Electricity Distribution

nationalgrid

Company Directive

STANDARD TECHNIQUE: OH4K/1

Relating to the Design of Insulated Aerial Bundle Conductor For LV Overhead Distribution Systems

Author: P Hooper

Implementation Date: September 2007

Approved by P J Wan

Policy Manager

Date: 13-09-07

All references to Western Power Distribution or WPD must be read as National Grid Electricity Distribution or NGED

Document Revision & Review Table		
Date	**Comments**	**Author**
26/02/2013	1. Page numbering in contents page amended. 2. Section 2 Safety – Reference to ST:OH5D added. 3. Section 11.1 Planning - paragraph added to clarify the requirements when retaining 'G', 'S' and 'L' poles. 4. Section 11.2 Replacement of Poles - paragraphs added / amended to clarify when poles shall be replaced.	Mike Chapman
28/08/2013	Section 11.2 - clarification that staff who test and assess will be suitably trained and competent	Paul Jewell

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FORWARD

Aerial Bundled Conductors (ABC) are made up of compact circular stranded hard-drawn aluminum conductors insulated with a single layer of cross-linked polyethylene. The conductor bundle is self supporting. All the connections are insulated making the complete system effectively insulated.

1.0 SCOPE

This standard technique sets out the requirements for the use of ABC. Where practicable ABC shall be used in place of open-wire LV distribution systems in the following circumstances:-

- Where existing LV lines are to be refurbished.
- Where two wire systems are to be converted to four wire systems
- Where a diversion of an existing line is needed for two or more spans.
- New LV lines or extensions

2.0 SAFETY

Any work carried out on an ABC system shall be in accordance with Section 8 of the Distribution Safety Rules and ST:OH5D.

3.0 CLEARANCES

3.1 General

All ABC overhead lines shall be designed for a hot curve temperature rating of 75ºC (See Appendix A).

Clearances shall be in accordance with POL:OH1. Where temporary building work or scaffolding infringes these clearances the ABC bundle must be protected with temporary shrouding such as PLP Treeguard.

3.2 Clearance from Trees

Bundles through trees require a reduced ‘corridor’ when compared with open-wire systems. However, under no circumstances must mature branches be allowed to come into contact with the bundle.

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Where the ABC bundle is close to trees or within 3m of any part of the tree which could provide unathorised access to the bundle (eg children climbing etc), it shall be sheathed with a PLP "tree guard" or equivalent, to provide mechanical protection.

4.0 CONDUCTORS

4.1 Types and Sizes

Aerial Bundle Conductors shall be to ESI Specification 43-13 and the following sizes shall be used

- 50 sq mm 2 conductor bundle
- 50 sq mm 4 conductor bundle
- 95 sq mm 2 conductor bundle
- 95 sq mm 4 conductor bundle
- 120 sq mm 4 conductor bundle.

4.2 Span Lengths

ABC shall be erected with:-

- A basic Span of 50 metres
- A Maximum Span of 90 metres

4.3 Erection sag

Erection sags and tensions are in tables 2, 3 and 4 appendix A.

5.0 POLES

5.1 Pole Fabrication

Poles shall be fabricated as shown on drawing 43-12/14 (ST:OH4T in part 1 of the overhead line manual). Pole sizes and ultimate loadings are as stated in BS 1990.

5.2 Factor of Safety

A factor of safety of 2.5 shall be applied to supports in normal locations. In exposed costal areas and in areas where the wind speed regularly exceeds 50 mph (380 N/mm²) the factor of safety shall be increased to 3.0.

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5.3 Un-stayed Poles

The minimum class of support to be used shall be a Medium class pole. Charts 1 and 2 shall be used in the selection of pole sizes for various deviations and wind loaded spans.

Where a service is to be attached to an un-stayed pole, care must be taken to ensure that the pole is capable of accepting the additional load. Where this is not the case the pole foundations may need to be enhanced as shown in fig 1.

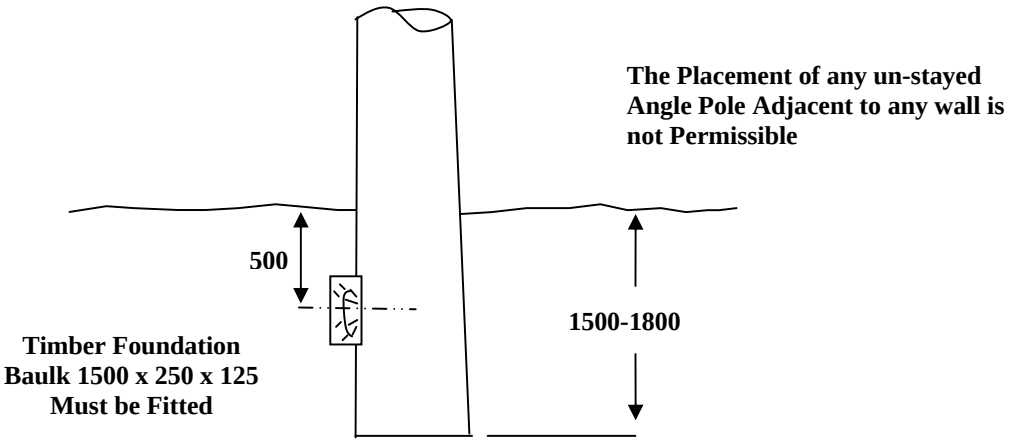

Fig 1

5.4 Stayed Poles

Charts 3 and 4 provide the selection data for stayed poles with a factor of safety of 2.5. Where the pole is in an exposed position and the factor of safety has been increased to 3.0 charts 5 and 6 shall be used.

6.0 STAYS

6.1 Stay Assembly

Stay assemblies shall be in accordance with ST:OH4L.

6.2 Stay Sizes

The following 1150 grade stay strand shall be used:-

- 7/3.25mm (Type 1) with a safe working load of 26kN
- 7/4.00mm (Type 2) with a safe working load of 40kN

6.3 Stay Angles

The angle between the pole and stay shall be within a range of 20°- 45°. Stay spreads are shown in chart 7.

6.4 Stay Insulators

Type 1 stay insulators shall be fitted in all stays associate with ABC lines.

6.5 Out of Balance Stays

At poles supporting both open-wire conductors and ABC bundles it will be necessary to provide an additional stay to cater for the out of balance loading imposed on the pole.

Typical tensions at 10°C for ABC bundles and 4 wire open-wire systems are given in the table below.

Conductor	**Tension kgf**
50 mm² ABC 2 Core	90
50 mm² ABC 4 Core	268
95 mm² ABC 2 Core	246.9
95 mm² ABC 4 Core	497
120 mm² ABC 4 Core	497
16 mm² HD Copper (3/0.104 inch²)	280
32 mm² HD Copper (3/0.147 inch²)	1020
70 mm² HD Copper (7/0.136 inch²)	1392
50 mm² Aluminium (7/0.122 inch²)	808
100 mm² Aluminium (7/0.137 inch²)	1072

7.0 ELECTRICAL CONNECTIONS

7.1 General

Only approved insulated connectors shall be used on ABC lines. These are listed in ST: OH 10A.

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7.2 Branch Connections

Branch connections shall be made using insulation piercing connectors (IPC's). IPC's should not be removed once they have been installed.

Care should be taken to ensure that cut ends of branch connectors are pushed fully home in to the end cap provided with the IPC.

7.3 Through Connections

Insulated compression joints shall be used at ABC section positions and for connection to open wire systems.

7.4 Conductor End Seals

All exposed cut ends of ABC cores shall be fitted with an end seal.

8.0 POLE FITTINGS

8.1 General

All fittings supporting ABC systems shall be in accordance with ESI specification 43-13.

8.2 Anchor Clamps

Anchor clamps shall be fitted in such a manner as to ensure that only the insulated jaws come into contract with the conductor's insulation.

Insulated cable tie supports can be used to keep the conductor's insulation away from any steelwork or stays.

8.3 Suspension Clamps

Suspension clamps are suitable for line deviations of up to 30° and for an uplift position on straight line poles where the vertical angle does not exceed 30°.

In situations where uplift can occur the suspension clamp should be captivated using keeper type suspension hook.

9.0 TRANSFORMER POLES

The phase cores shall be connected directly into the pole-mounted fuses.

The neutral core shall be removed from the bundle just above the fuses and connected directly on to the transformer neutral stem.

A length of ABC minus the neutral shall then be used for the phase connections between the transformer and the fuses.

10.0 SERVICES FROM ABC LINES

10.1 Services

ABC services shall be connected in accordance with ST: OH 6A.

10.2 Service Spans

The maximum aerial span for concentric service cable is:-

- 30m for single phase cables
- 20m for three phase cables

Where the spans exceed these values it will be necessary to erect a service pole with an ABC span.

10.3 Service Connections

All work shall be carried out in accordance with ST: OH 14A.

A maximum of four connections (i.e. two single phase or one three phase service) can be accepted on any one pole. Where more than four connections are required a Service Connection Box will be needed.

As it is not possible to check polarity with a test lamp on the main, polarity shall be confirmed at the service cut-out.

10.4 Service Disconnections

All work shall be carried out in accordance with ST: OH 14A.

