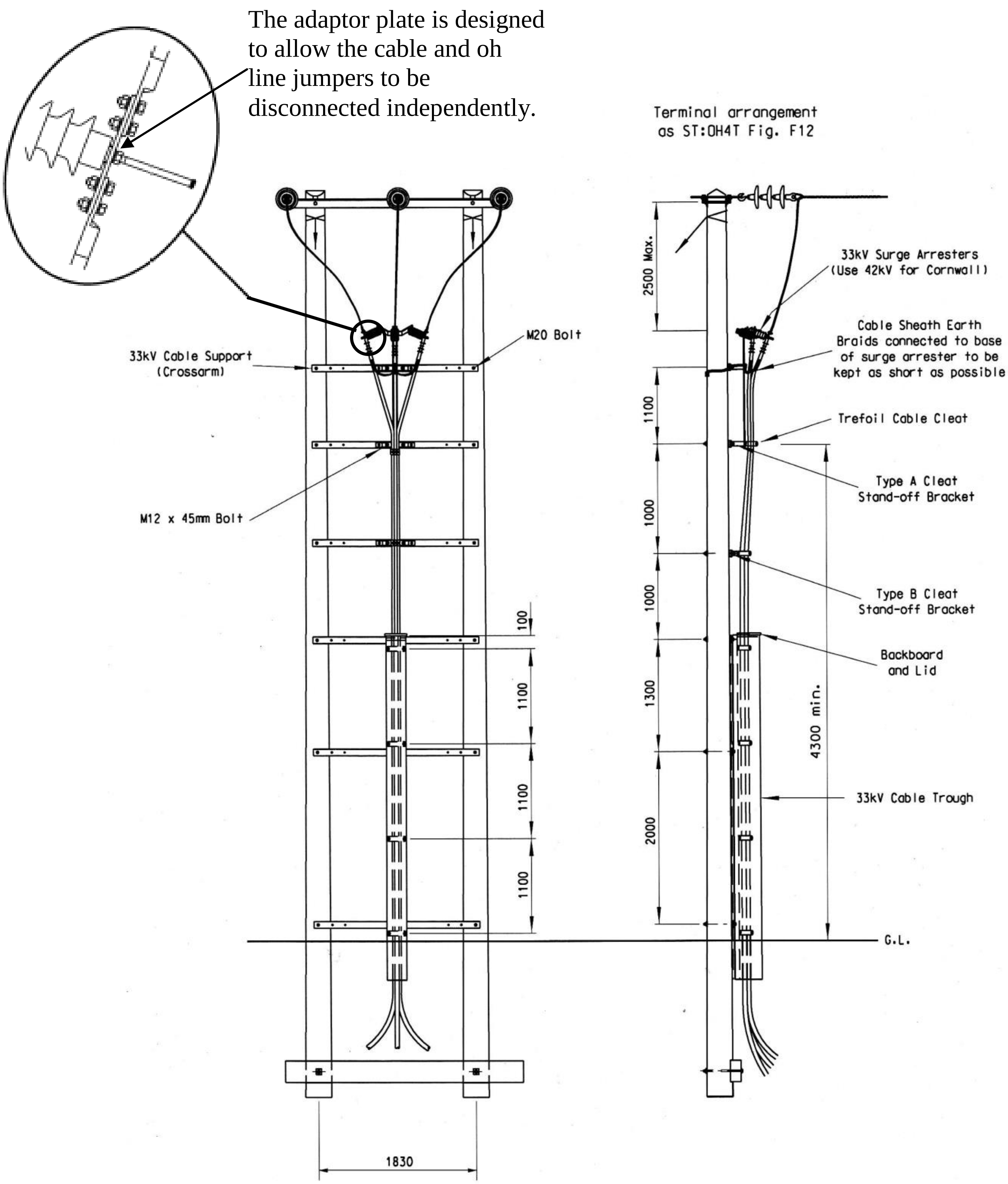
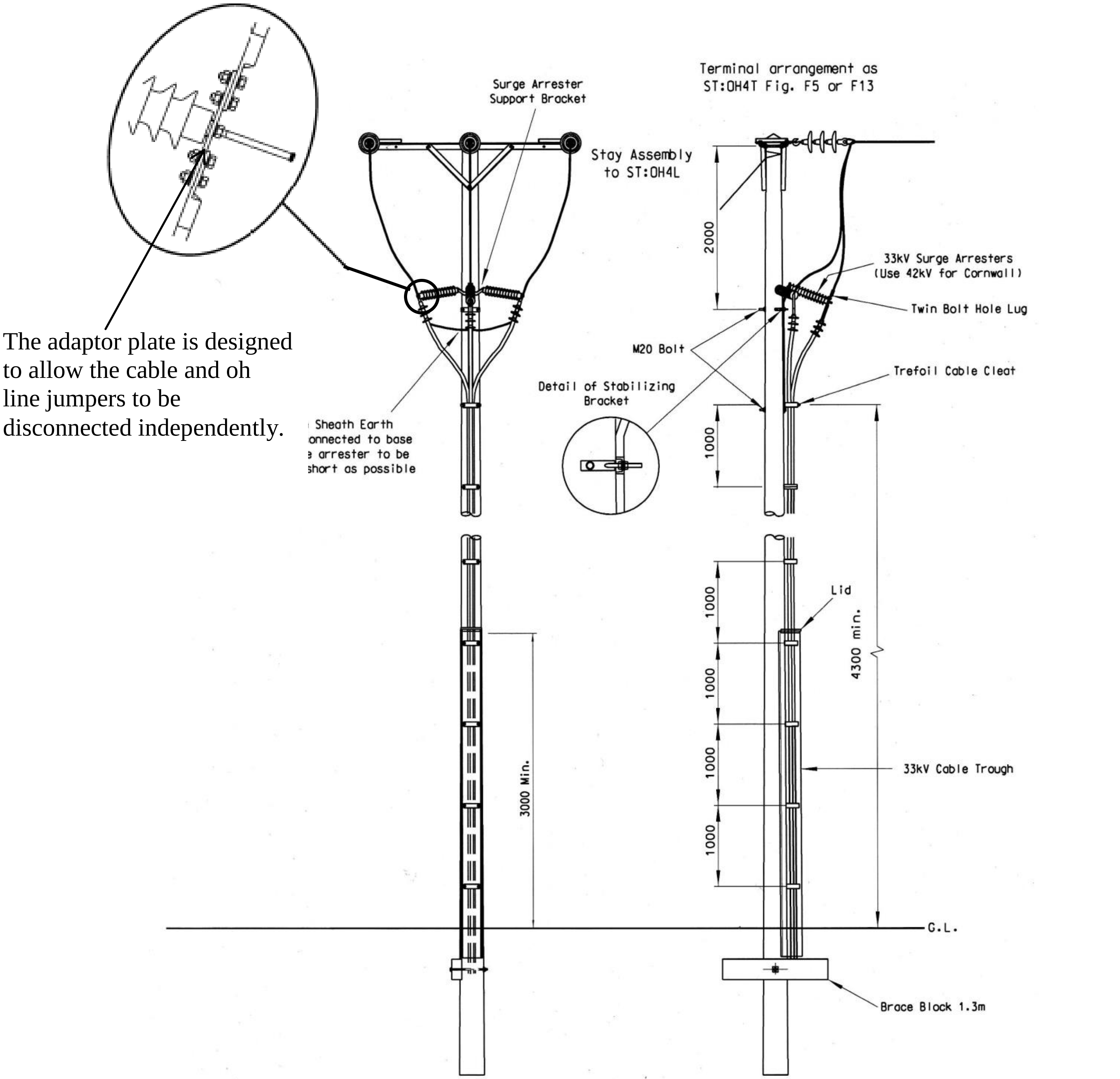


Note: Anti-Climbing device as detailed in ST:OH4M required

FIG 7
33kV CABLE TERMINATION
'H' POLE ARRANGEMENT
(3 X SINGLE CORE EPR CABLES)



Note: Anti-Climbing device as detailed in ST:OH4M required

FIG 8
33kV CABLE TERMINATION
SINGLE POLE ARRANGEMENT
(3 X SINGLE CORE EPR CABLES)

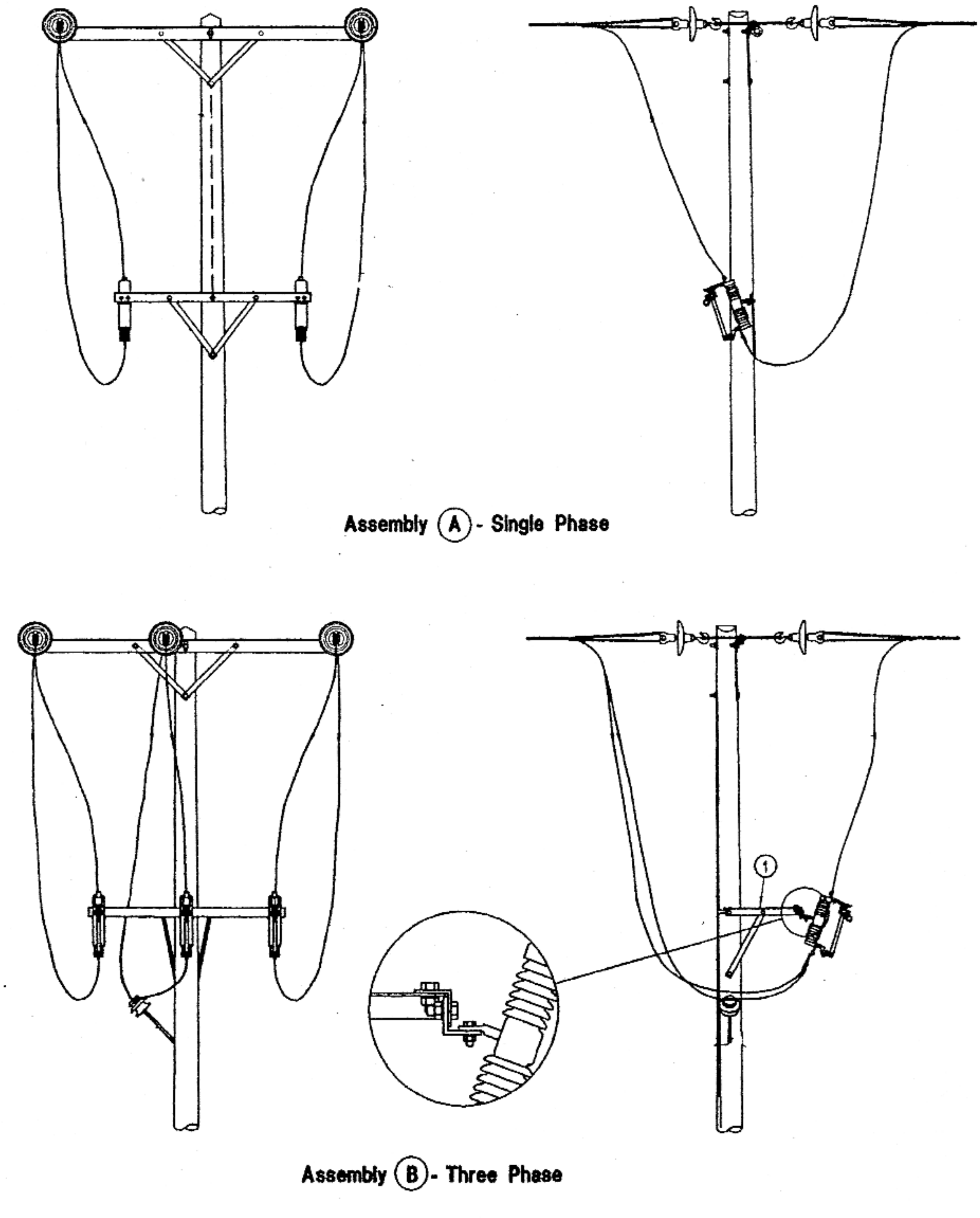
11.0 11kV EXPULSION FUSES AND AUTOMATIC SECTIONALISING LINKS (ASL's)

11kV fuses and ASL's shall be mounted as shown on fig 9. Where the fuses are mounted by them selves the pole steelwork should not be earthed but must be bonded to the crossarm. The positioning of fuses on tee-off poles should be avoided.

Jumpers to fuses shall be arranged in such a way as that a minimum clearance of 200mm will be maintained between the feeder and load side of the fuses.

When positioning the jumpers, it will be necessary to take into account the possible movement of the jumpers etc in order to ensure that the minimum clearance will be maintained under all conditions. (see Section 6)

Whenever possible, the jumpers should be arranged as shown in fig 9. Where no equipment is mounted bellow the fuses the preferred arrangement shall be to connect the incoming supply to the bottom contact of the fuse, where this is not possible without having to cross the jumpers then the incoming supply shall be connected to the top contact of the fuse.



NOTE:- Expulsion Fuse brackets to be fitted to inside face of crossarm

FIG 9
11kV EXPULSION FUSES AND ASL, MOUNTING ASSEMBLY

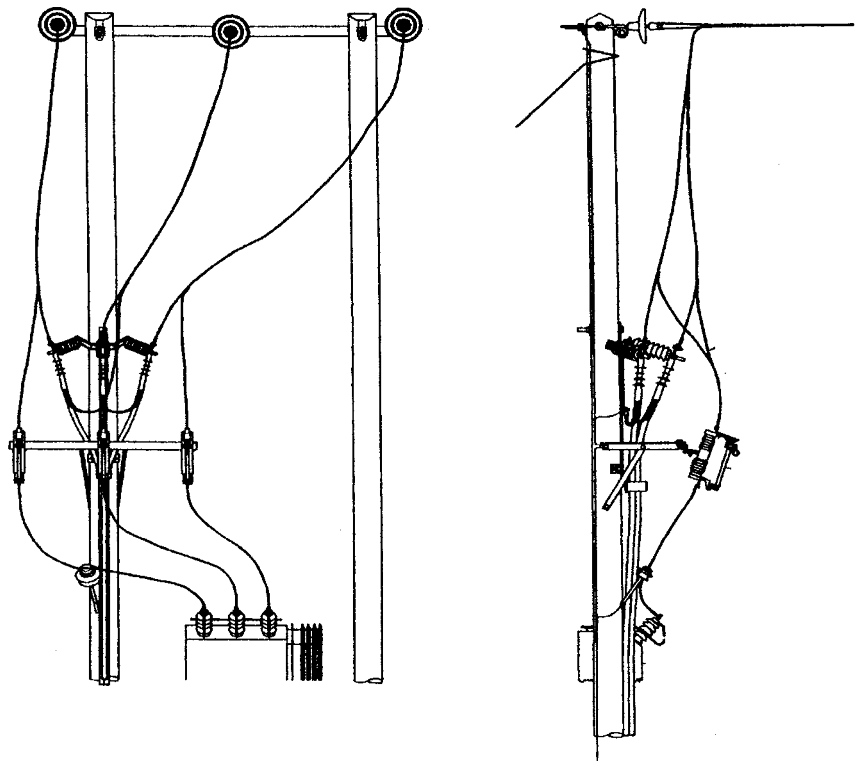


FIG 10
11kV EXPULSION FUSES, TRANSFORMER, EXPULSION FUSE ARRANGEMENT

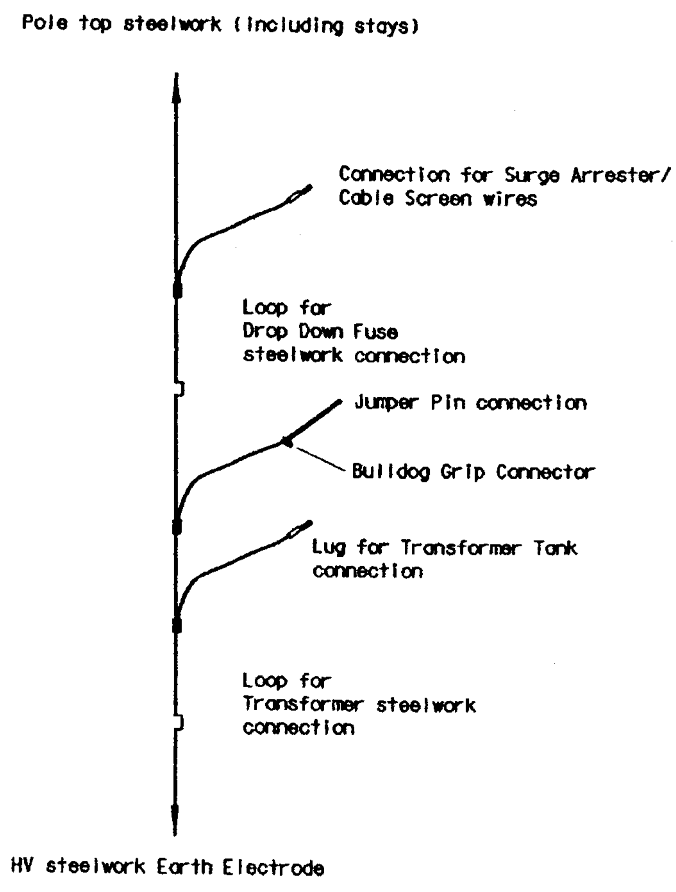


FIG 11
DIAGRAM OF EARTH CONNECTIONS FOR FIG 10

12.0 AIR BREAK SWITCH DISCONNECTORS (ABIs, ABSDs, ABLs)

All ABSDs shall comply with the current version of WPD specification EE 10.

All new 11kV ABSDs shall be fitted with a mechanism which is hook stick operated. To allow for ease of maintenance and provide protection for large raptors 11kV ABSDs shall be of the low level type and mounted below the line whenever possible as shown in fig 12.

33kV ASBD's shall be fitted with either a hook mechanisms or with ground level handles. Where interference by vandals is likely the ABSD shall be fitted with a hook stick mechanism.

Where existing ABSDs are operated at ground level (as shown in figs 13, 14 and 15) the operating rod shall be fitted with insulated inserts and provided with an equipotential mat below the operating handle. Where the earth mat is to be replaced, the arrangement used should be as shown in fig 21.

Earthing arrangements for ABSDs which are to be operated via a ground mounted handle shall be as detailed in section 15 of this standard technique.

Earthing arrangements for powered ABSDs with ground level control boxes shall be as detailed in section 15.6 of this Standard Technique.

Anti climbing guards shall be shall be fitted as detailed in ST:OH4M. ASBDs with hook stick mechanisms do not require anti-climb guards, unless they are in a high risk area.

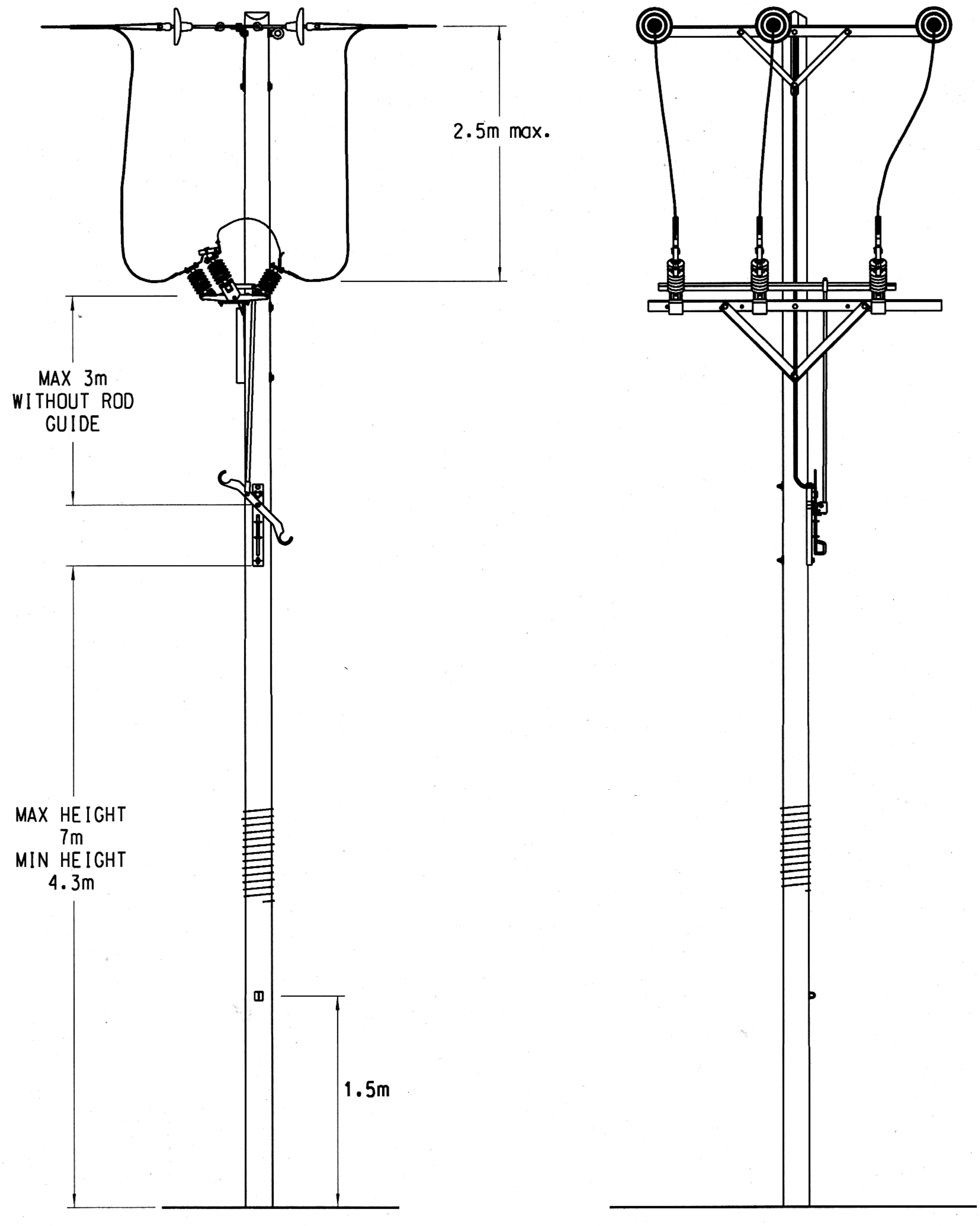


FIG 12
11kV AIR BREAK SWITCH DISCONNECTOR
SINGLE POLE MOUNTING WITH HOOK STICK OPERATING MECHANISM

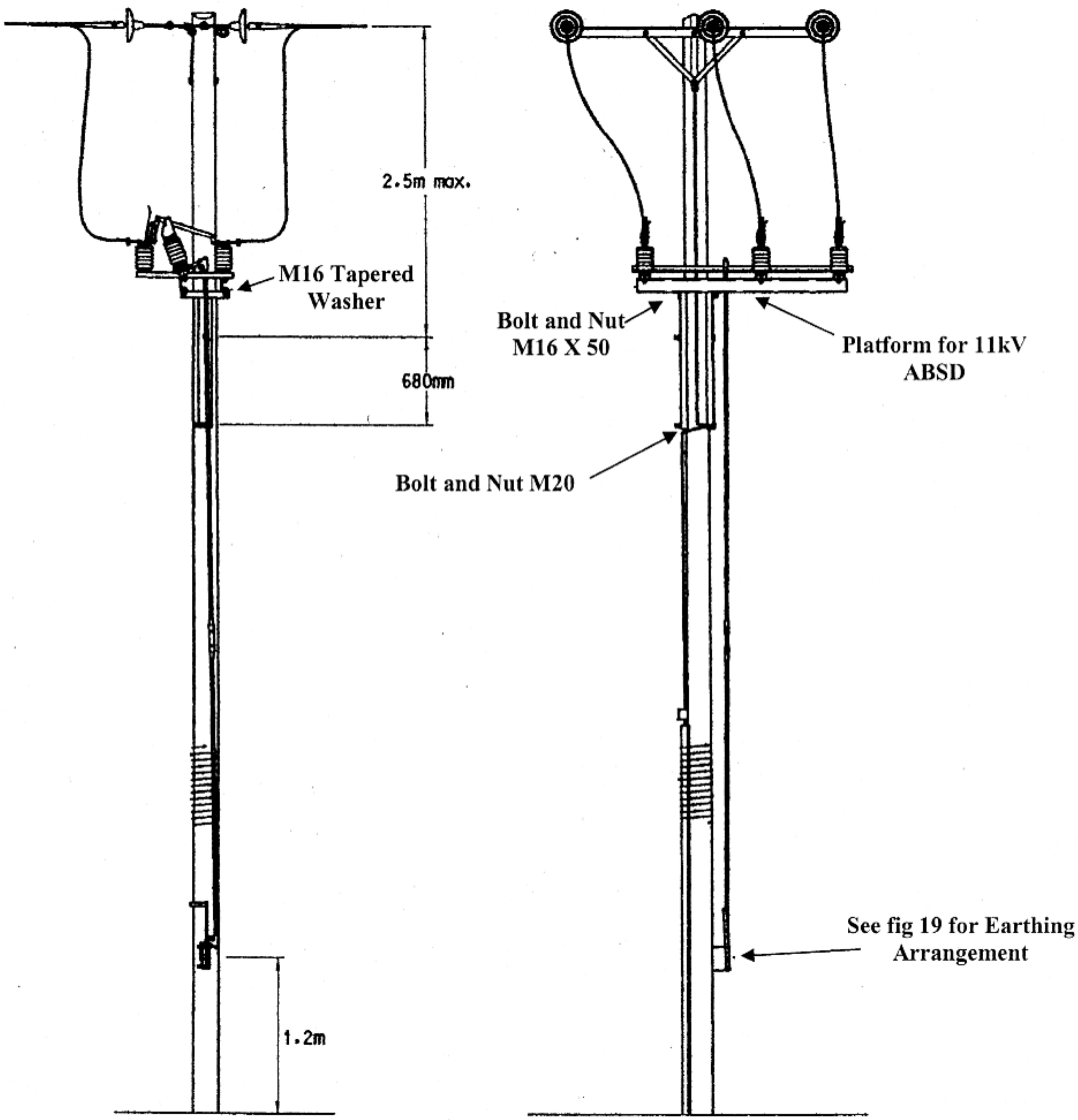


FIG 13
11kV AIR BREAK SWITCH DISCONNECTOR
SINGLE POLE MOUNTING
(Existing installations -New installations should be hook stick operated)

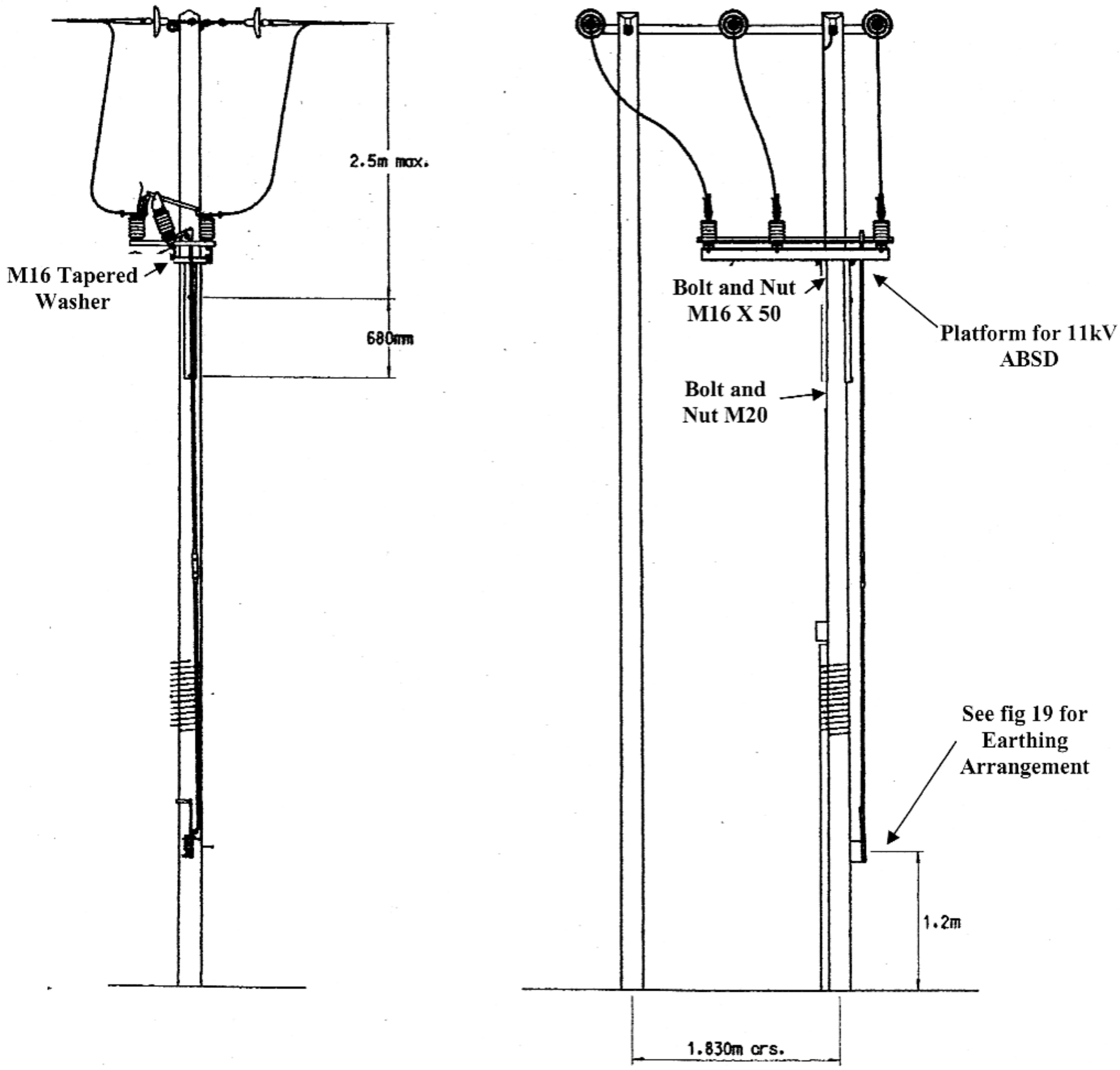


FIG 14
11kV AIR BREAK SWITCH DISCONNECTOR
H POLE MOUNTING

(Existing installations -New installations should be hook stick operated)