For services connected directly to the ABC core the method of disconnection will be to:-

- Cut the phase core 150mm from the connector
- Fit an end seal over the stub end
- Do not remove the insulated piercing connector

Reconnection can be achieved by connecting the live stub using an insulate compression through joint.

10.5 Service Disconnection Box

A plastic, weatherproof connection box shall be used for multiple service connections of up to 9 phase and neutral service cores.

The box shall be attached to the pole using 16mm bolts or coach screws. Where possible the box shall be fitted above the ABC main to reduce the risk of damage by ladder etc.

To connect the Service Connection box to the ABC main 50 sq mm tails shall be used, with two insulation piercing connector's fitted on each side of the pole as shown in fig 2. The tails shall be supported with cable ties as necessary.

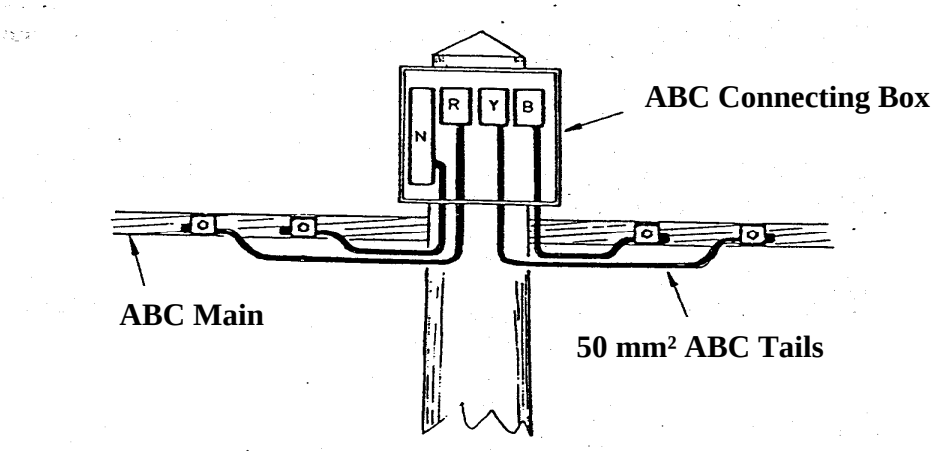

Fig 2

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Multi-purpose electrical grease should be applied to the conductor ends before fitting them into the terminals.

11.0 REFURBISHMENT OF EXISTING LINES

11.1 Planning

Where open-wire systems are to be replaced with ABC, an on site inspection should be carried in order to determine site specific problems prior to work commencing.

All 'G', 'S' and 'L' poles, if retained, shall be tested in line with ST:OH5B to ascertain their condition and that they are fit for purpose to meet the requirements of this ST prior to work commencing on site.

Whenever practicable the ABC bundle should be erected with the existing LV conductors live. If this is not possible then the work should be planned in such a way as to ensure that supply interruptions are kept to a minimum.

Prior to any work commencing a risk assessment in accordance with ST: HS 20A should be carried out.

11.2 Replacement of Poles

All decayed poles labeled 'D' shall be replaced prior to the open-wire network being replaced with ABC.

For business efficiency 'S' and 'L' poles shall normally be replaced as part of refurbishment work, however; subject to satisfactory testing and assessment as described in 11.1 above by a suitably trained and competent person, the project controller may decide that their continued use is safe and appropriate. In this case care shall be taken to ensure that these poles retain the correct classification in CROWN after the work has been completed.

Good poles 'G' shall be retained where possible and only replaced where they do not meet the requirements of this ST.

Replacement poles shall be of a size and at span lengths as detailed in paragraphs 4 and 5.

Do not cut off the pole heads of retained poles.

11.3 Replacement Stays

Older pattern stay rods plus any rods showing bad corrosion shall be replaced. In addition, even where stay rods are adequate, it will probably be necessary to replace all staywire and fixings.

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APPENDIX A

Table 1

ABC DESIGN CRITERIA					
	2x50 ABC	4x50 ABC	2x95 ABC	4x95 ABC	4x120 ABC
Greased Conductor Weight (kg/m)	0.35	0.70	0.65	1.30	1.63
Cross Sectional Area of Conductor (mm²)	100	200	190	380	480
Conductor Overall Diameter (mm)	24.5	29.5	32.5	39.0	44.0
Coefficient of Linear Expansion (/Degree C)	2.30E-05	2.30E-05	2.30E-05	2.30E-05	2.30E-05
Modulus of Elasticity (kg/mm²)	5491.20	5491.20	5491.20	5491.20	5491.20
Rated Breaking Strength of Conductor (kgf)	1549	3098	3119	6238	7910
Basic / Recommended Span (m)	50	50	50	50	50
Wind Pressure on Conductor (N/m²)	380	380	380	380	380
Radial Ice Thickness (mm)	4.75	4.75	4.75	4.75	4.75
Ice Density (kg/m³)	913	913	913	913	913
Absolute Maximum Working Tension (MWT) Limit (kgf)	371.76	743.52	748.56	1497.12	1898.40
Temperature at MWT Limit (Degrees C)	-5.6	-5.6	-5.6	-5.6	-5.6
Maximum "Everyday" Tension (EDT) Limit (kgf)	133.59	267.18	248.09	496.18	496.18
Temperature at EDT Limit (Degrees C)	10	10	10	10	10
Maximum Conductor Tension (MCT) (kgf) -6ºC	371.76	707.93	717.77	1080.27	1016.99
Maximum Conductor Weight (MCW) (kg/m)	0.75	1.17	1.16	1.90	2.29
Maximum Conductor Pressure (MCP) (kg/m)	1.32	1.51	1.63	1.88	2.07
Freezing Point Tension (FPT) (kgf) at 0 ºC	96.91	311.65	289.58	579.17	550.09

Table 2

ERECTION TENSION TABLE (kgf) Main Line 50m Basic Span					
Temp (°C)	50 mm² 2 Core	50 mm² 4 Core	95 mm² 2 Core	95 mm² 4 Core	120 mm² 4 Core
0	101	341.5	317.5	635	583.7
5	96.9	311.7	289.6	579.2	550.1
10	93.3	287.3	266.9	533.7	521.3
15	90	267.2	248.1	496.2	496.2
20	87	250.3	232.4	464.8	474.2
25	84.3	236	219.1	438.1	454.8
30	81.8	224	207.6	415.2	437.4

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Table 3

DESIGN SAG TABLE FOR 4 Core 50 and 95 mm² (Main Line)											
Cold Curve											
Temp	**Span Length (m)**										
(°C)	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**
-5.6	0.40	0.51	0.63	0.77	0.91	1.07	1.24	1.42	1.62	1.83	2.05
Hot Curve											
Temp	**Span Length (m)**										
(°C)	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**
75	0.90	1.14	1.41	1.70	2.03	2.38	2.76	3.17	3.60	4.07	4.56

Table 4

DESIGN SAG TABLE FOR 4 Core 120mm² (Main Line)											
Cold Curve											
Temp	**Span Length (m)**										
(°C)	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**
-5.6	0.55	0.70	0.87	1.05	1.25	1.46	1.70	1.95	2.22	2.50	2.81
Hot Curve											
Temp	**Span Length (m)**										
(°C)	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**
75	0.99	1.25	1.55	1.87	2.23	2.62	3.03	3.48	3.96	4.47	5.02

Table 5

DESIGN SAG TABLE FOR 2 Core 50mm² (Main Line)											
Cold Curve											
Temp	**Span Length (m)**										
(°C)	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**
-5.6	0.69	0.87	1.08	1.30	1.55	1.82	2.11	2.42	2.76	3.11	3.49
Hot Curve											
Temp	**Span Length (m)**										
(°C)	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**
75	1.08	1.36	1.68	2.04	2.43	2.85	3.30	3.79	4.31	4.87	5.46

Table 6

DESIGN SAG TABLE FOR 2 Core 95mm² (Main Line)											
Cold Curve											
Temp	**Span Length (m)**										
(°C)	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**
-5.6	0.40	0.51	0.63	0.77	0.91	1.07	1.24	1.42	1.62	1.83	2.05
Hot Curve											
Temp	**Span Length (m)**										
(°C)	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**
75	0.90	1.14	1.41	1.70	2.03	2.38	2.76	3.17	3.60	4.07	4.56