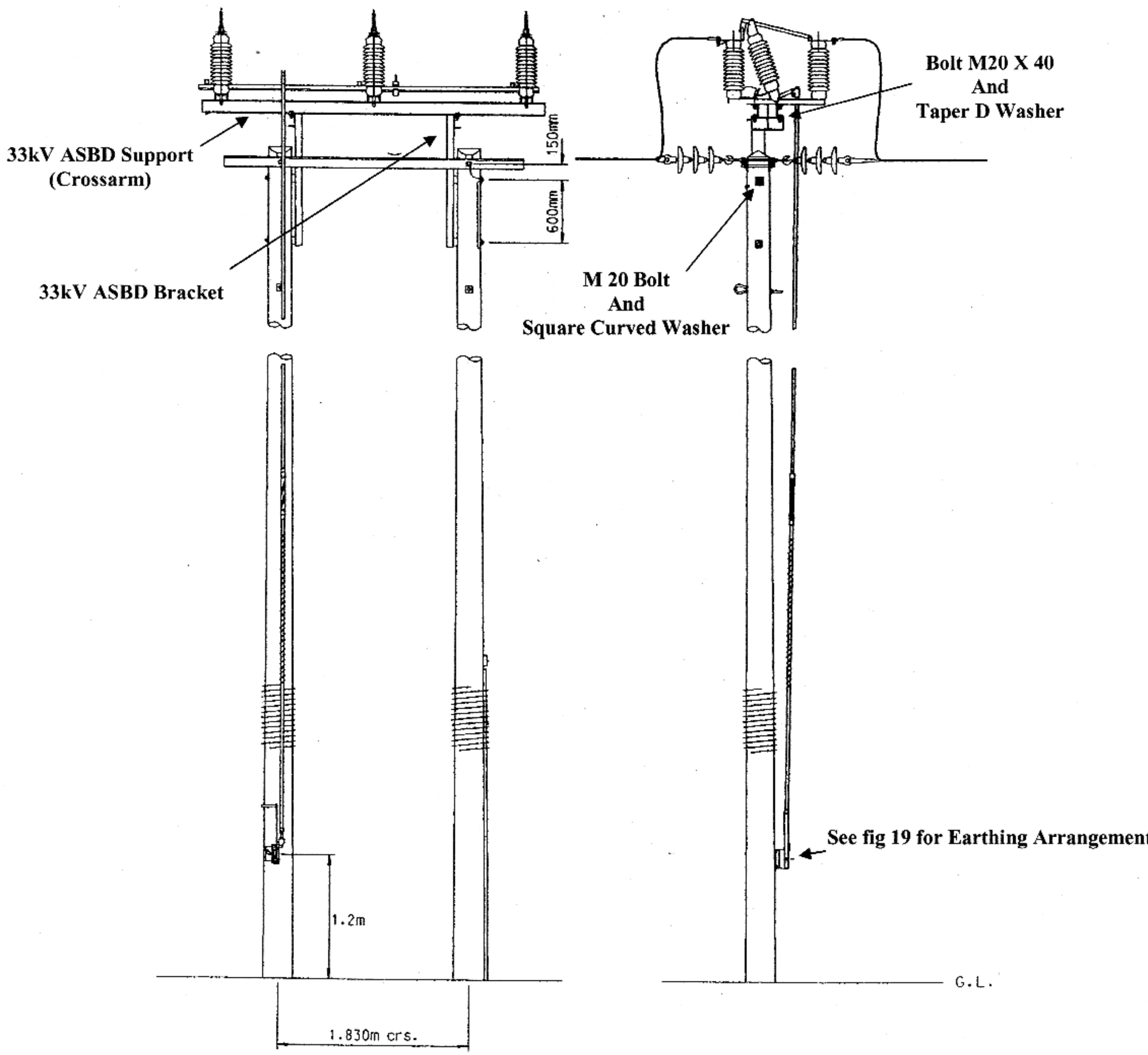


FIG 15

33kV AIR BREAK SWITCH DISCONNECTER WITH GROUND MOUNTED OPERATING HANDLE

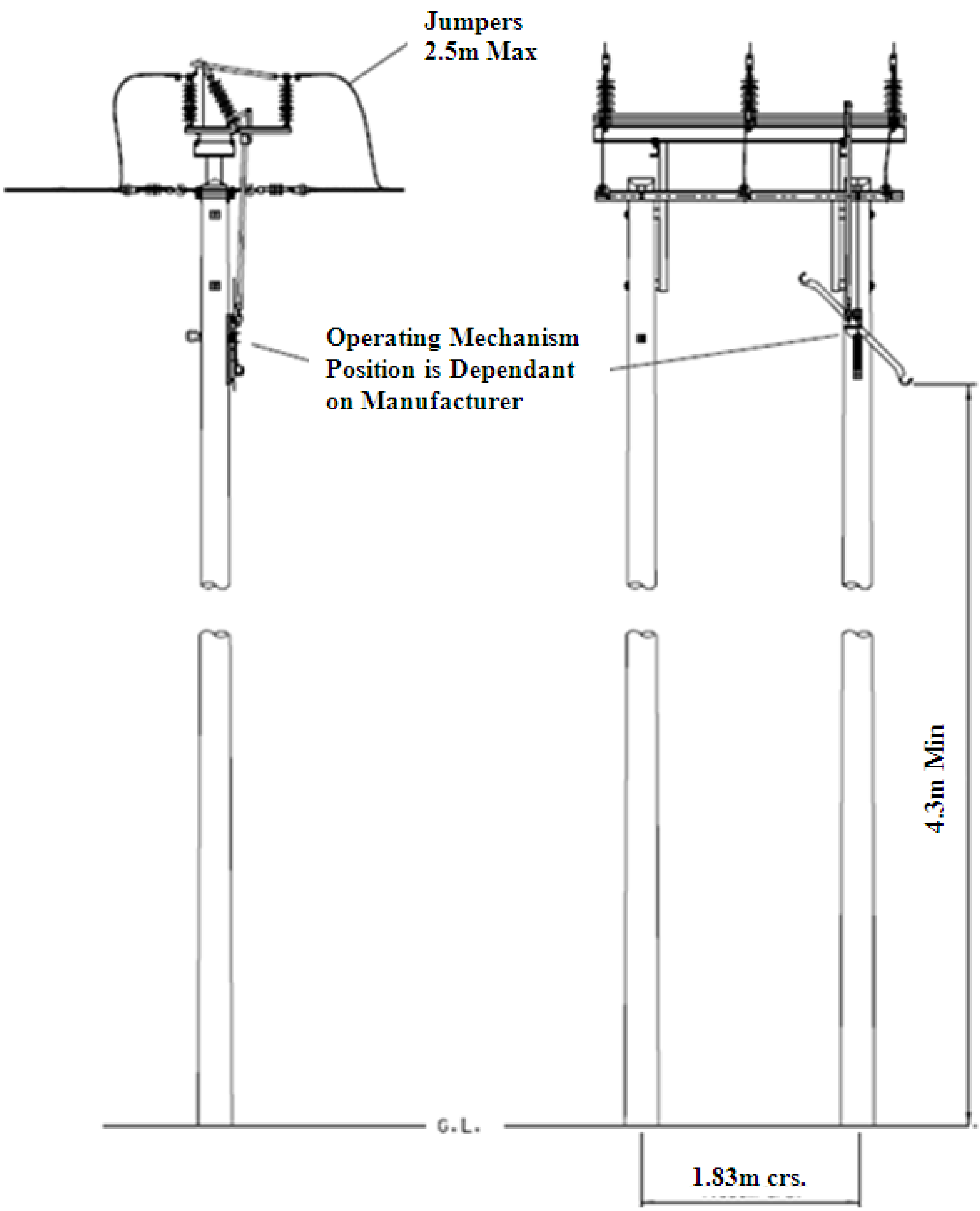


FIG 16
33kV AIR BREAK SWITCH DISCONNECTER WITH HOOK STICK
H POLE CONSTRUCTION

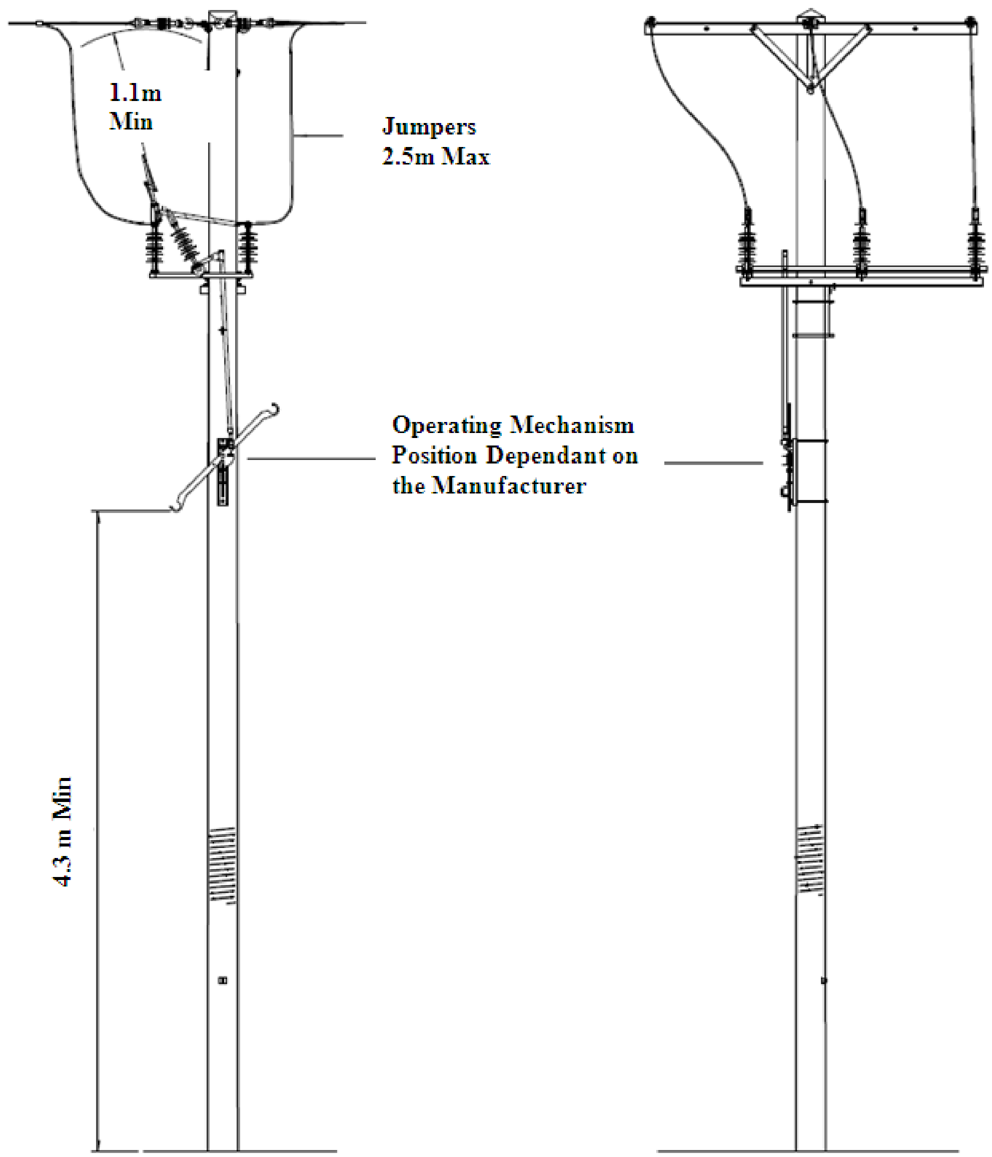


FIG 17
33kV AIR BREAK SWITCH DISCONNECTER WITH HOOK STICK
SINGLE POLE

13.0 POLE MOUNTED AUTO-RECLOSERS (PAMR'S) / SECTIONALISERS

13.1 PMARs shall normally be mounted on the load side of the pole as shown in fig 18.

VTs shall be mounted at the same level as the PMAR but on the opposite side of the pole, and connected to the two outside phase conductors.

PMARs shall be protected by surge arresters mounted alongside the HV bushings on both sides of the PMAR. Where this is not possible, three surge arresters may be mounted above the PMAR on the pole using an 11kV cable termination bracket and connected to the bushings on the source side of the PMAR.

Aerials should be positioned as high on the pole as is practicable, ensuring that no part can infringe a distance of 1.1m from any live conductor.

13.2 Radio Repeater Stations

Radio repeater stations shall only be installed on low voltage poles or 11kV poles which do not have pole mounted transformers present. Where the unit is installed on an 11kV pole the low voltage power source must be obtained from a dedicated voltage transformer.

The unit shall be installed in such a position as to be inaccessible to the general public and not infringe the Working and Access Clearance of the closest 11kV conductor.

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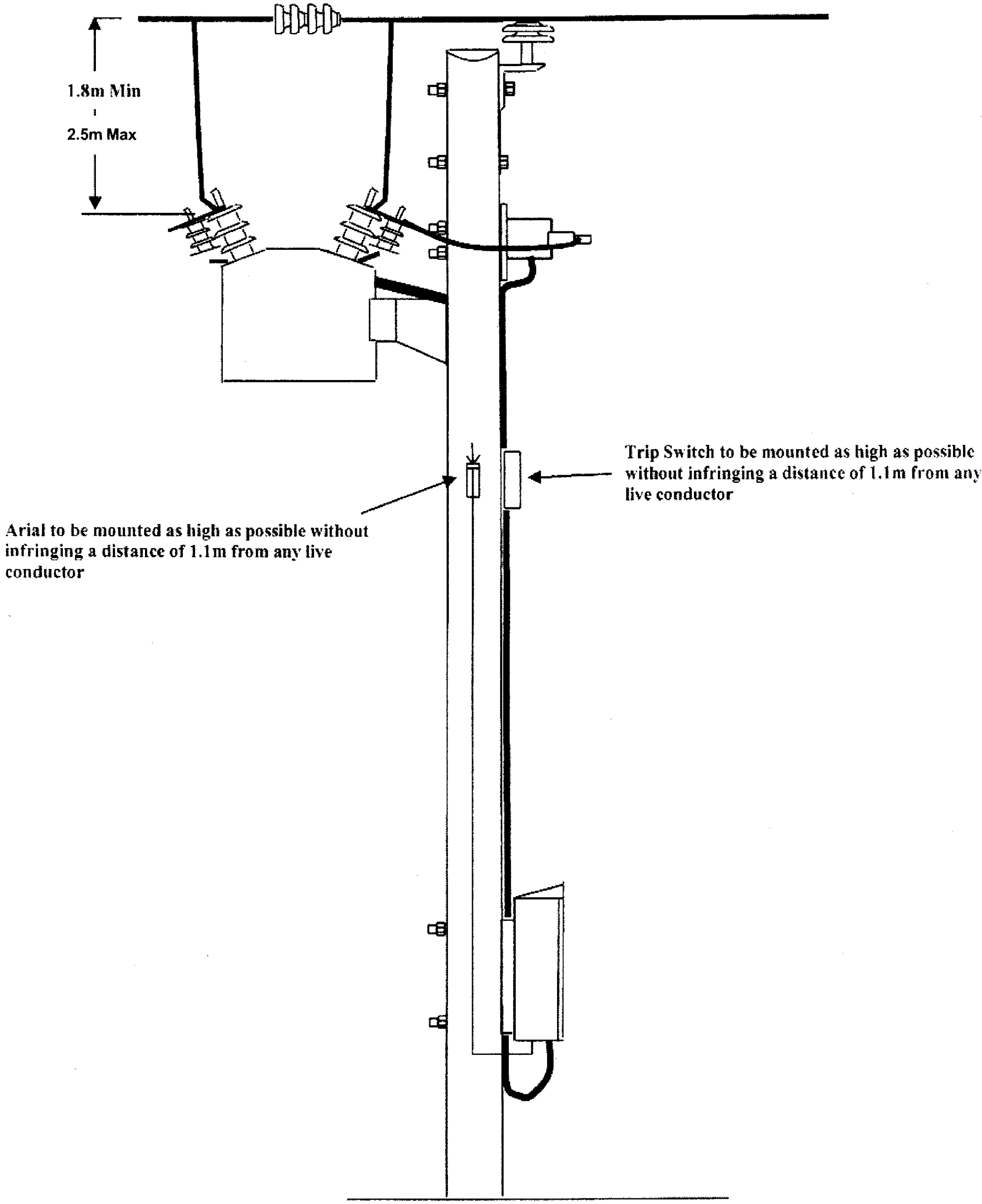


FIG 18
TYPICAL ARRANGEMENT FOR A POLE MOUNTED AUTO-RECLOSERS / SECTIONALISER

14.0 POLE MOUNTED 11kV REGULATORS

11kV regulators shall be mounted on stout poles as shown in fig 19. The overhead line engineer shall be consulted if the regulator is to be mounted on an angle pole.

The maximum size of regulator will be 200kVA and protected by surge arresters mounted phase to earth or jumpers to line.

Earthing arrangement shall be as detailed in section 15.6 of this Standard Technique.

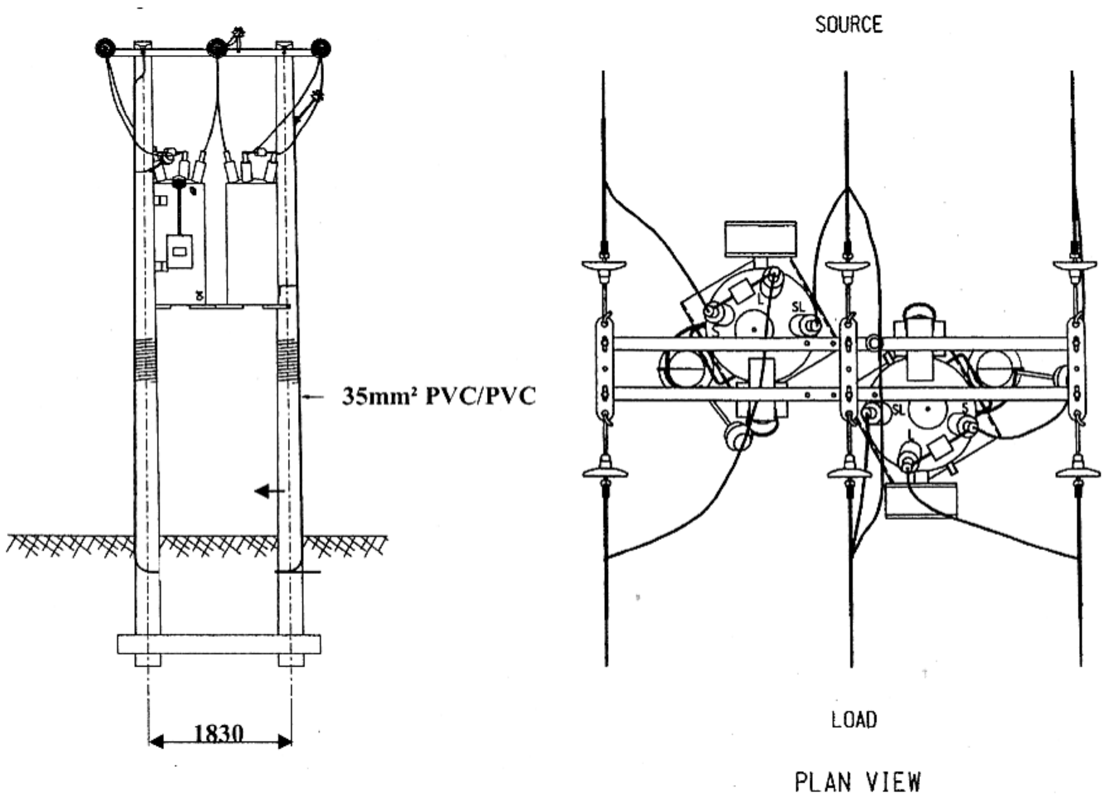


FIG 19
POLE MOUNTING FOR COOPERS 11kV REGULATORS

15.0 EARTHING REQUIREMENTS

Wood pole lines are generally of an unearthed construction with the exception of supports which carry auxiliary equipment. The following section must be read in conjunction with ST: TP21D.

HV lines shall only be earthed at the following locations:-

- Pole Mounted Transformers
- Air Break Switch Disconnectors which are operated using a ground level operating handle. Hook stick ASBDs do not require an earth.
- Cable Pole positions
- Surge Arrester positions
- Joint HV/BT positions
- Joint HV/LV positions
- Pole Mounted Auto-Reclosers

All earthing systems shall be tested in accordance with both ST:TP21D and 21O.

The following sections contain the earthing requirements for equipment connected to the overhead line system. However where a risk of theft of earthing conductor exists, 70mm^2 copper clad steel conductor may be used within the design as shown in Appendix D.

15.1 Pole Mounted substations

On transformer poles all steelwork including the transformer tank and stays but excluding LV 'D' iron brackets were fitted, shall be bonded to the HV steelwork earth. The HV earth electrode will normally be at the base of the pole but must be segregated from other earth systems.

Where possible the LV neutral shall be earthed at the first pole away from the transformer pole with the following exceptions:-

- The LV conductors run in more than one direction from the transformer pole
- There are customers connected within the first span
- There are customers connected directly from the transformer pole

In these cases the LV earth shall be connected at the transformer pole. The HV and LV earthing systems shall be segregated by at least 9m and segregation test carried out in accordance with ST:TP21O.

Where practicable the HV earthing system shall be positioned close to the pole and the LV earthing system at the remote position. The LV earth system shall be connected to the transformer neutral using PVC/PVC insulated conductor see fig 18. This improves the performance of the earthing system during lightning storms.

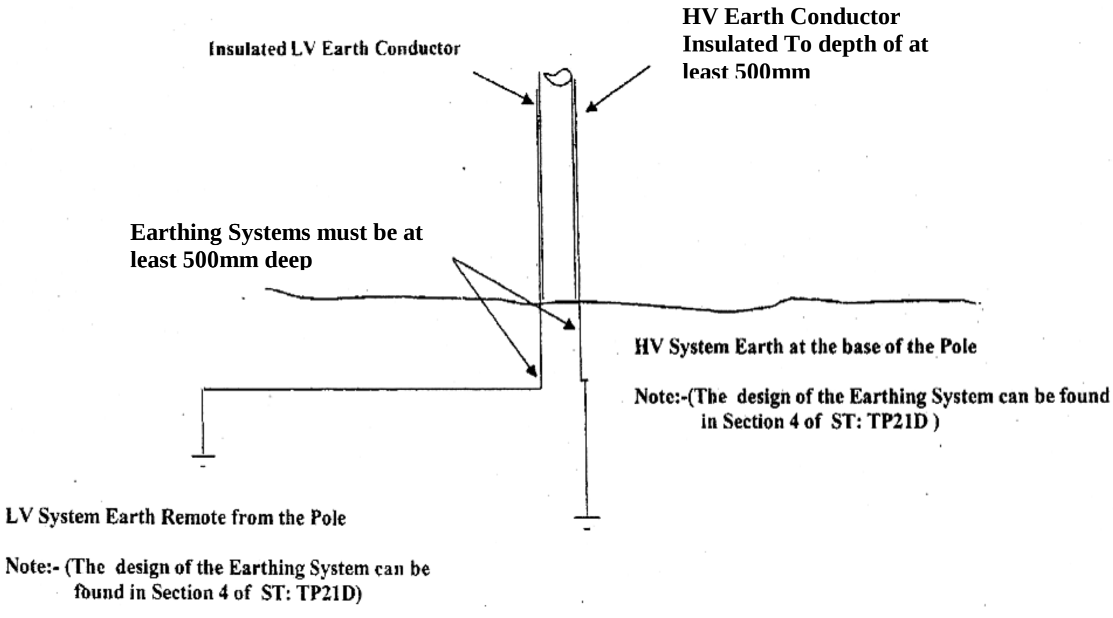


FIG 20

Figure 20 shows the preferred arrangement for the low and high voltage earthing systems connected to a 11kV pole mounted substation. It is important that:-

- The cable connecting the low voltage earth system to the neutral is fully insulated

- The LV and HV earth cables are separated by a minimum of 120 degrees around the circumference of the pole

- The conductor connecting the HV earthing system shall be insulated to minimum depth of 500mm

A small (100mm maximum) section of the insulation may be removed to allow the earthing systems to be tested but this must be at a minimum distance of 3 metres from ground level, and positioned such that the bare conductor can not come into contact with the pole.

15.2 Air Break Switch Disconnectors with Ground Level Operating Handle

On supports carrying 33kV or 11kV ABSDs, all steelwork including stays where fitted but excluding operating rods and handle, shall be bonded to the HV steelwork earth. Anti-climb guards and support brackets shall not be earthed.

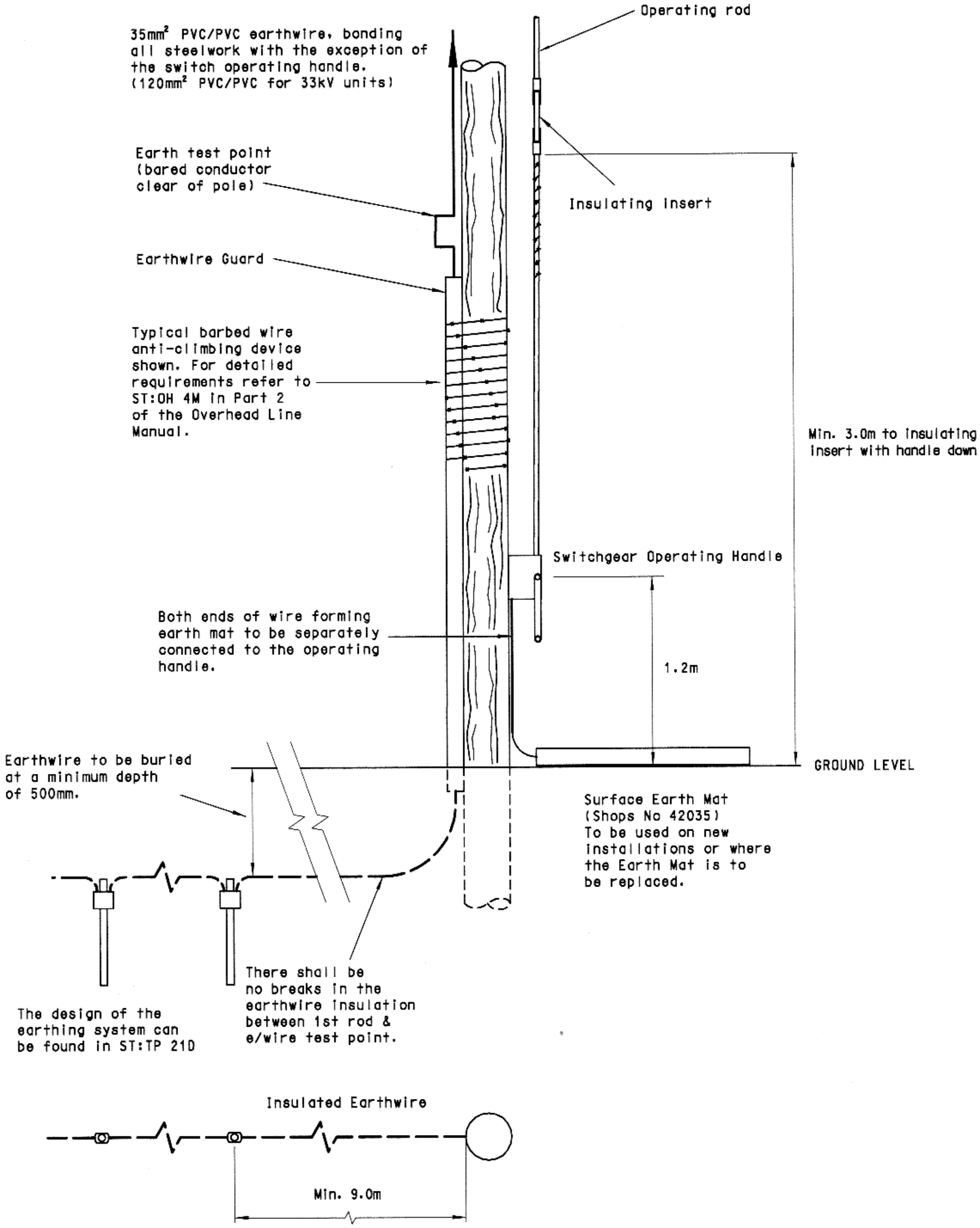


FIG 21
AIR BREAK SWITCH DISCONNECTOR EARTH MAT

All new 11kV ABSDs shall be fitted with a mechanism which is operated by a hook stick (see fig 12).

33kV ABSDs shall be fitted with either a mechanism which is operated by a hook stick (see fig 16 and 17) or ground level operating handle (see fig 15).

ABSDs (33kV) which are operated via a ground level operating handle (see fig 15) shall have an insulating link fitted into the operating rod assembly and positioned such that:-

- The lower end of the link remains at a minimum height of 3 metres above ground level when at its lowest operating position.

- It can not be shorted out by the barbed wire anti-climbing guard fitted to the pole.

Where practicable all 33kV ABSDs operated via a ground level operating handle shall be fitted with a surface earth mat as shown in fig 21 to provide protection for the operator. Where this is not possible a buried earth mat can be formed using one continuous length of $70mm^2$ bare, HDC conductor positioned as close to the surface as possible.

The HV steelwork earth shall be installed such that :-

- It is positioned as far from the operating handle earth mat as possible (minimum 9 m segregation)

- Connected to the steelwork by an insulated cable as shown in fig 18

- The cable connecting the steelwork earth shall be run down the pole on the opposite side to the operating handle (minimum 120 degrees of separation)

- Tested to ensure segregation from the earth mat as described in ST: TP21O

Where earth mats associated with existing 11kV or 33kV ABSDs operated via a ground level operating handle require replacement, the above arrangements as described for new (33kV) handle operated ABSDs shall apply.

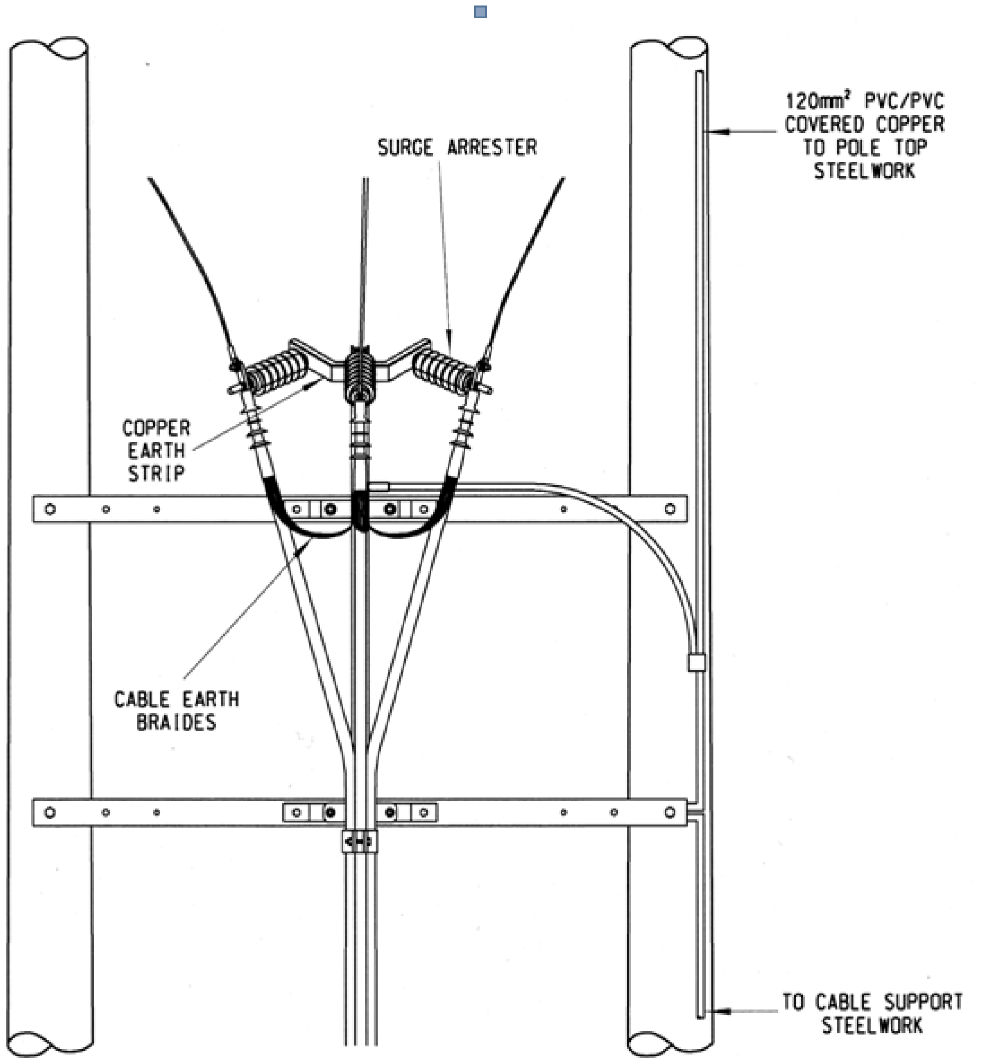
15.3 11kV Cable Termination Poles

The 11kV cable sheath shall be bonded to the HV steelwork earth lead which must connect all the steelwork including stays where fitted. The connection length between the earth end of the surge arrester and the cable sheath screen wires shall be kept as short as practicable.

15.4 33kV Cable Termination Poles

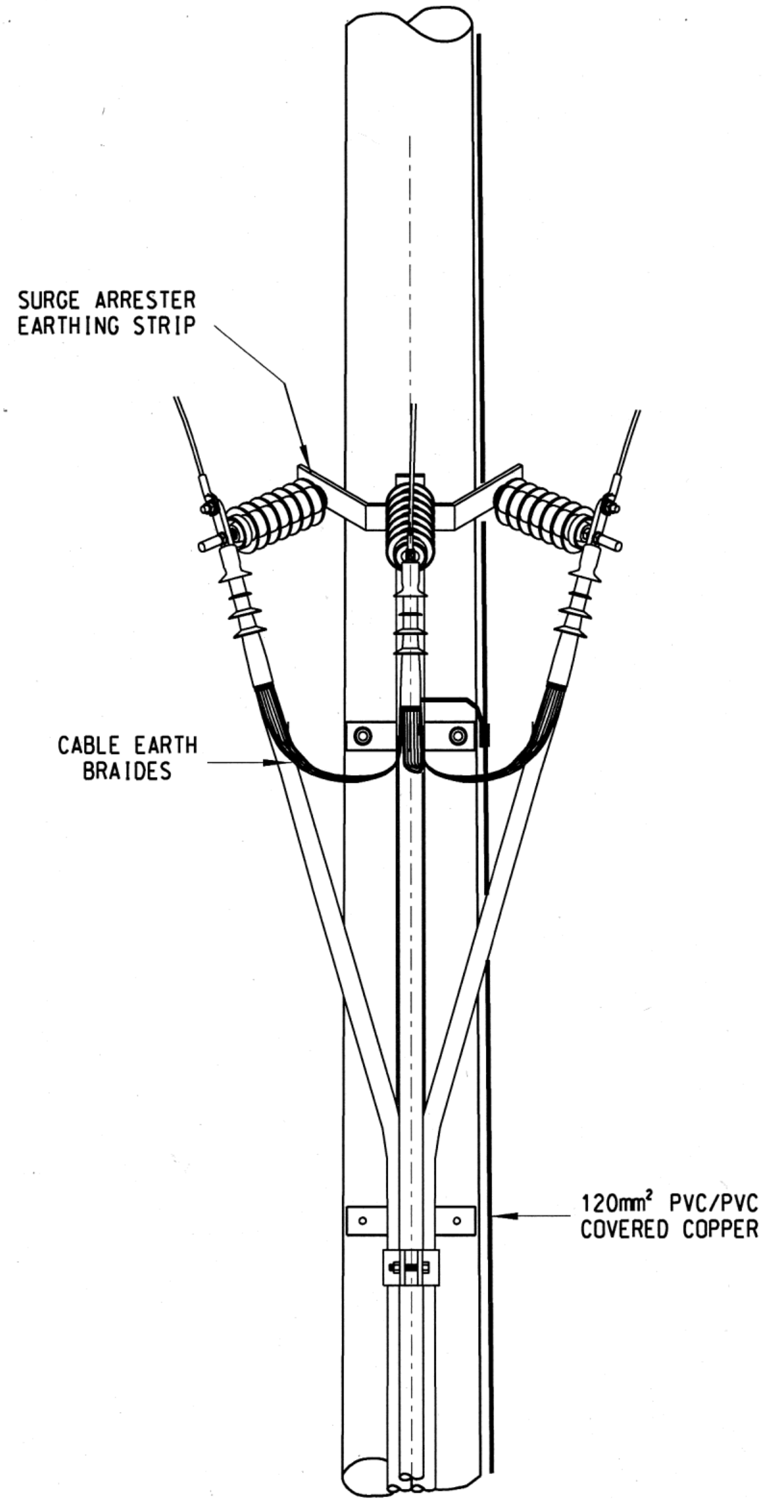
Earthing of 33kV underground cable terminations are dependent upon the individual circuit requirements.