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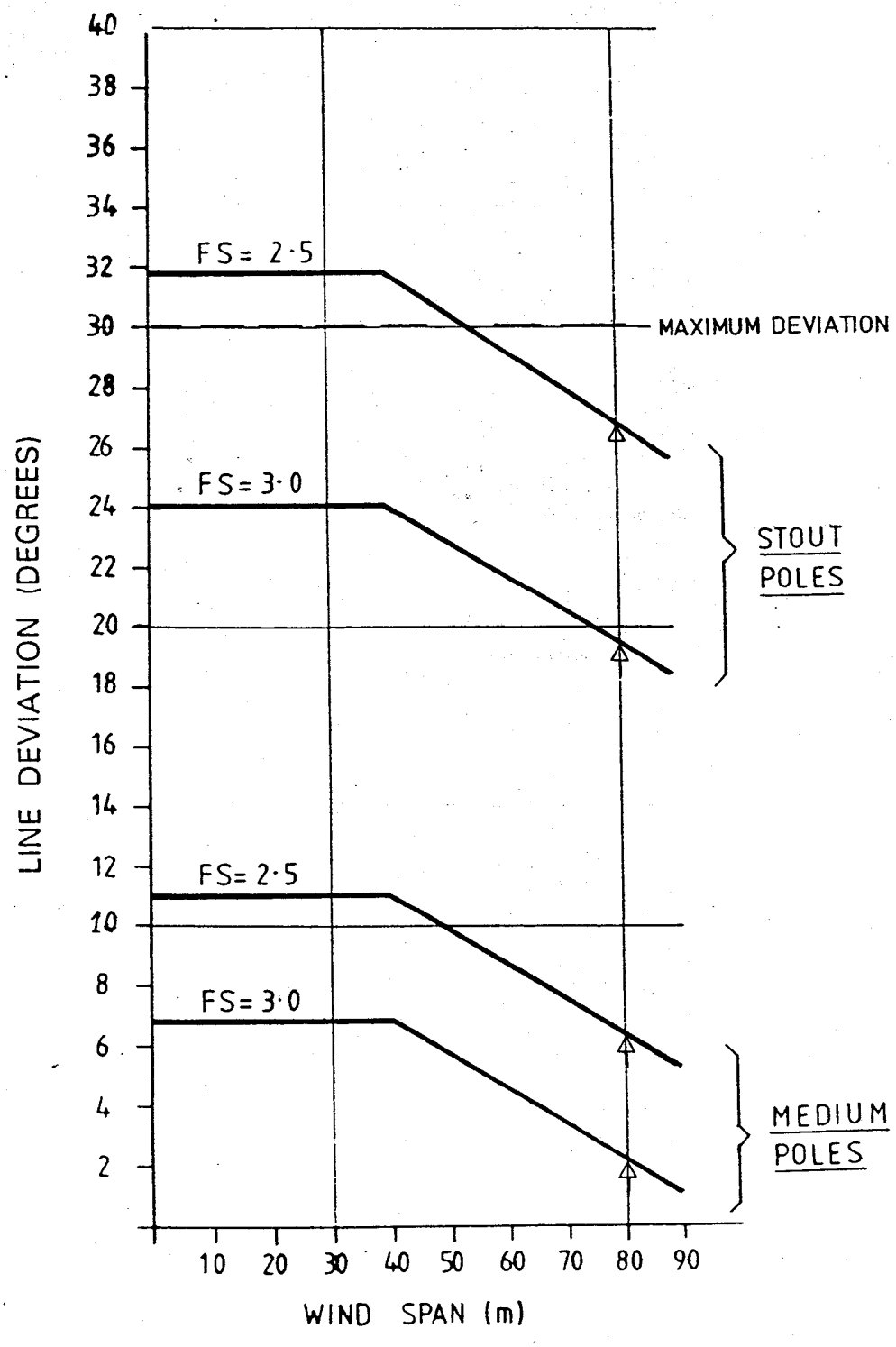
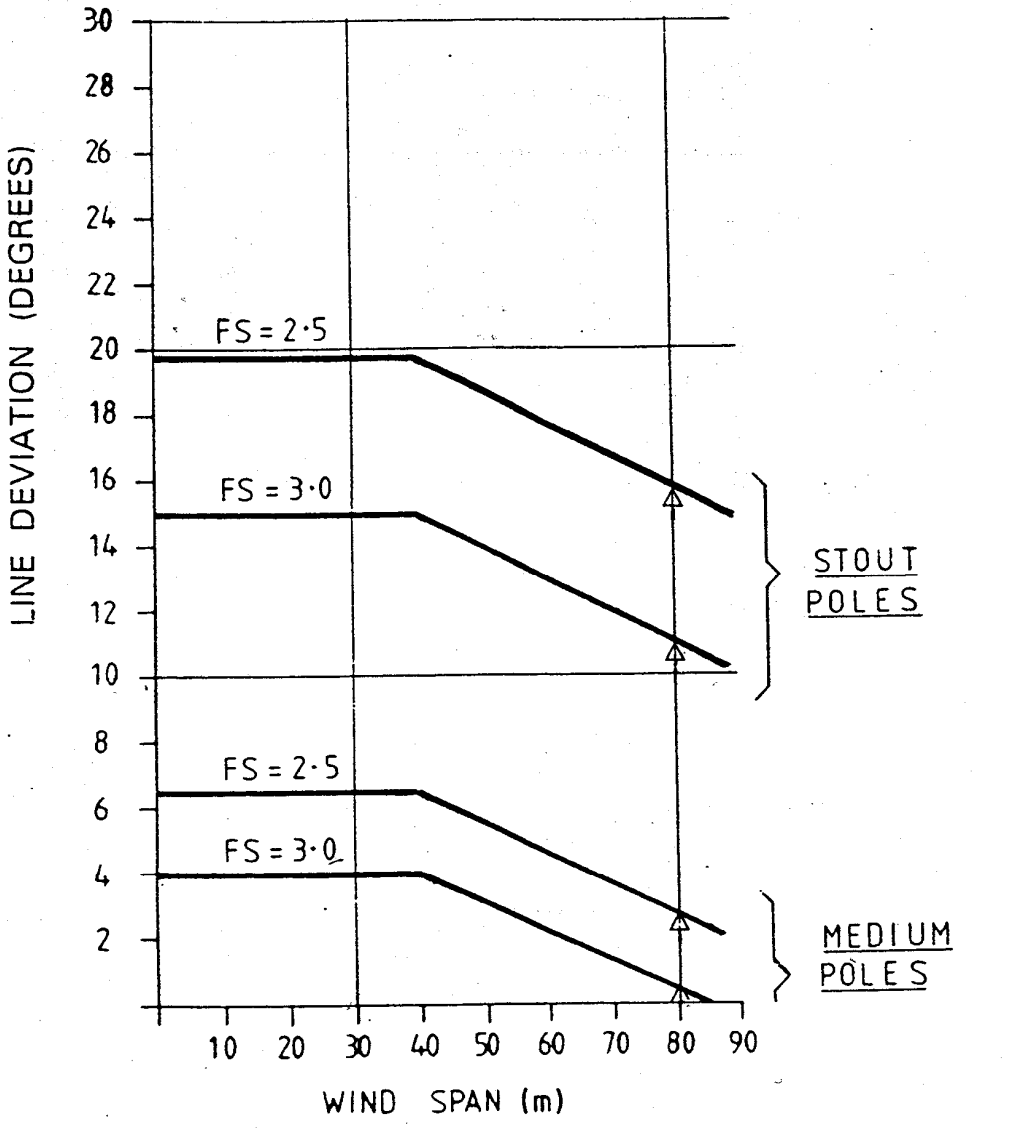


An allowance has been included in this chart for aerial service attachments.

Chart 1- Un-stayed Angle Pole Selection Chart
For 50 sq mm ABC



An allowance has been included in this chart for aerial service attachments.