Where practicable, the earth lead for 33kV cable poles may be connected to the main substation earth system. (See figures 22 and 23).



Note: -Earthing Connections are diagrammatic for clarity. Avoid sharp bends in Earth leads and keep them as short as practicable

FIG 22
33kV CABLE TERMINATION
COMBINED SURGE ARRESTER / STAND OFF INSULATOR
EARTHING ARRANGEMENT – H POLE



Note: -Earthing Connections are diagrammatic for clarity. Avoid sharp bends in Earth leads and keep them as short as practicable

FIG 23
33kV CABLE TERMINATION
COMBINED SURGE ARRESTER / STAND OFF INSULATOR
EARTHING ARRANGEMENT – SINGLE POLE

15.5 Surge Arresters

The bases of the surge arresters shall be strapped together using a copper strip and connected to the HV steelwork earth lead which must be bond all steelwork including stays where fitted. Earthing leads shall have sweeping curves, not sharp bends. The earthing system shall have a maximum resistance value of 10Ω for 33kV and for 11 and 6.6kV in accordance with ST:TP21D (ie 20Ω for 11kV and 15Ω for 6.6kV).

15.6 Pole Mounted Auto-Reclosers (PMARs), Powered ABSDs & 11kV Regulators

All steelwork, stays, the PMAR and its control box shall be bonded to the HV steelwork earth. Where control boxes are mounted at ground level, a surface earth mat shall be provided (Shops No 42035), bonded to the HV earth (see fig 24)

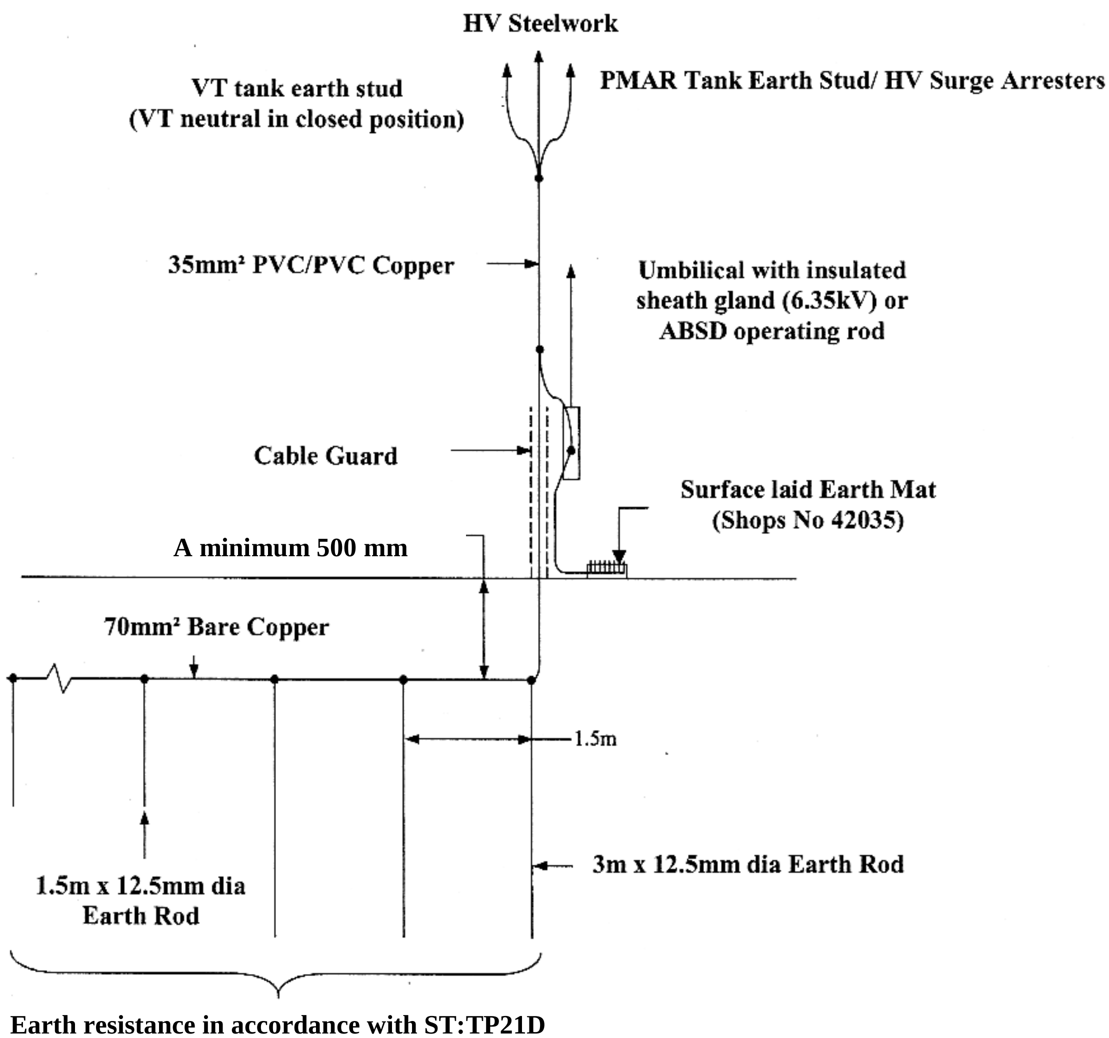


FIG 24
EARTHING OF PMARs, POLE MOUNTED SF6 SWITCHES, 11kV REGULATORS & POWERED ABSDs WITH GROUND LEVEL CONTROL OR DRIVE BOX

15.7 Radio Repeater Stations

Where the unit is attached to a Low Voltage pole the external metalwork of the cabinet shall be connected to the dedicated earth conductor where an SNE system is present on the pole or to the combined neutral / earth conductor where PME system exists.

Where the unit is to be attached to an 11kV pole the external metalwork shall be bonded to the existing HV metalwork.

15.8 Earthing on LV Lines

Transformer neutral earths shall be separated from HV steelwork earths.

On Protective Multiple Earth (PME) systems the neutral shall be earthed along the LV system as described in section 5 of ST: TP21D.

Where equipment such as street lighting brackets, static balancers or regulators are mounted on LV poles the non-current carrying metalwork must be bonded to the neutral conductor. At cable poles any sheath or armouring on the mains cables shall also be bonded to the LV neutral.

There is no requirement to bond reel insulators, D iron brackets, LV stays or pole bolts.

15.9 Bonding on HV Lines

All HV stays shall be bonded to the steelwork supporting the line (crossarm etc) using the integral central "King Wire" on the preformed pole-top make-off.

Pole steelwork supporting "live" equipment must be bonded together but shall be unearthed, unless mounted with equipment which is earthed (see paragraph 15.0). ASBD hook stick mechanisms, 11kV fusegear brackets, tee-off crossarms etc. shall be bonded to the pole top steelwork and pilot pins shall be bonded to the line crossarm.

15.10 Earthing Conductors

The following conductors shall be used:-

- Transformer LV neutral & PME earth leads shall be a minimum of 35mm² copper conductor, PVC (blue) insulated and PVC sheathed (Grey) to BS 6004

- HV steelwork earth leads other than 33kV cable pole steelwork earth leads shall be 35mm² copper conductor, PVC insulated and PVC sheathed (Grey) to BS 6004

- LV system earth leads other than transformer LV neutral and PME earth leads shall be 16mm² copper conductor, PVC insulated and PVC sheathed (Grey) to BS 6004

- Joint HV/BT Construction steelwork earth leads shall be 35mm² hard drawn copper conductor, PVC insulated (green) to BS 6485

- 33kV Cable Pole steelwork earth lead shall be 120mm² copper conductor, PVC insulated (blue) and PVC sheathed (Grey) to BS 6346 (Shops No 30028)

- In areas where a risk of theft exists 70mm^2 copper clad steel conductor insulated (green) and PVC sheathed (Grey) (Shops No 42344) may be used to replace all 35mm^2 copper conductor

Page revised 9 December 2014

15.11 Fixing of Earth Leads

Earthing conductors will normally be fixed to wood poles with wire staples spaced at intervals of 500mm. They should be kept as remote as possible from other 'live' conductors. Take care not to damage the lead insulation when hammering in the staples.

All earth leads shall be protected to a height of 3 metres above ground level by means of PVC capping (Shops No 30408).

To enable the earth systems to be tested the PVC insulation may be removed from 100mm section of the conductor at height of not less than 3 metres from ground level. The bare conductor shall be clear of the surface of the pole.

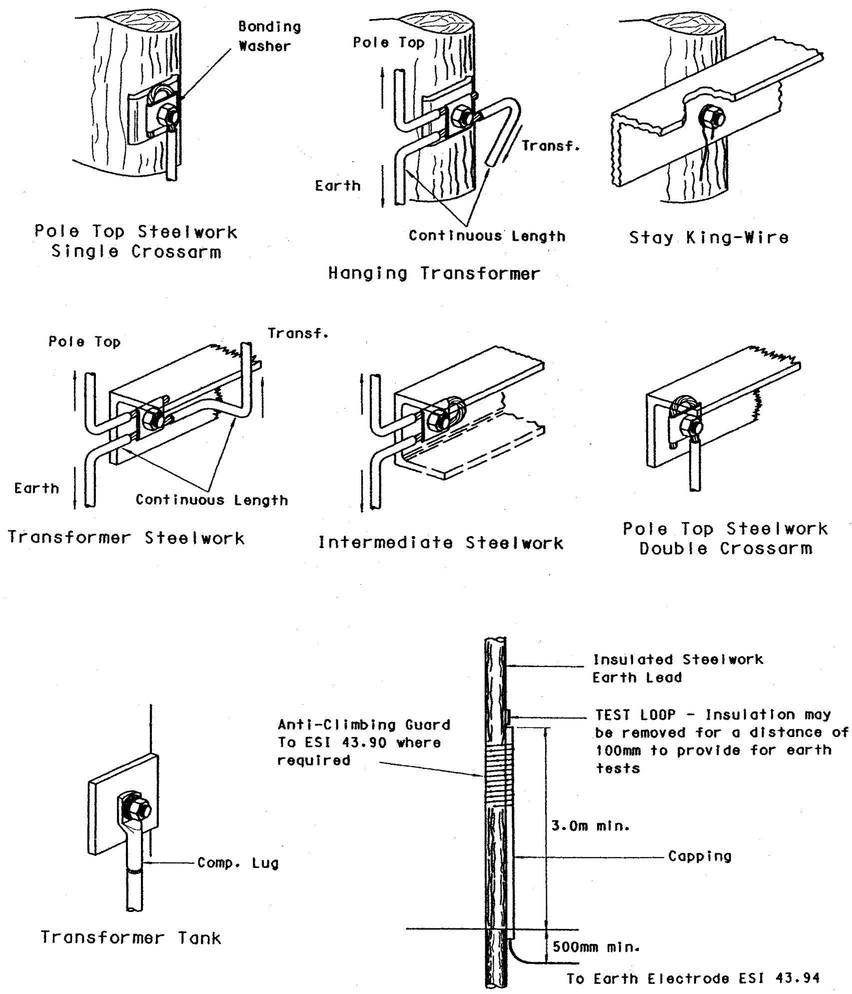


FIG 25
TYPICAL EARTHING AND BONDING ARRANGEMENTS

15.12 Installation of the surface earth mat for ABI's, Auto Re-closers etc

The surface earth mat consists of a one metre square galvanised steel grid with a 1.8 m long 40mm wide galvanised steel bar protruding from its centre which has been welded to the bottom (SHOPS No 42035).

If the mat is to be installed in a location where there is a need for additional weight, such as where there is a risk of agricultural machinery dragging the mat, fast drying concrete (eg Post-Crete) shall be added to the mat on site.

Installation

Position the earth mat such that a person operating the switch etc is standing as near to the centre of the mat as possible.

Ensure that the ground on which the mat is to be placed is as level as practicable. Where there is a need to use concrete it is suggested that the ground be excavated to allow the bottom of the mat to sit just below the ground level.

Connect the mat to the operating handle etc and place the mat into position. Where there is a need to cut the galvanised steel bar paint the cut surface with galvanised paint.

15.13 Earth Electrodes

Earth electrodes shall comply with ENA TS 43-94. To achieve the required earth resistance the earthing system shall consist of driven earth rods and/or bare copper conductor of not less than $70mm^2$ (see ST:TP21D).

The conductors shall be buried at a depth of not less than 1 metre and laid in a position that is not likely to be disturbed by subsequent site activity.

Connections to the earth electrodes shall be made using either compression joints or thermic welds (see ST:TP21L).

Where surge arresters are fitted, where possible a rod should be installed at the base of the pole in such a position as to allow the earthwire to come directly down the pole and on to the earth rod in a straight line. The earthwire may then be continued to other rods in order to obtain the required resistance or thermal rating.

16.0 GENERAL ARRANGEMENTS FOR 33KV POINT's OF CONNECTION.

16.1 Introduction

Whilst WPD's preferred method and lowest cost option for the connection of embedded generation onto the existing 33kV network is still the traditional 2 span spur incorporating an ABSD and a cable termination this section introduces an alternative method of connecting these points of connections and whilst they may be more expensive the business in particular Primary System Design have requested that these alternative methods be allowed so as to assist with the minimising timescales that would normally apply in obtaining wayleaves and applying for Section 37 consents which can take many months to obtain for a traditional spurred connection.

These structures represent the best options in terms of operational safety, network reliability, the least environmental impact and will assist in speeding up the overall process of obtaining the necessary permissions required for new connections.

Therefore at the specific request of the ICP the following non-standard arrangements which are outlined below can be considered as Points of Connection

16.2 Operational

The restrictions put in place by SOP294 which relate to the rise in potential due to differing earthing systems do not apply with this structure. The use of a rod operated switch in conjunction with the physical separation between the cable termination steelwork / arrestor earth and the position the operator will stand restricts this rise, this is further mitigated as the operative will also be wearing safety boots and rubber gloves when operating the switch.

The structure shall be built under dead conditions, subsequent minor work on the cable termination pole after initial installation is permitted with isolation via the associated switch but the requirements of the DSR's and STOS2F Clause 3.4 must be met.

16.3 Variations

Site conditions and/or existing network configuration may mean these non-standard structures may not always be suitable; under these circumstances each case should be treated on an individual basis and the responsible design engineer should provide a detailed proposal of the intended network configuration to seek approval from the local network owner and relevant policy engineer to ensure the proposed configuration is fit for purpose and to identify any associated network risks.

16.4 General Arrangements

Figures 16.4.1, 16.4.2 & 16.4.3 are designed so as to offer flexibility in terms of the positioning of the absd pole relative to the cable term pole and the layout of equipment on the cable term pole. However being a non-standard structure there are a number of specific requirements which are listed below and on the GA drawings.

1. To minimise the risk of future hedge cutting, wherever possible the building of the structure within a hedge row should be avoided; where this is unavoidable the section of hedge should be removed and replaced with fencing.

2. The dimensions given on the drawings are optimal and require a ground to line clearance of 9.7m which should ensure that all statutory and operational clearances are maintained, if adjusted the clearances will need to be verified as suitable and must meet the minimum clearances as detailed in STOH1A & STOH4H Section 6.

3. 33kV Rod Operated ABSD – Shops No. 50834.

4. 33kV Surge Arrestors – Shops No. 50413.

5. Jumpers shall be covered (10m coil of 120mm AAAC covered conductor item code 60559, stripping tool item code 41479) between ABSD and Cable termination and will require further support if longer than 2.5m.

6. The Cable Term is to be built at its final erected position in line with ST:CA3V and should incorporate the surge arrestor adaptor plate (50415), backing plate (41292), and earthing pins (50416) as depicted.