Chart 2- Un-stayed Angle Pole Selection Chart
For 95 and 120 sq mm ABC

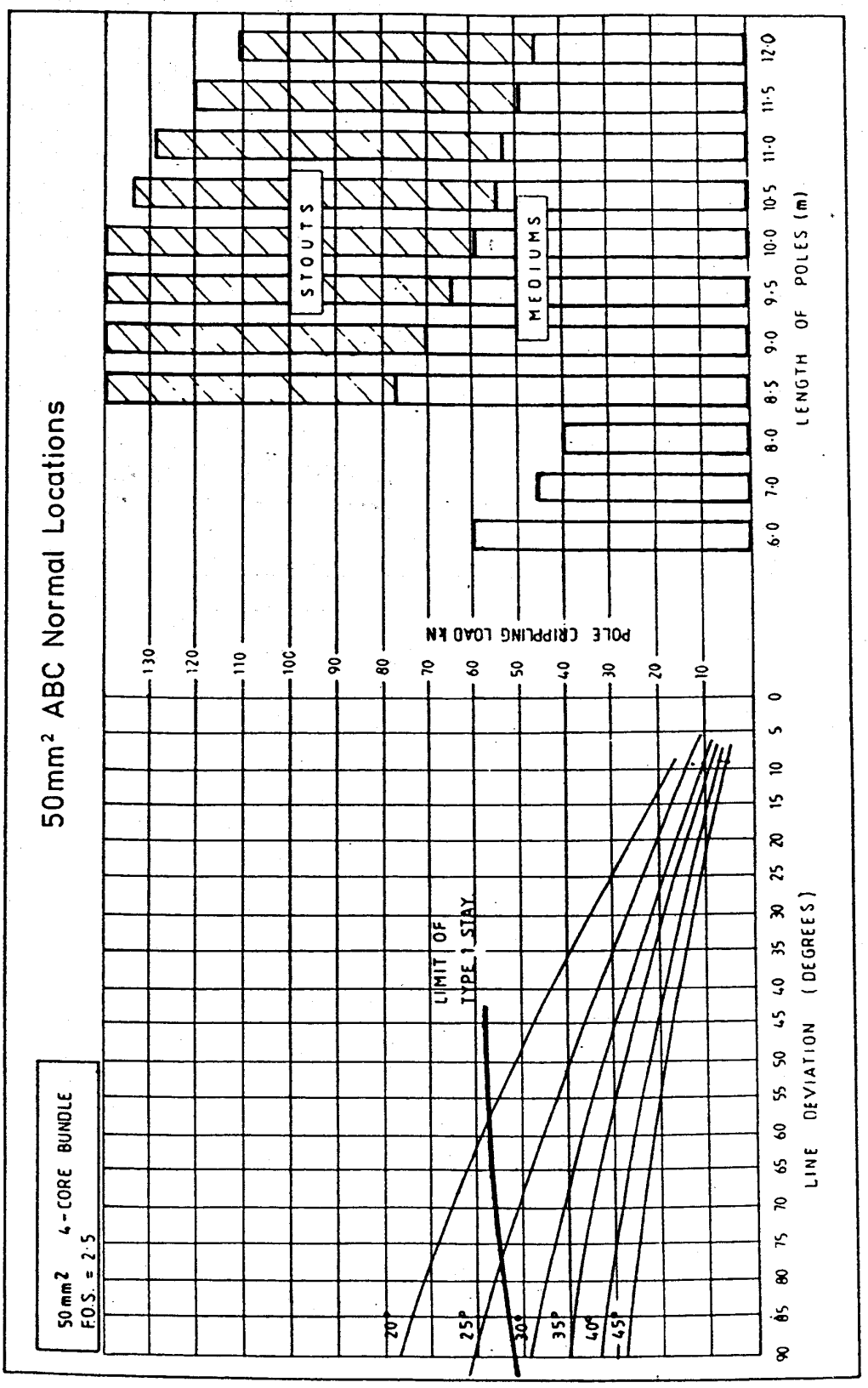


Chart 3- Stayed Pole Selection Chart For 50 sq mm ABC Normal Locations (F.O.S= 2.5)

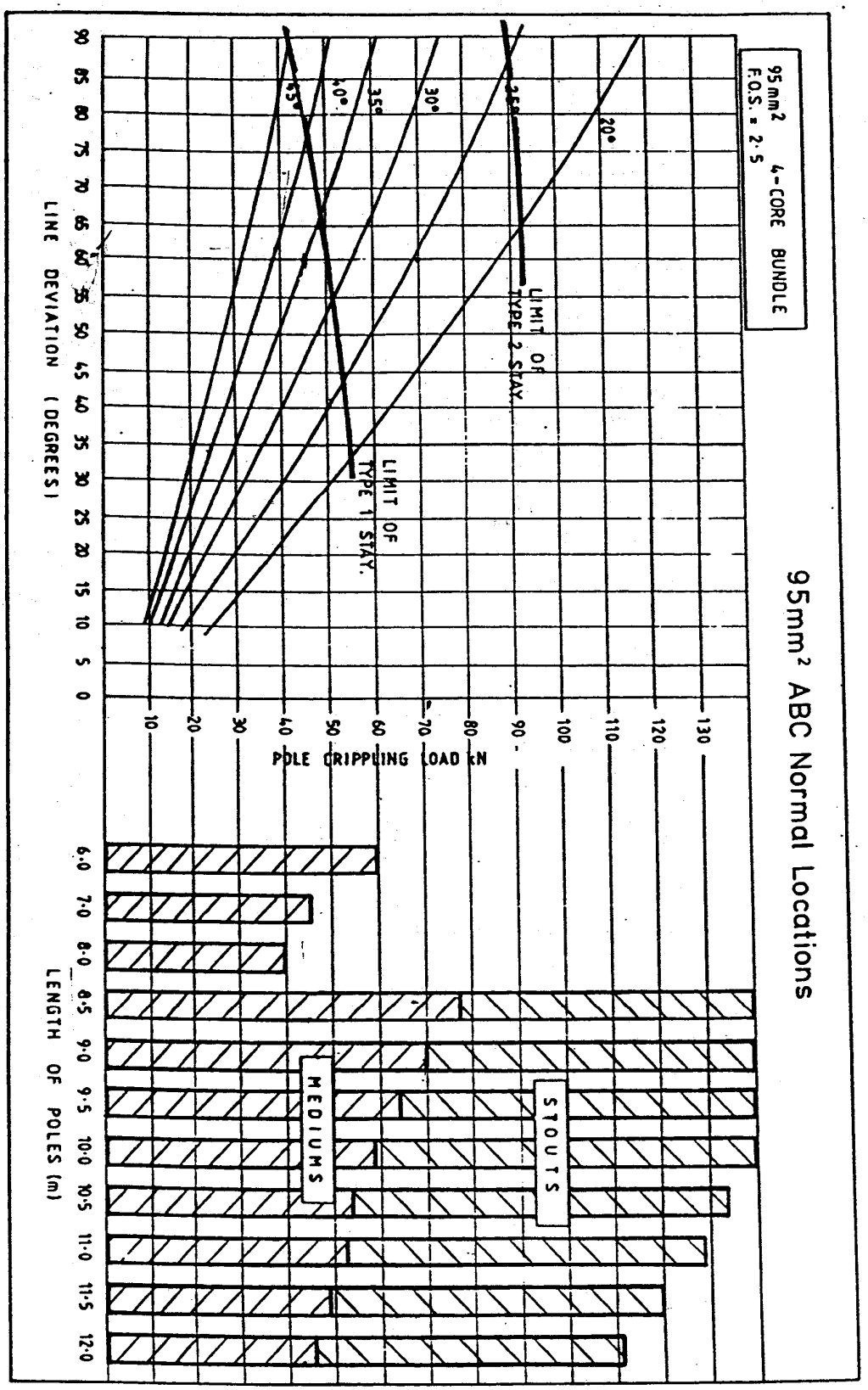


Chart 4- Stayed Pole Selection Chart For 95 and 120 sq mm ABC Normal Locations (F.O.S= 2.5)

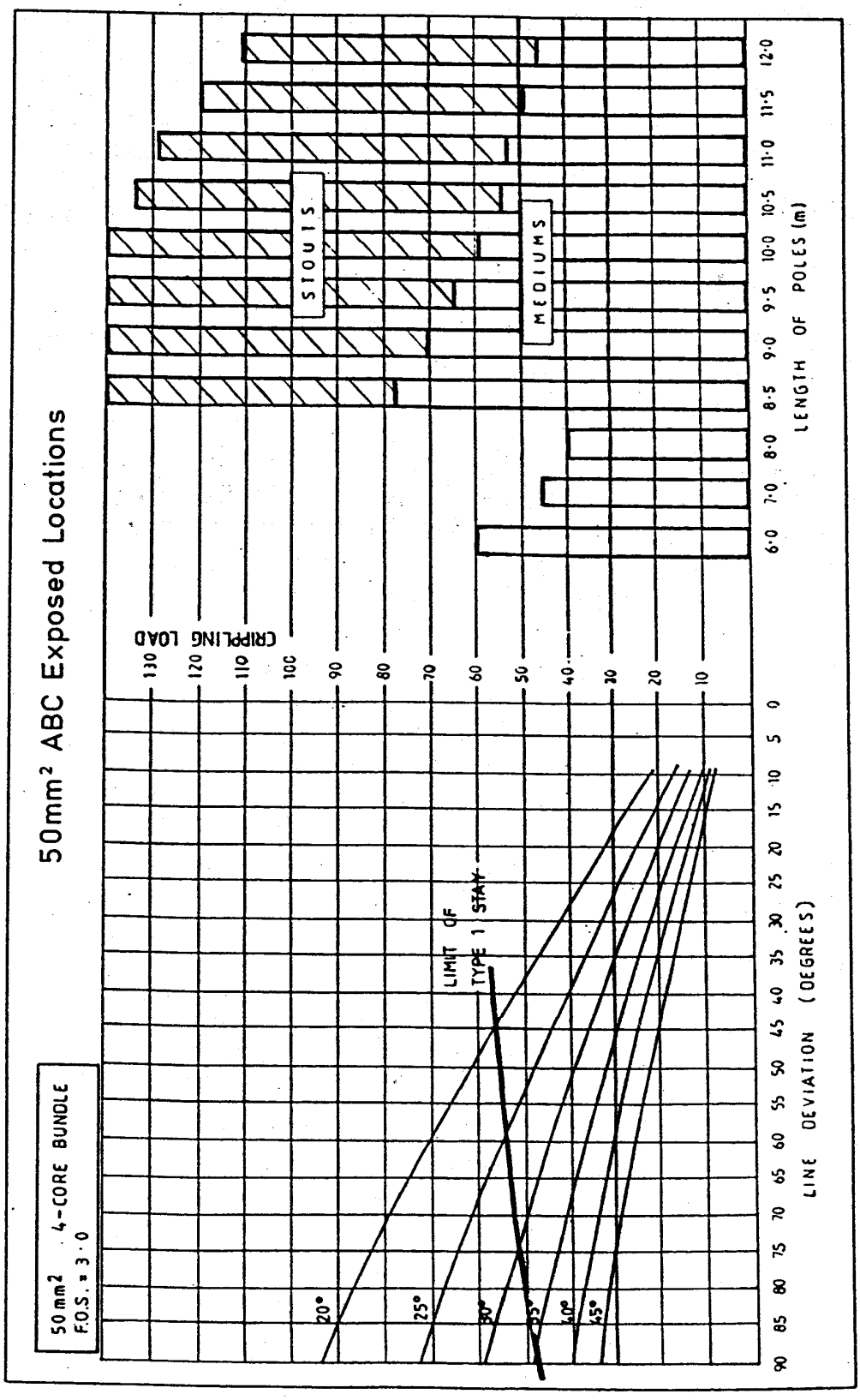


Chart 5- Stayed Pole Selection Chart For 50 sq mm ABC Exposed Locations (F.O.S=3.0)

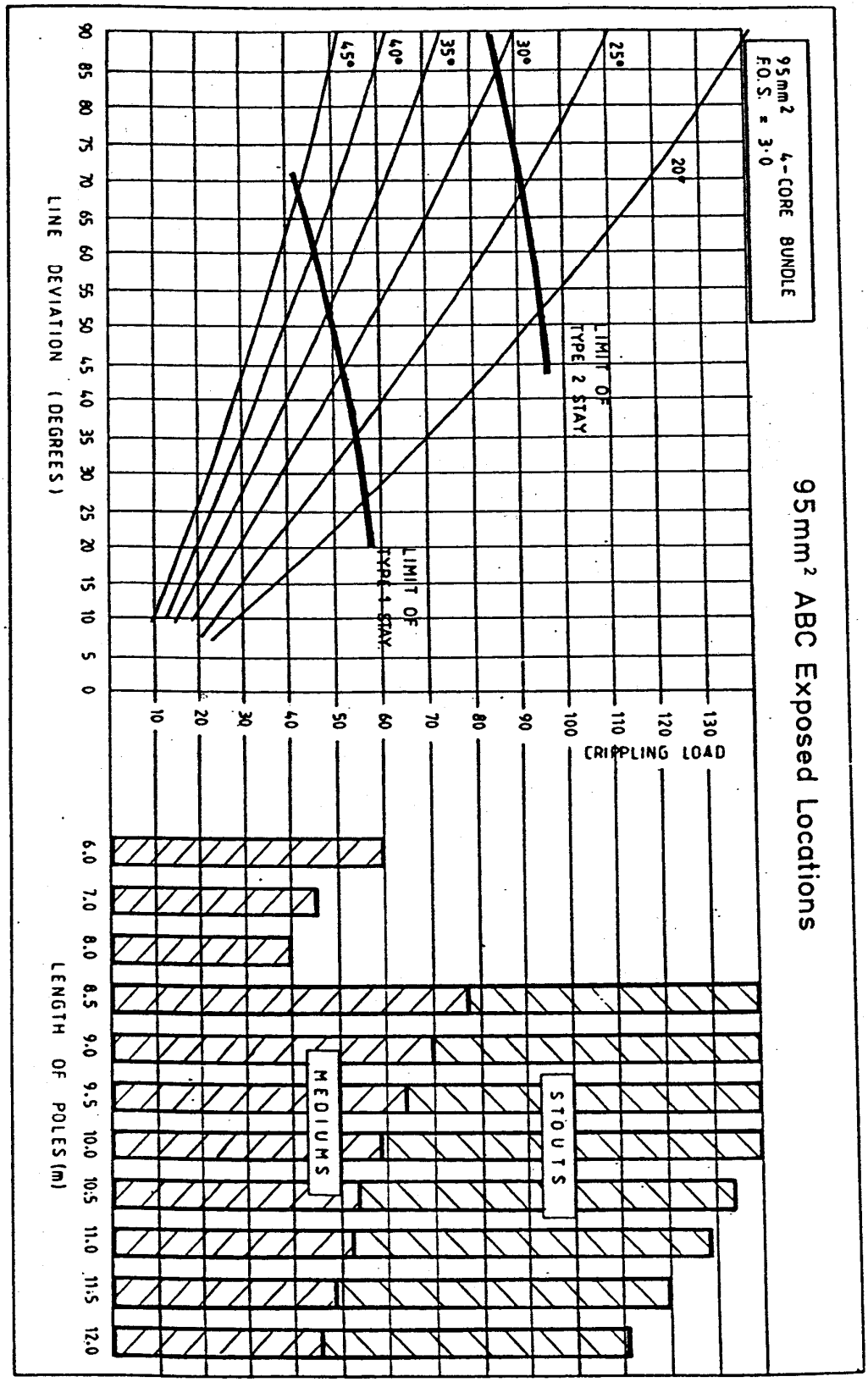
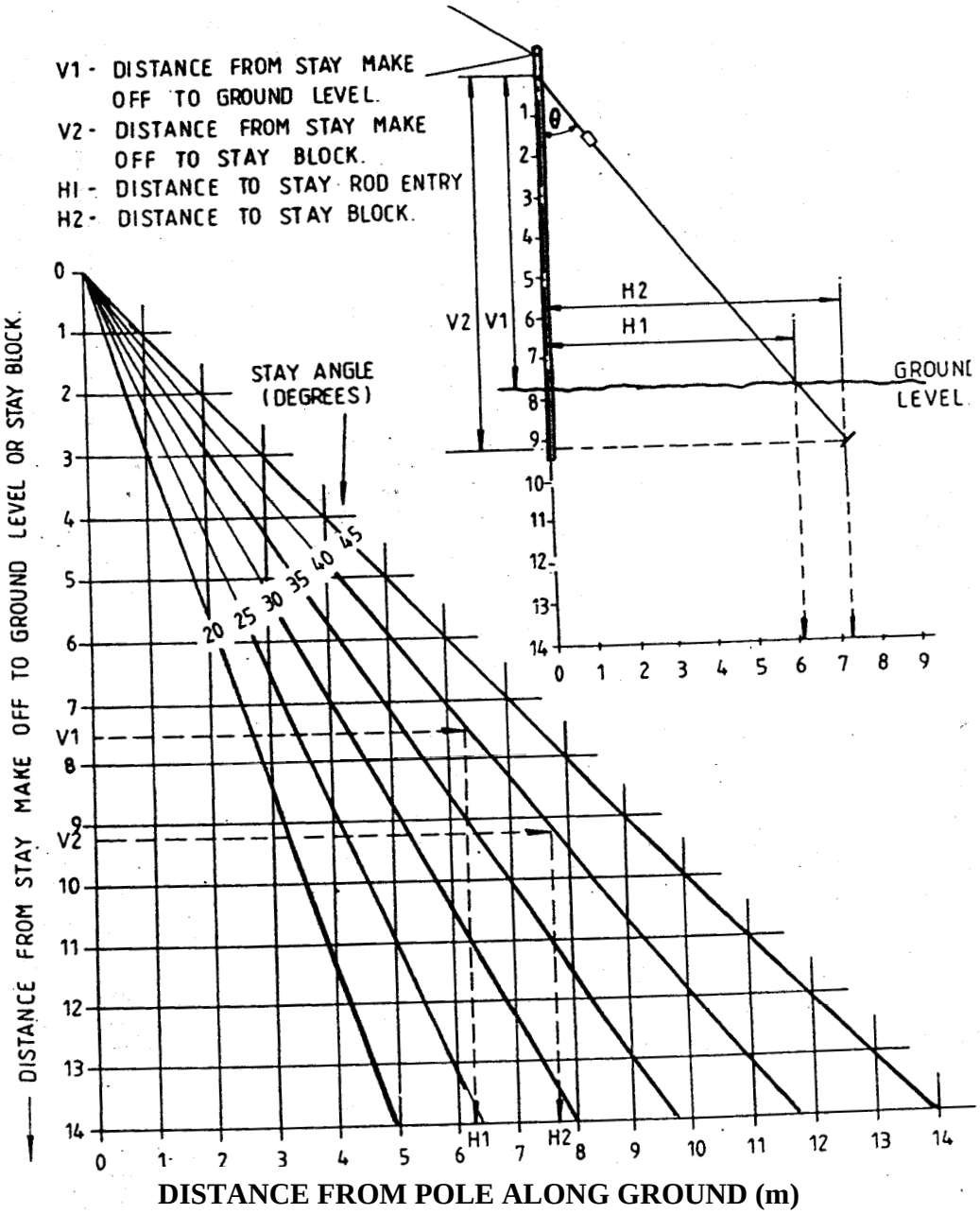


Chart 6- Stayed Pole Selection Chart For 95 and 120 sq mm ABC Exposed Locations (F.O.S = 3.0)