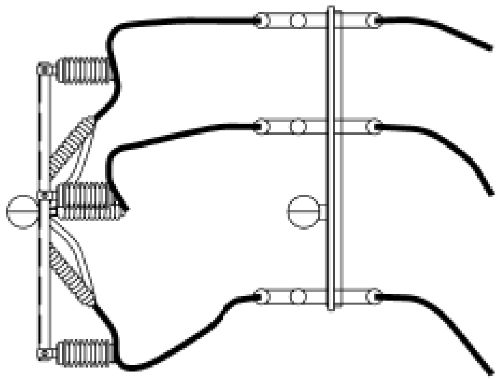
7. Anti-Climbing Devices shall be fitted in accordance with ST:OH4M.

8. Pole Signage shall be fitted in line with ST:OH4N.

9. The steelwork earth should be run down the pole with 120mm^2 PVC/PVC Covered Copper in line with ST:OH4H Section 15.4 & 15.5; the PVC/PVC earth should then be installed in the ground in a direction that is angled away from the position the operative will stand for a length of at least .5m where it should be converted to bare conductor at the position of the 1st earth rod, the earthing installation should then be installed in accordance with a method as outlined in ST:TP21D.

10. Where a handle operated absd is to be used a polymeric insulator shall be used for the insulated insert in the operating handle. The earthing mat and steelwork earth shall be installed in accordance with ST:OH4H Section 15.2 and the minimum segregation of 9m between the steelwork earth and the earth mat shall be assured by placing the insulated earth inside a HDPE or MDPE duct.

Page Amended 10th October 2014



Plan View

Construction Notes:

1. Pole top arrangement and order of absd pole in relation to cable term pole for illustrative purposes only.

2. Min pole separation of 2m is required, however this may need to be increased if an existing section pole is being utilised so as to ensure clearance between the end of conductor term and intermediate make off.

3. Pole top steelwork is based on 1.2m spacing's, if an existing pole is being utilised then consideration needs to be given to the existing conductor spacing's. Existing Angle positions should not be used

4. Cross arm (30390) can be used as the steady channel fitted with tie straps (30467), right angle post insulator bracket (60255) and 33kV post insulators (30422).

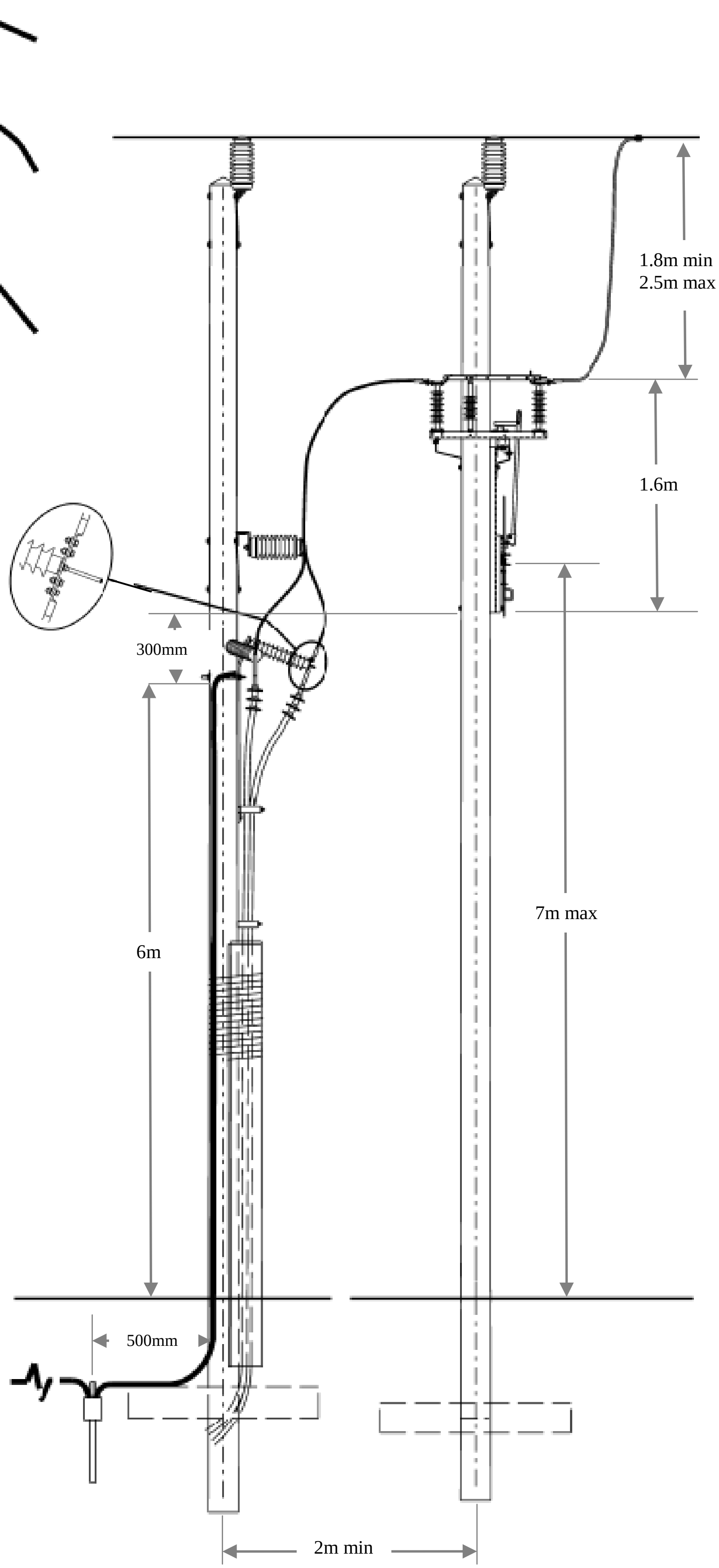
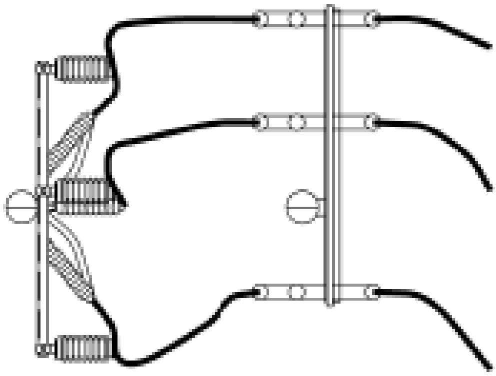


Fig 16.4.1 OHL Tee Off to ABSD and Underground Cable under the Mainline



Plan View

Construction Notes:

1. Pole top steelwork based on 1.2m spacing's.

2. Cross arm (30389) can be used as the steady channel fitted with tie straps (30467), post insulator bracket (60255) and 33kV post insulators (30422).

3. Where a distance greater than 3.5m can be achieved between poles centres then the structure should be built as standard.

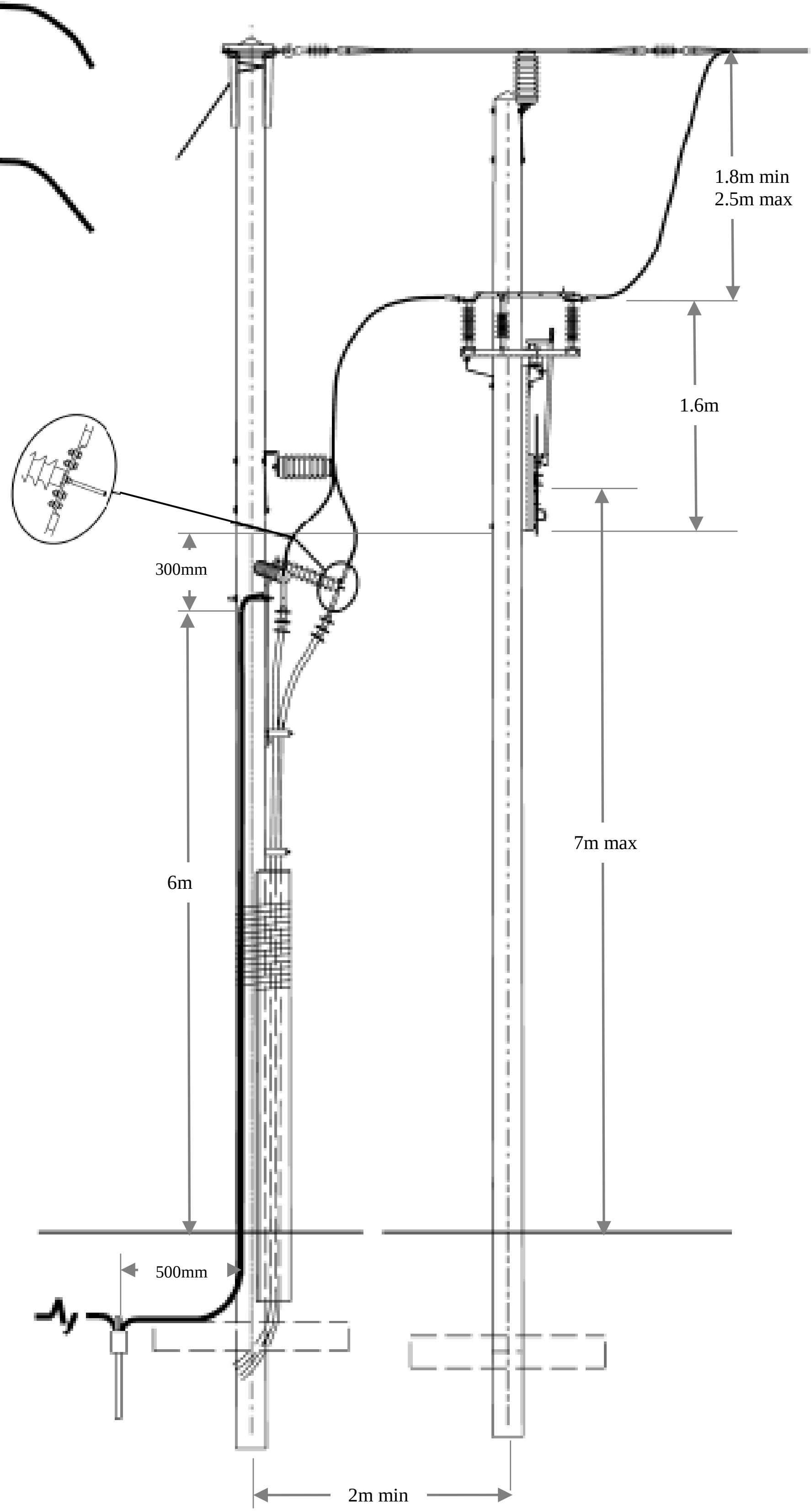
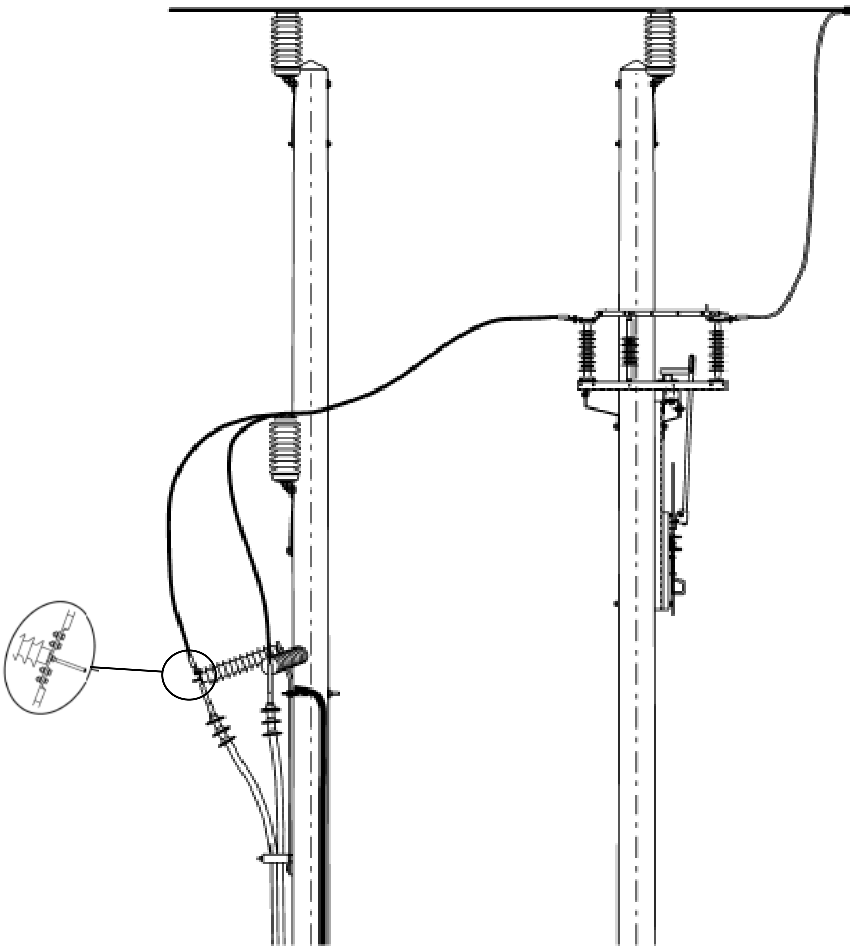


Fig 16.4.2 – OHL Spur Line Tee off to ABSD and Underground Cable.



Construction Notes:

1. Pole top arrangement and order of absd pole in relation to cable term pole for illustrative purposes only.

2. Pole top steelwork is based on 1.2m spacing’s, if an existing pole is being utilised then consideration needs to be given to the existing conductor spacing’s. Existing Angle positions should not be used.

3. Dimensions in line with Fig 16.4.1

4. Where site conditions dictate the Cable Term can be built on the opposite side of the pole than depicted in Fig 16.4.1. A steady channel (30390), tie straps (30467) and 33kV post insulators (30422) fitted into the outer holes of the channel will be required to feed the jumpers down onto the cable term. Note cross arm (30390) will need to be drilled with an additional 22mm hole, 550mm from the outer hole of the channel to ensure jumper clearances are maintained.

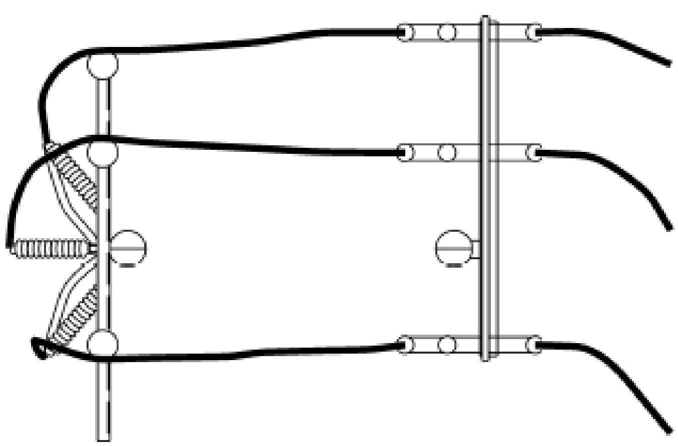


Fig 16.4.3 Cable Termination on Opposite Side of Pole.

MATERIAL LISTS

The following tables list the materials required to erect the item of plant as described within the heading of each table. However for clarity the following lists do not contain the materials required for either the construction of the main overhead line (crossarms etc) or earthing systems, as the choice of materials required will very depending on design (see ST:OH4D, ST:OH4G and ST: TP21D).