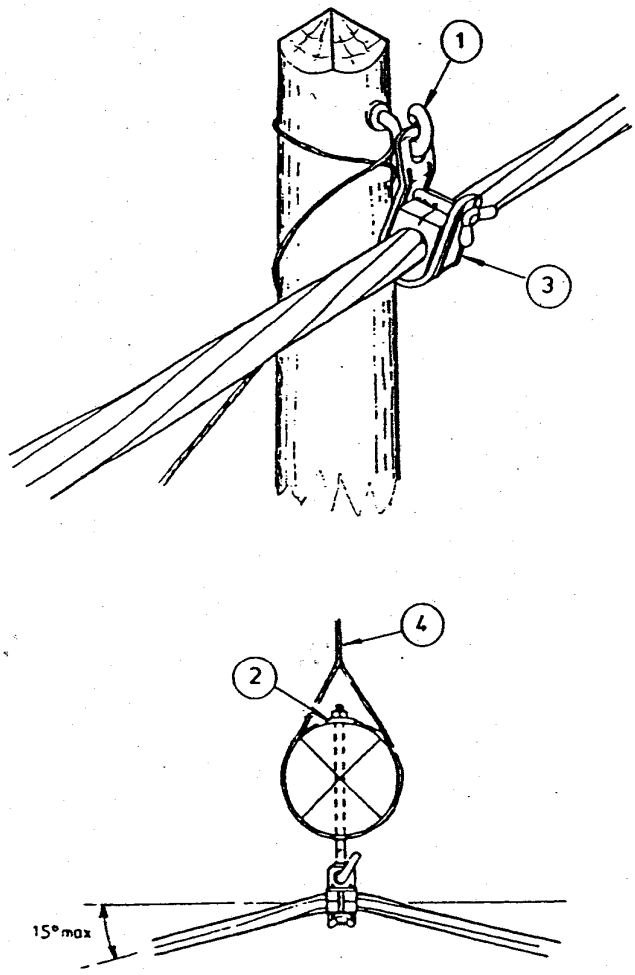
Notes:-

1. The stay slope should always be the greatest possible up to 45°

2. No stay slope shall be less than 20°

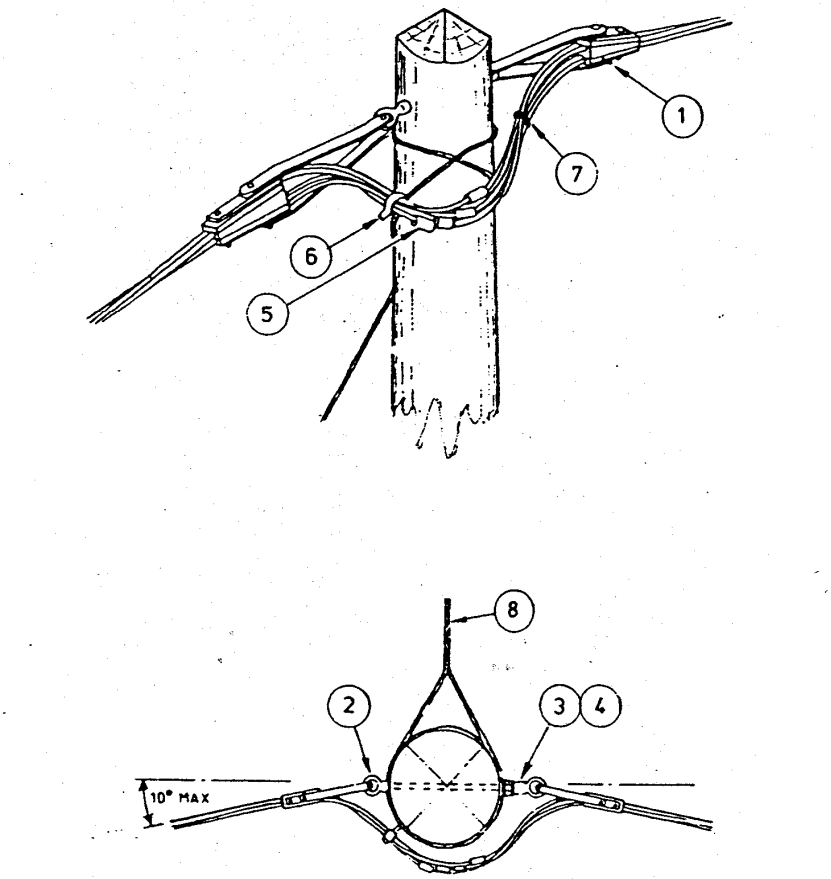
Chart 7 –Stay Setting Chart

APPENDIX C



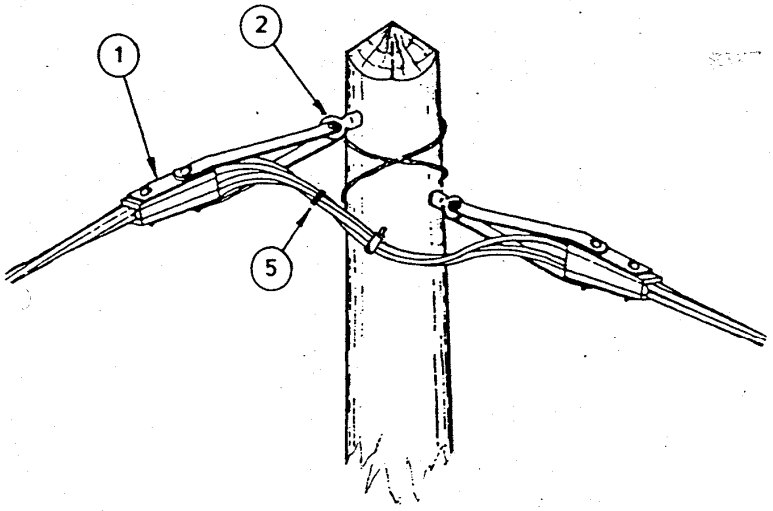
SCHEDULE 0F COMPONENTS			
Item No	**Description**	**Shops No**	**Quantity**
1	**Pig Tail Hook (200 mm) or Pig Tail Hook (300 mm)**	**37328**	**1**
2	**Square Washer Curved**	**30522**	**1**
3	**Suspension Clamp (50) or Suspension Clamp (95)**	**30195 30196**	**1**
4	**Stay Assembly**		**As required**

Fig 1 ABC Intermediate Pole, 0° - 30° Line Deviation

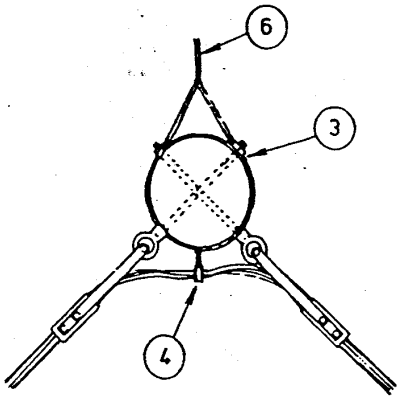


SCHEDULE 0F COMPONENTS			
Item No	**Description**	**Shops No**	**Quantity**
1	**Anchor Clamp (50) or Anchor Clamp (95)**	**30193 30194**	**2**
2	**Eye Bolt (200 mm) or Eye Bolt (300 mm)**	**30130 30131**	**1**
3	**Square Washer Curved**	**30522**	**1**
4	**Eye Nut**	**30138**	**1**
5	**Non- Tension Joint (50-50) or Non- Tension Joint (95-95)**	**30314 30315**	**4**
6	**Cable Tie Support**	**30210**	**As Required**
7	**Cable Tie**		**As Required**
8	**Stay Assembly**		**As Required**

Fig 2 ABC Running Section Pole, 0° - 20° Line Deviation

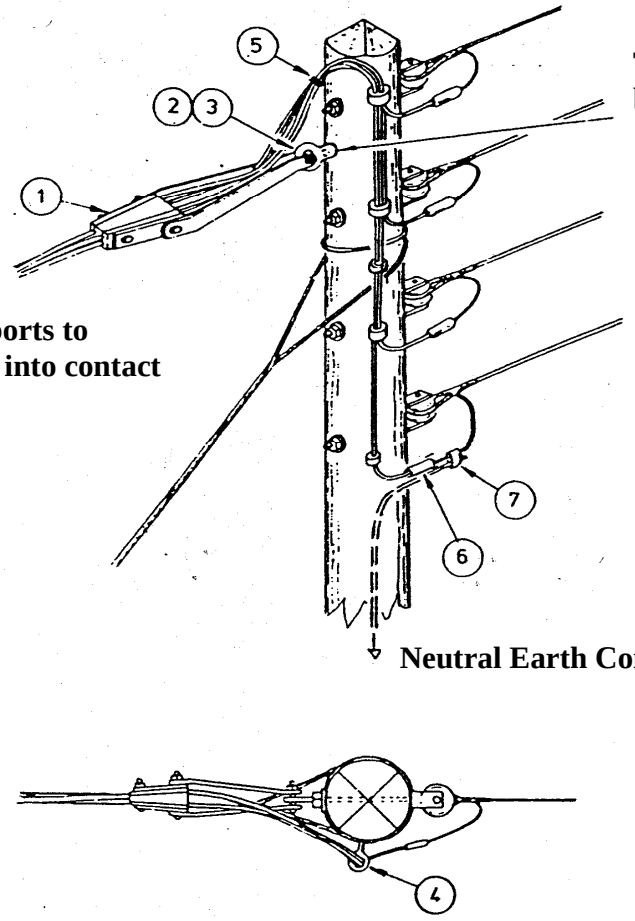


Separation of cross drillings to be a minimum distance of 100 mm between centres.



SCHEDULE 0F COMPONENTS			
Item No	**Description**	**Shops No**	**Quantity**
1	**Anchor Clamp (50) or Anchor Clamp (95)**	**30193 30194**	**2**
2	**Eye Bolt (200 mm) or Eye Bolt (300 mm)**	**30130 30131**	**2**
3	**Square Washer Curved**	**30522**	**2**
4	**Cable Tie Support**	**30210**	**As Required**
5	**Cable Tie**		**As Required**
6	**Stay Assembly**		**As Required**

Fig 3 ABC Running Section Pole, 20° - 90° Line Deviation



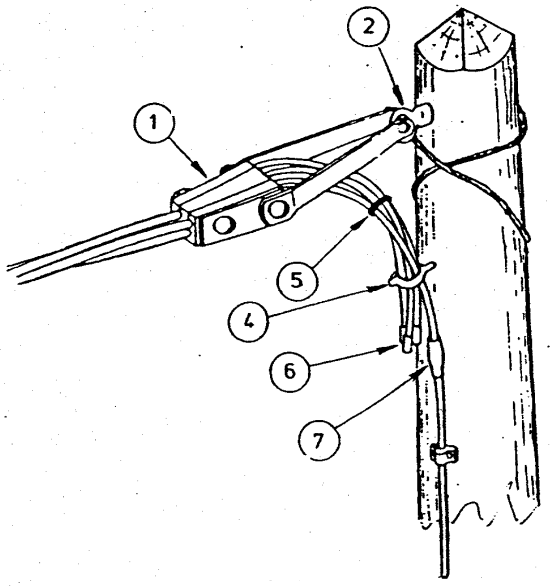
To be centrally positioned between existing fixings

Use sufficient bundle supports to ensure ABC can not come into contact with the stay make-off

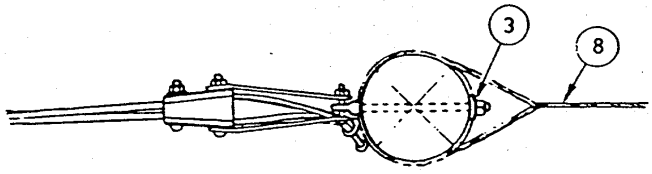
Neutral Earth Connection- where required

SCHEDULE 0F COMPONENTS			
Item No	**Description**	**Shops No**	**Quantity**
1	**Anchor Clamp (50) or Anchor Clamp (95)**	**30193 30194**	**1**
2	**Eye Bolt (200 mm) or Eye Bolt (300 mm)**	**30130 30131**	**1**
3	**Square Washer Curved**	**30522**	**1**
4	**Cable Tie Support**	**30210**	**As Required**
5	**Cable Tie**		**As Required**
6	**Non-tension Comp Joint**		**4**
7	**Crimp Comp Joint for Earth**		**1**

Fig 4 ABC to Open Wire Transition Pole

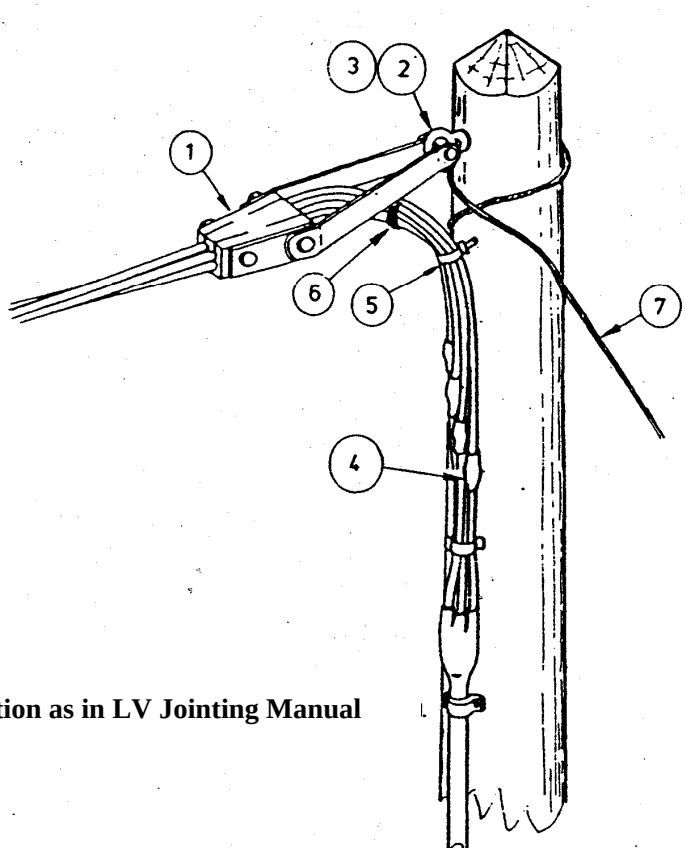


Neutral Earth Connection- for PME System



SCHEDULE 0F COMPONENTS			
Item No	**Description**	**Shops No**	**Quantity**
1	**Anchor Clamp (50) or Anchor Clamp (95)**	**30193 30194**	**1**
2	**Eye Bolt (200 mm) or Eye Bolt (300 mm)**	**30130 30131**	**1**
3	**Square Washer Curved**	**30522**	**1**
4	**Cable Tie Support**	**30210**	**As Required**
5	**Cable Tie**		**As Required**
6	**Comp End Seal**		**3**
7	**Non-tension Comp Joint**		**1**
8	**Stay Assembly**		**As Required**

Fig 5 ABC Terminal Pole



Cable Termination as in LV Jointing Manual

SCHEDULE 0F COMPONENTS			
Item No	**Description**	**Shops No**	**Quantity**
1	**Anchor Clamp (50) or Anchor Clamp (95)**	**30193 30194**	**1**
2	**Eye Bolt (200 mm) or Eye Bolt (300 mm)**	**30130 30131**	**1**
3	**Square Washer Curved**	**30522**	**1**
4	**Pole Termination 95ABC/70cu Pole Termination 50ABC/32cu**	**30319 30316**	**4**
5	**Cable Tie Support**	**30210**	**As Required**
6	**Cable Tie**		**As Required**
7	**Stay Assembly**		**As Required**

Fig 6 ABC Cable Pole

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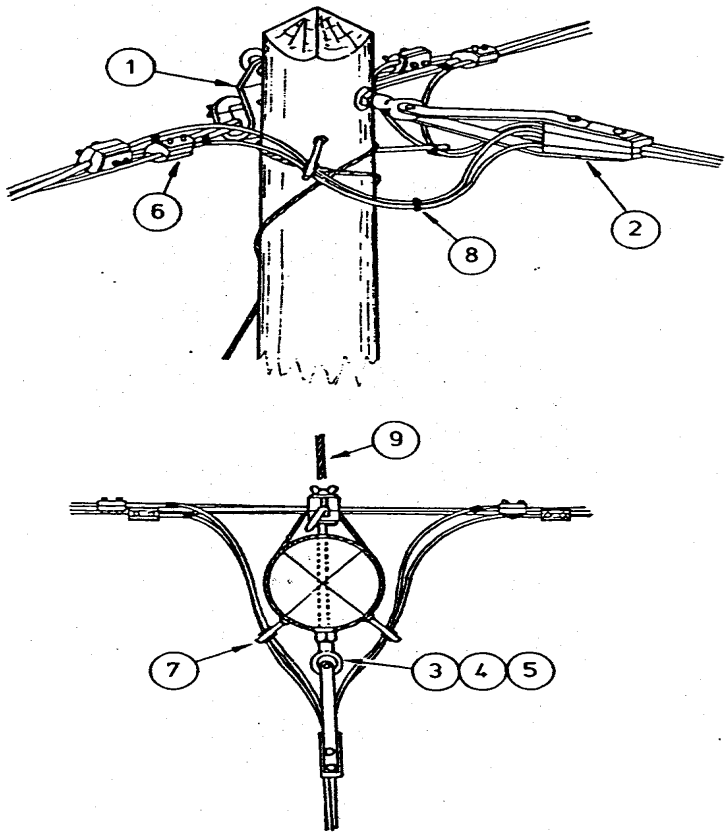
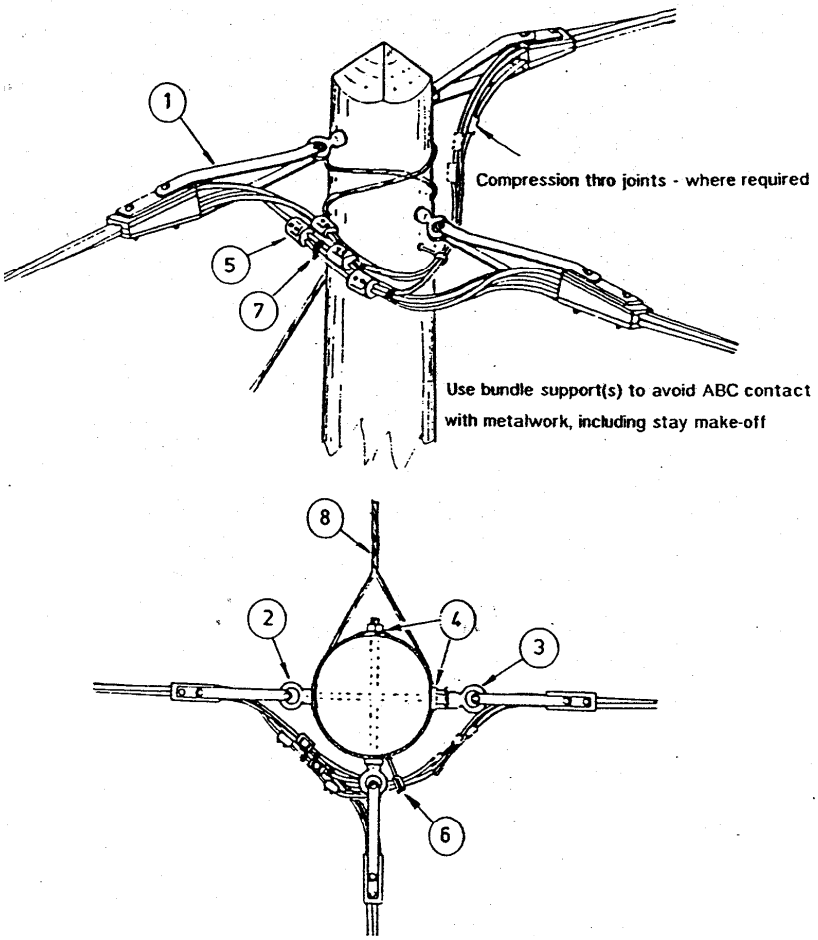