11kV JUMPER SUPPORT ARRANGEMENTS (FIG 1)		
ITEM DESCRIPTION	**SHOPS NO**	**QUANTITY**
H POLE JUMPERS		
Crossarm, 11kV Pilot	30387	1
Washer, Tapered Square	30521	4
Washer, Square Curved	30522	4
Bolt M16 (to suit pole)	-	2
Nut M16	36797	2
Pin, Pilot	30444	3
Insulator, 11kV Pin	30413	3
Preformed Side Bind	30634	3
SINGLE POLE JUMPERS		
Bracket 11kV Pilot	30146	1
Coach Screw 10 x 76mm	30509	1
Bolt, M20 (to suit pole)	-	1
Nut M20	30136	1
Washer, Square Curved	30522	1
Pin, Pilot	30444	3
Insulator, 11kV Pin	30413	3
Preformed Side Bind	30634	3

POLE MOUNTED TRANSFORMER SINGLE BOLT FIXING (FIG 2)		
ITEM DESCRIPTION	**SHOPS NO**	**QUANTITY**
M20 Bolt length to suit Pole dia	-	1
M20 Washer, Round Flat	30517	1
M20 Washer, Square Curved	30522	1
Nut M20	30136	1
LV Fuse Carriers	31713	3
Note See Appendix C for LV conductor and fuse sizes		

POLE MOUNTED TRANSFORMER SINGLE POLE PLATFORM (FIG 3)		
ITEM DESCRIPTION	**SHOPS NO**	**QUANTITY**
Transformer Platform Assembly for Single Pole (Complete with Fixings)	30540	1
LV Fuse Carriers	31713	3
See Appendix C for LV conductor and fuse sizes		

POLE MOUNTED TRANSFORMER H POLE PLATFORM (FIG 4)		
ITEM DESCRIPTION	**SHOPS NO**	**QUANTITY**
Transformer Platform H Pole	30541	1
LV Fuse Carriers	31713	3*
Note * 6 LV fuse carriers are required for 315kVA transformers. See Appendix C for LV conductor and fuse sizes		

POLE MOUNTED TRANSFORMER LAZY LEG H POLE (FIG 5)		
ITEM DESCRIPTION	**SHOPS NO**	**QUANTITY**
Transformer Platform H Pole (Complete with Fixings)	30541	1
M20 Bolt length to suit Pole dia	-	2
M20 Nut	30136	2
M20 Washer, Round Flat	30517	4
H POLE JUMPERS (FIG 1)		
Crossarm, 11kV Pilot	30387	1
Washer, Tapered Square	30521	4
Washer, Square Curved	30522	4
Bolt M16 (to suit pole)	-	2
Nut M16	36797	2
Pin, Pilot	30444	3
Insulator, 11kV Pin	30413	3
Preformed Side Bind	30634	3

11kV CABLE TERMINATION ARRANGEMENT (FIG 6)		
ITEM DESCRIPTION	**SHOPS NO**	**QUANTITY**
Surge Arresters 15kV	50412	3
Surge Arrester Adaptor Plate	50415	3
Earthing Pin	50416	3
Bracket, 11kV Cable Termination	40423	1
Earth Strip for Surge Arresters	40422	1
Bolt, M20 x 300mm (to suit Pole)	30124	1
M20 Nut	30136	1
Washer, Square Curved	30522	1
Coach Bolt 12 x 50mm	-	1
Compression Lug (to suit conductor)	-	3
Coach Screw 10 x 76mm	30509	2
Cable Cleat (to suit cable)	-	As required
Lid	36507	1
Troughing	36510	As required
Cleat	-	As required
Cleat fixings	-	As required
Cable Capping (earthwire)	30408	As required

33kV CABLE TERMINATION H POLE ARRANGEMENT (FIG 7)		
ITEM DESCRIPTION	**SHOPS NO**	**QUANTITY**
Surge Arrester Support Bracket and Earthing Strip	42595	1
Surge Arrestor Adaptor Plate	50415	3
Earthing Pin	50416	3
Crossarm, 33kV Cable Support	36353	6
Cleat Stand-off Bracket (Type A)	36411	1
Cleat Stand-off Bracket (Type B)	36412	1
*Trefoil Cable Cleat	-	6
Backboard and lid	36508	1
Trough 33kV Cable	36410	2
Brace Block 2.6m	30093	1
** Twin Bolt Hole Mechanical Lug	-	3
Surge Arrester 33kV	50413	3
(Surge Arrester 42kV Cornwall)	(30580)	(3)
FIXINGS		
Bolt M12 x 45	30096	8
Bolt M12 x 75	30103	14
M12 Nut	30135	22
Bolt M20 x length to Suit Pole	-	14
M20 Nut	30136	14
Washer, Square Flat for M20	30523	2
Washer, Square Curved for M20	30522	14
***Anti-Climbing Device	-	2

NOTE

* For 3 x 185mm² single core cable use shops no 30869

** For 3 x 185mm² single core cable use shops no 37606 for 400mm² use shops no 30874

*** The type of Anti-Climbing device required for the various type of location is shown in ST: OH 4M

33kV CABLE TERMINATION SINGLE POLE ARRANGEMENT (FIG 8)

ITEM DESCRIPTION	SHOPS NO	QUANTITY
Surge Arrester Support Bracket and Earthing Strip	42595	1
Surge Arrester Cable to OH line Adaptor Plate	50415	3
Earthing Pin	50416	3
Support Stabilizing Bracket	42596	2
*Trefoil Cable Cleat	-	1
**Trefoil Cable Cleat	-	6
Lid	36507	1
Trough 33kV Cable	36510	2
Brace Block	30091	1
Twin Bolt Hole Lug 185mm²	37606	3
Surge Arresters 33kV	50413	3
(Surge Arresters 42kV Cornwall)	(30580)	3
FIXINGS		
Bolt M20 x Length to Suit Pole		6
M20 Nut	30136	6
Bolt M12 X 45	30096	2
M12 Nut	30135	2
Screw M12 x 150	-	6
Washer, Square Flat for M20	30523	3
Washer, Square Curved for M20	30522	1
**Anti-Climbing Device	-	1

Note
For 3 x 185mm² single core cable use shops no 30869

11kV EXPULSION FUSE PLATFORM ASSEMBLY SINGLE PHASE (FIG 9A)

ITEM DESCRIPTION	SHOPS NO	QUANTITY
Crossarm 11kV Auxiliary Equipment	30388	1
Strap Crossarm Tie Light	30467	2
Fuse Cut Out and Carrier	34300	2
Fuse Mounting Bracket	33723	2
M20 x 300 Bolt	30124	2
M20 x 40 Bolt	30115	1
M20 Nut	30136	3
Washer, Square Curved for M20	30522	2
M12 x 45 Bolt	30096	4
M12 Nut	30135	4
Compression Lug	-	4
Compression Connector	-	3
Bonding Conductor	-	As Required

11kV EXPULSION FUSE PLATFORM ASSEMBLY THREE PHASE (FIG 9B)		
ITEM DESCRIPTION	**SHOPS NO**	**QUANTITY**
Platform Assembly Consisting of:-		
11kV Aux Equipment Crossarm	30388	1
11kV Aux Equipment Bracket	30156	2
11kV Crossarm tie strap	30467	2
Coach Screw 13X 102mm	30508	2
Washer Tapered Square	30521	2
Bolt M16X 300	30112	1
Bolt M20X 40	30115	4
Bolt M12X 45	30096	9
Fuse Cut Out and Carrier	34340	3
Fuse Mounting Bracket	33723	3
Compression Lug	-	6
Compression Connector	-	6
Insulator 11kV Pin type	30413	1
Pin, Pilot, Coachscrew	30443	1
Preformed Side Bind	-	1
Conductor Bulldog Grip	30169	1
Bonding Conductor	-	As Required

11kV ABSD SINGLE POLE MOUNTING WITH HOOK STICK OPERATING MECHANISM (FIGS 12 & 14)		
ITEM DESCRIPTION	**SHOPS NO**	**QUANTITY**
Platform 11kV ASBD	30543	1
Bolt and Nut M16 x 50	30104	4
Washer, Taper M16	30513	10
M20 Bolt and Nut (to suit pole)	-	4
M20 Nut	30136	4
M16 Bolt	-	2
M16 Nut	36797	2

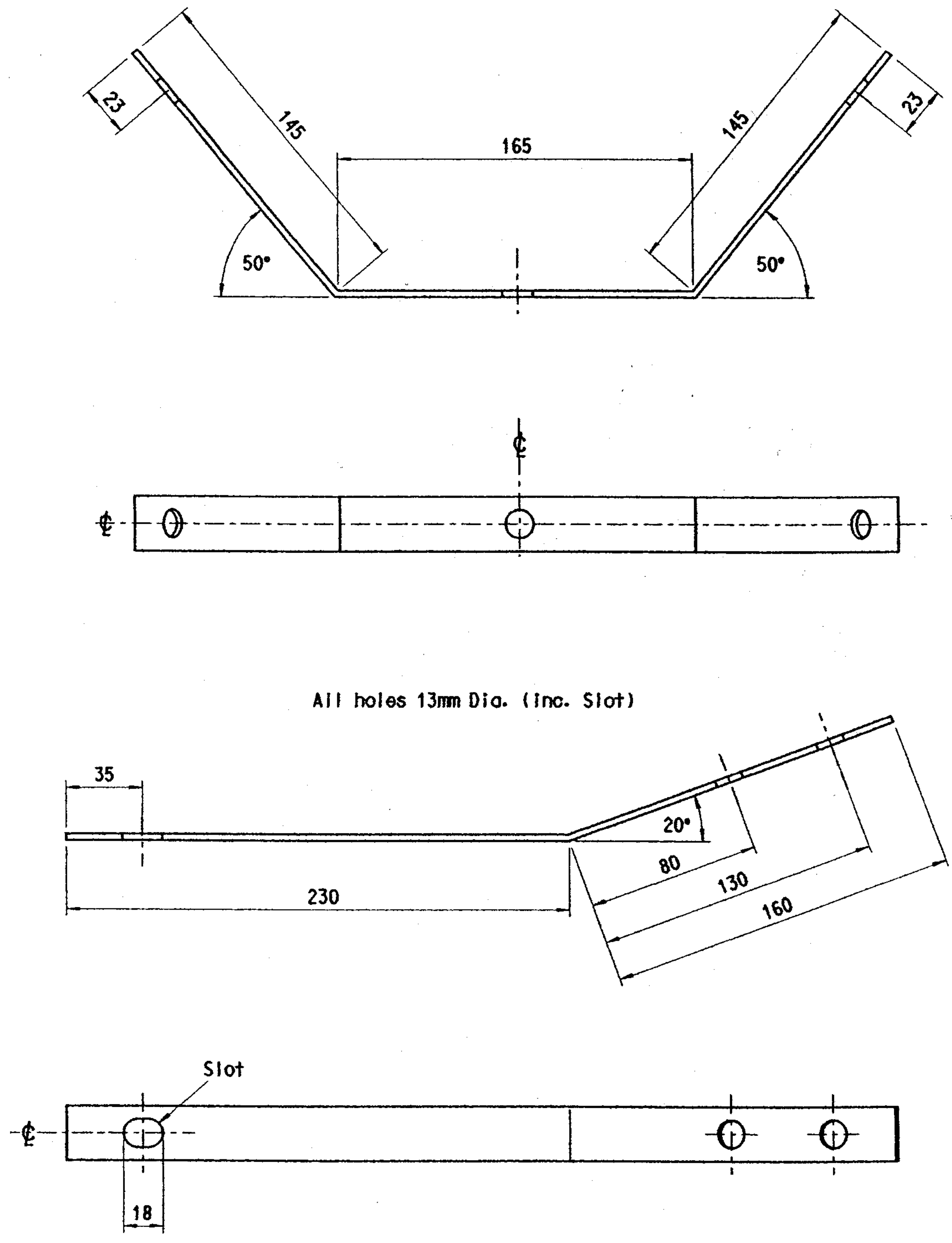
11kV ABSD SINGLE POLE MOUNTING WITH GROUND MOUNTED OPERATING HANDLE (FIGS 13 & 14)		
ITEM DESCRIPTION	**SHOPS NO**	**QUANTITY**
Platform 11kV ASBD	30543	1
Bolt and Nut M16 x 50	30104	4
Washer, Taper M16	30513	10
M20 Bolt (to suit pole)	-	4
M20 Nut	30136	4
M16 Bolt (to suit pole)	-	2
M16 Nut	36797	2
Surface Laid Earth Mat	42035	1

33kV ABSD MOUNTING ARRANGEMENT (FIG 15)		
ITEM DESCRIPTION	**SHOPS NO**	**QUANTITY**
Crossarm, 33kV ASBD	30400	2
Bracket, 33kV ASBD	30147	1
Bolt M20 x 40	30115	4
Washer, Taper D	30514	As Required
M20 Bolt (to suit pole)	-	4
M20 Nut	30136	8
Washer, Square Curved	30522	4
Surface Laid Earth Mat	42035	1

POLE MOUNTED AUTO-RECLOSER (FIG 18)		
ITEM DESCRIPTION	**SHOPS NO**	**QUANTITY**
M20 Bolt length to suit Pole dia	-	8
M20 Nut	30136	8
M20 Washer, Round Flat	30517	8
M20 Washer, Square Curved	30522	8
Coach Bolt 12 x 50mm	-	4
*Surface Laid Earth Mat	42035	1
Note *Only to be used where access to the control panel is at ground level		

POLE MOUNTED COOPERS 11kV REGULATORS (FIG 19)		
ITEM DESCRIPTION	**SHOPS NO**	**QUANTITY**
M20 Bolt length to suit Pole dia	-	6
M20 Washer, Round Flat	30517	6
M20 Washer, Square Curved	30522	6
Nut M20	30136	6
*Surface Laid Earth Mat	42025	1
Note *Only to be used where access to the control panel is at ground level		

ADDITIONAL DIAGRAMS



Notes

1. Material 25 x 3mm annealed plain copper strip to BS 1432.

FIG 26
EARTHING STRIP FOR 11kV SURGE ARRESTERS

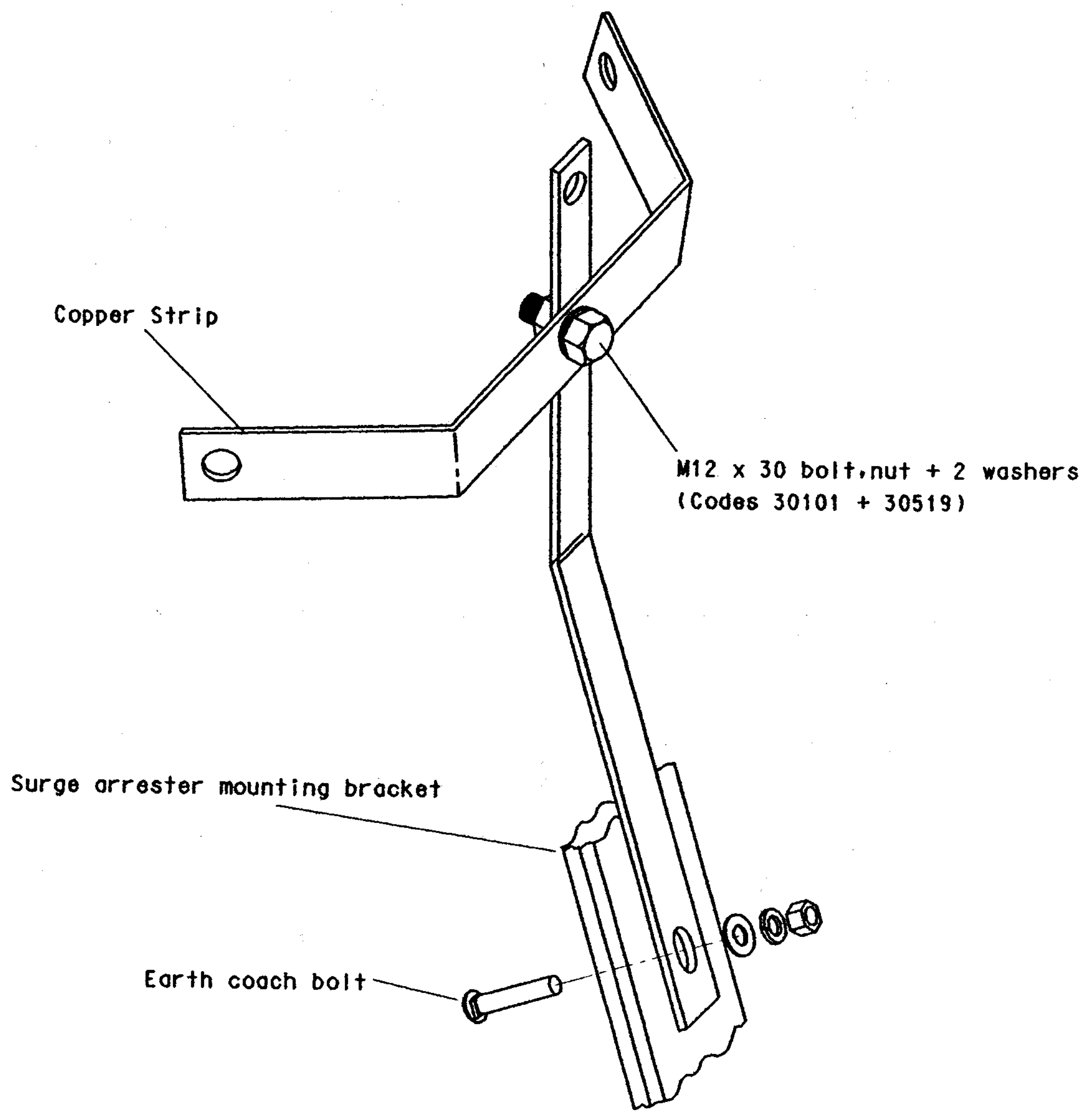
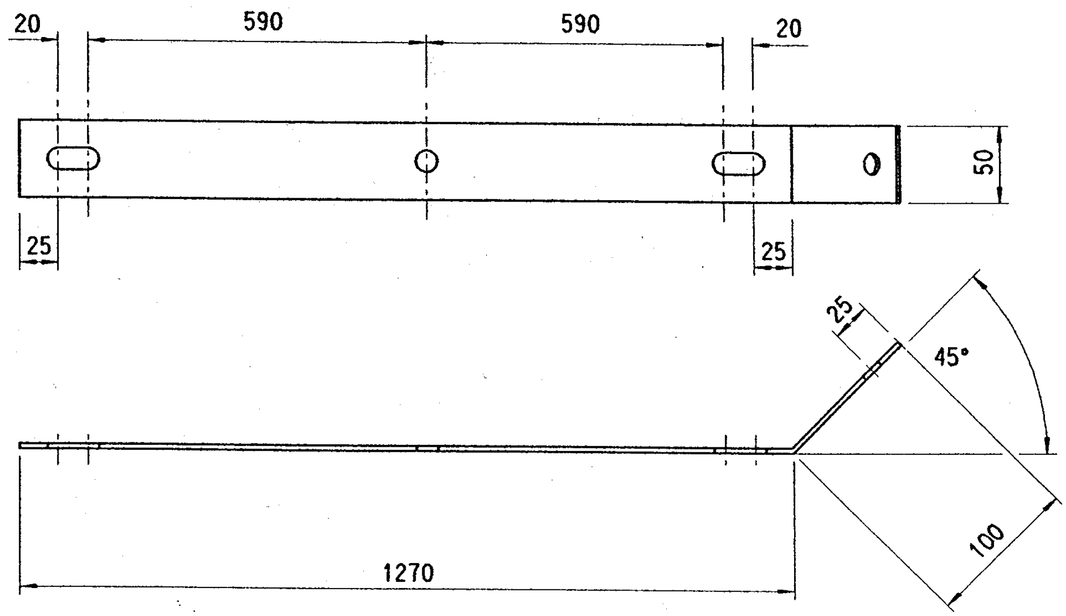
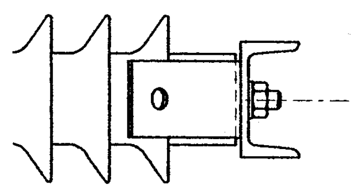


FIG 27
ASSEMBLY OF EARTHING STRIP FOR 11kV SURGE ARRESTERS





Notes
1. All dimensions in millimetres.
2. Material 50 x 3mm annealed plain copper strip to BS 1432.
3. All holes to be 14mm dia. All slots to be 14mm full rad.

FIG 28
EARTHING STRIP FOR 33kV SURGE ARRESTERS
H POLE ARRANGEMENT

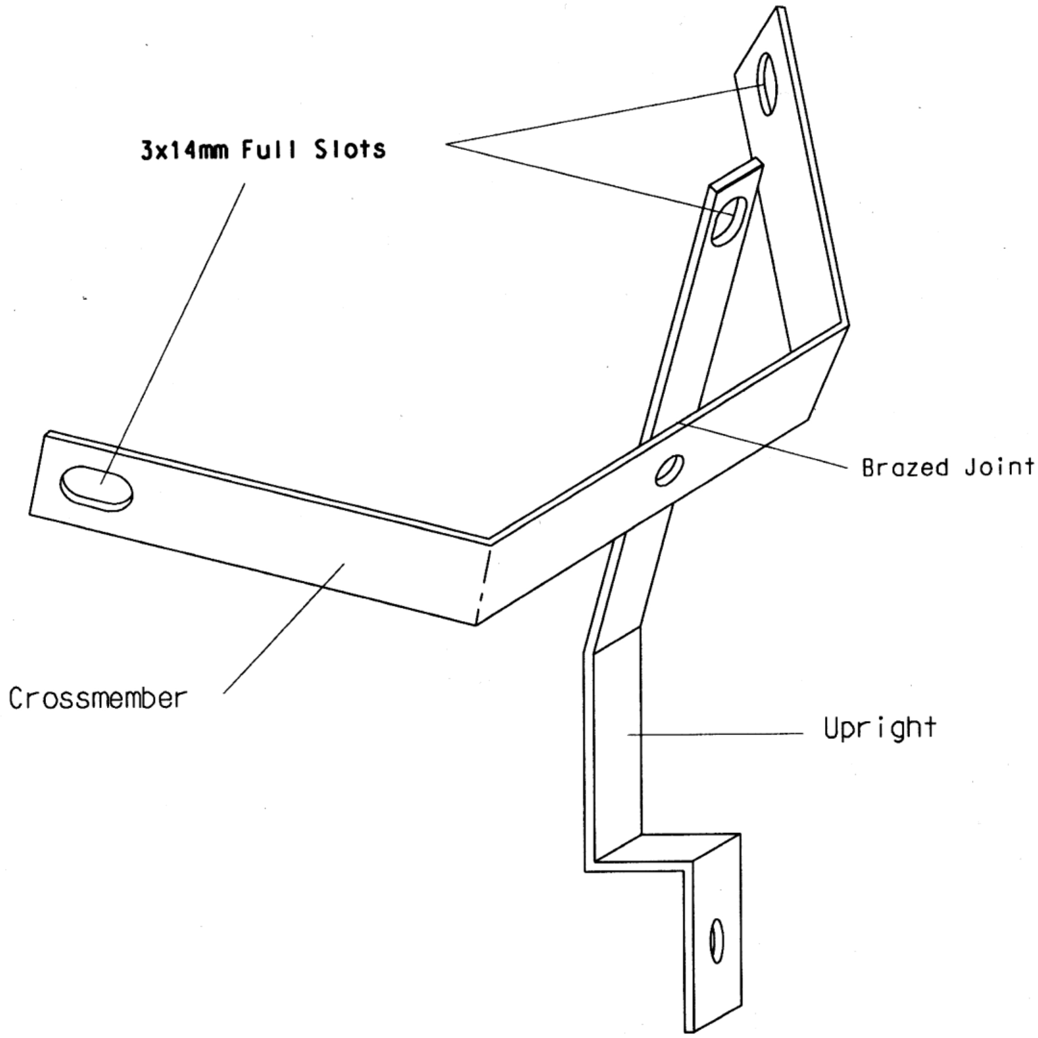
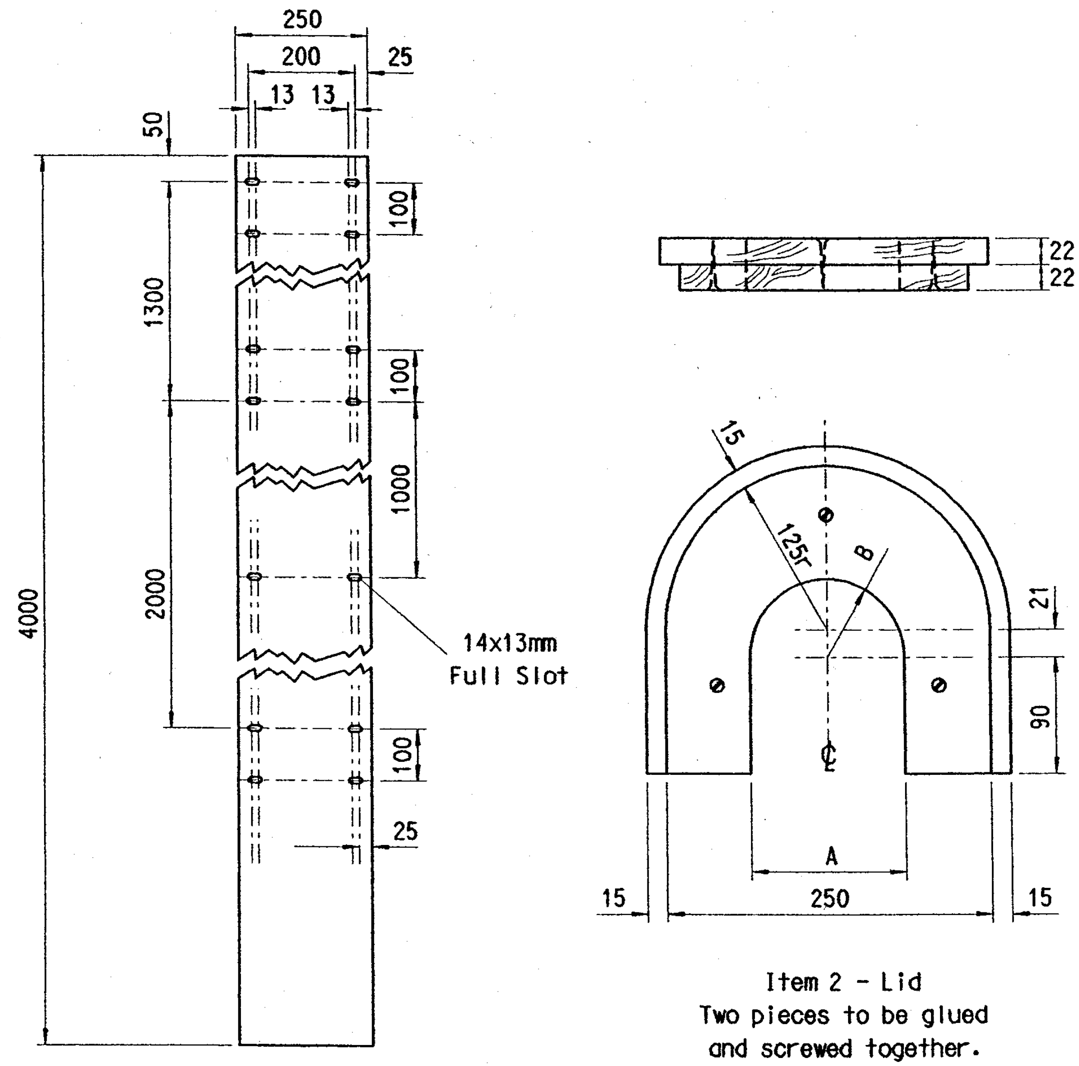


FIG 29
33KV SURGE ARRESTER EARTHING STRIP



Item 2 - Lid
Two pieces to be glued
and screwed together.

Item 1 - Backboard
250 x 50 Deal Board

3x185sq.mm s/c	A=120 B=60
3x400sq.mm s/c	A=130 B=65

Notes

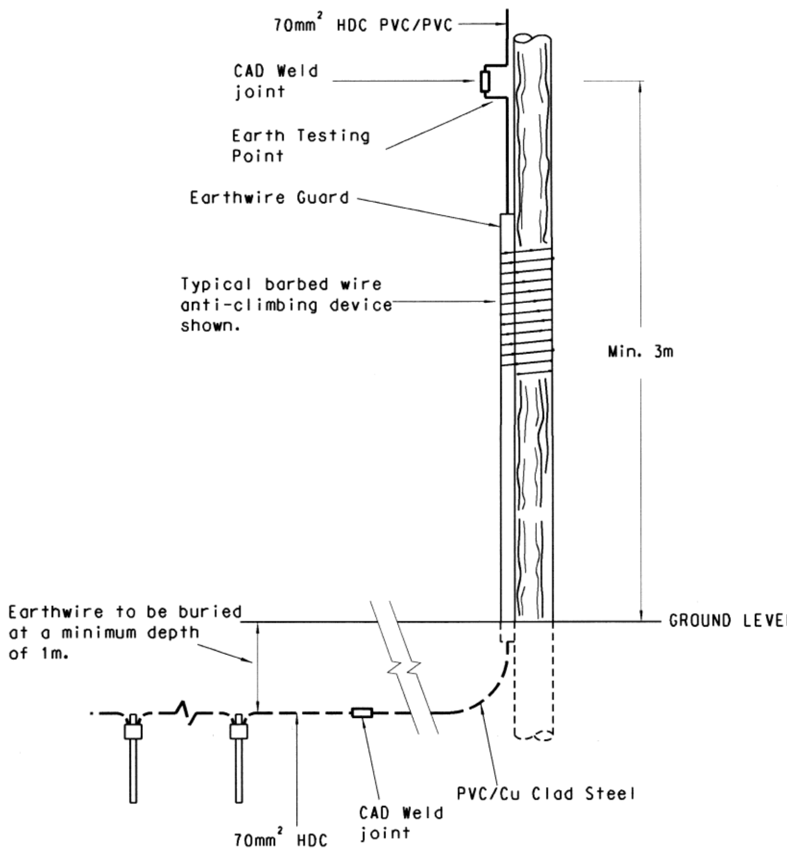
1. All dimensions in millimetres.
2. To be manufactured from Deal, timber to be straight grained and free from large shakes and knots.
3. To be creosoted to BS 913 after manufacture.

FIG 30
33kV CABLE BACKBOARD AND LID
H POLE ARRANGEMENT

TRANSFORMER LV WIRING AND FUSE SIZES			
Transformer Rating (kVA)		**Transfer Secondary Wiring (mm²)**	**Standard Fuse Size (BS 88 Part 5)**
5 to 16	2 Wire	32	100A
25	2 Wire	70	160A
25	3 Wire	32	100A
25	4 Wire	32	100A
50	2 Wire	120	315A
50	3 Wire	70	160A
50	4 Wire	70	160A
100	3 Wire	120	315A
100	4 Wire	70	200A
200	4 Wire	120	315A
315	4 Wire	either 2x 120 or 1x 185	either 2x 315A or 1x 400A

Note: - 95mm² ABC may be used instead of 70mm² Copper
50mm² ABC may be used instead of 35mm² Copper

ALTERNATIVE ARRANGEMENT FOR EARTHING



The above diagram shows the general arrangement for main earthing conductors in areas where the risk of theft is greater than normal. The diagram does not show the earthing system (see ST: TP 21D) or connections to the equipment.

This design is used in order to provide a deterrent, whilst allowing for standard working practices to be used when making the connections to the equipment etc.

The design consists of a length of copper clad steel joined at both ends to 70mm² hard drawn copper. A minimum length of 4m of the copper clad steel will be required if the earthing system is to be constructed at the base of the pole, this will be increased to 13m (9+4=13) when used to connect an earthing system which is segregated from the pole.

The joints are to be made at ground level using Exothermic Welding techniques (CadWeld) as described in ST: TP 21L.

Once the joints have been made the section of PVC copper clad steel conductor shall be attached to the pole ensuring that it extends to a distance of at least 3m up the pole and 1m into the ground. The remaining connections to the equipment etc can then be made using standard methods such as crimping etc.

The following table provides the Shops number for the equipment to be used.

Description	Shops No
Copper Clad Steel Conductor	42344
Mould GFC-P100-Y4	42525
Frame/Handle Clamps L160 (Part No 161000)	42526
Cadweld Plus Control unit (Part No 165745)	42528
20 X No 65 Welding Cartridge (Colour powder sachet Green)	42527
Tool Set including Gloves, Cleaning Brush and Steel Wire Brush	42529

MAXIMUM RESISTANCE

The following information has been taken directly from section 4 in ST:TP21D.

11kV and 6.6kV

The resistance of 11kV and 6.6kV earthing systems shall, as far as reasonably practicable, be no higher than:

- 20 ohms for 11kV earthing systems.
- 15 ohms for 6.6kV earthing systems.

It is recognised that at some sites with particularly high soil resistivities it may not be reasonably practicable to satisfy the above criteria. This is deemed to be the case where the electrode extends for a distance of 200m or more from the installation without reaching the required resistance. In such cases an earth resistance of up to 40 ohms may be accepted as long as the equipment is protected by sensitive earth fault (SEF) protection. In Peterson Coil earthed systems the SEF protection only has to be in service when the Peterson Coil is shorted.

LV Earthing Systems

The resistance of LV earthing systems shall be:

- No higher than the maximum allowable resistance for the associated HV earthing system and;
- No higher than 20 ohms where PME or PNB earth terminals are to be made available.

PME Earth Electrodes
The earth resistance of individual PME earth electrodes shall be 100 ohms or less.

APPENDIX F

SUPERSEDED DOCUMENTATION

This document supersedes ST:OH4H/4 dated December 2012 which should now be withdrawn.

APPENDIX G

ASSOCIATED DOCUMENTATION

ST: TP 21D The manual of Earthing Practices
ST: TP 210 Measurements Associated with Earthing System
ST:OH 4M Anti-Climbing Guards

APPENDIX H

IMPACT ON COMPANY POLICY

This revision allows for a standardised approach to be used for the majority of enquiries that relate to the connection of embedded generation. Section 16 within this document supersedes the interim GA drawings 16.4.1 & 16.4.2 sent out in Dec 13

The revision also introduces the surge arrestor adaptor plate so that the cable and oh line can be disconnected independently from one another whilst still maintaining the CME's at the surge arrestor.

APPENDIX I

IMPLEMENTATION OF POLICY

Implementation Actions
Planning Engineers – Need to refer to section 16 when providing a Point of Connection for the connection of Embedded Generation, when a standard connection cannot be obtained

Team managers to Brief out the constructional requirements of Section 16 and the requirement for a surge arrestor adaptor plate to Planning Engineers Wayleave Officers, Technicians, Linesmen & Jointers.

APPENDIX J

KEY WORDS

Auxiliary Equipment, Wood Pole