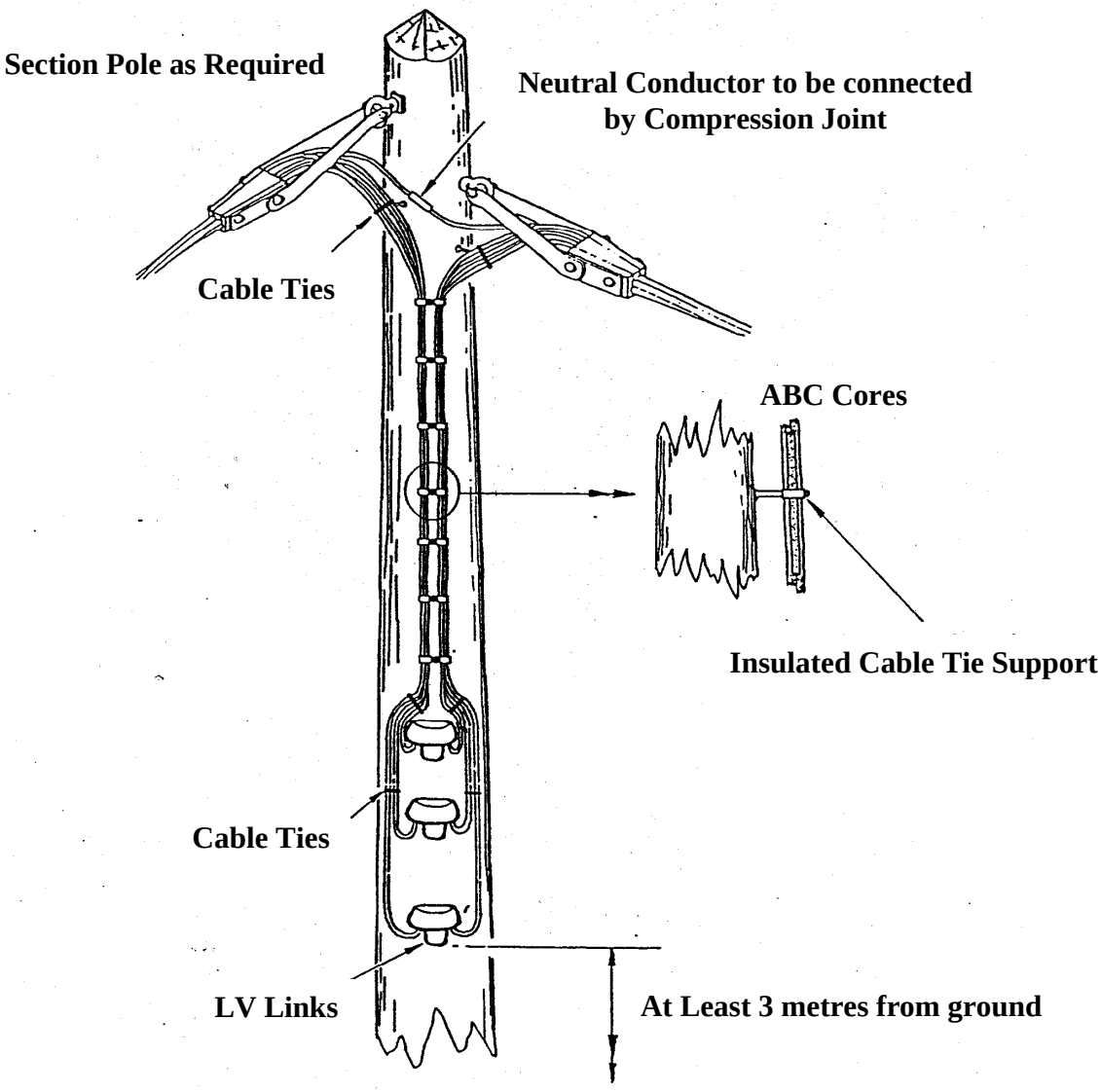
SCHEDULE 0F COMPONENTS			
Item No	**Description**	**Shops No**	**Quantity**
1	**Suspension Clamp (50) or Suspension Clamp (95)**	**30195 30196**	**1**
2	**Anchor Clamp (50) or Anchor Clamp (95)**	**30193 30194**	**1**
3	**Pig Tail Hook (200 mm) or Pig Tail Hook (300 mm)**	**37328**	**1**
4	**Eye Nut**	**30138**	**1**
5	**Square Washer Curved**	**30522**	**1**
6	**Insulation Piercing Connector**		**4**
7	**Cable Tie Support**	**30210**	**As required**
8	**Cable Tie**		**As required**
9	**Stay Assembly**		**As required**

Fig 7 ABC Tee-Off Intermediate Pole



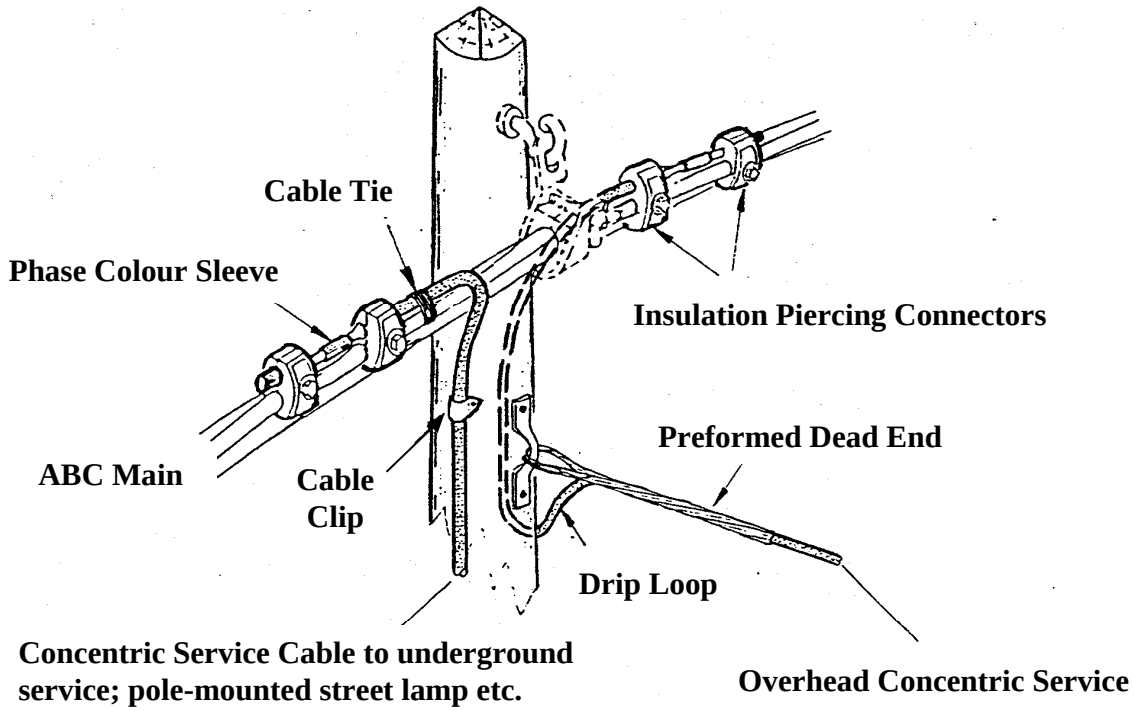
SCHEDULE 0F COMPONENTS			
Item No	**Description**	**Shops No**	**Quantity**
1	**Anchor Clamp (50) or Anchor Clamp (95)**	**30193 30194**	**3**
2	**Eye Bolt (200 mm) or Eye Bolt (300 mm)**	**30130 30131**	**2**
3	**Eye Nut**	**30138**	**2**
4	**Square Washer Curved**	**30522**	**2**
5	**Insulation Piercing Connector**		**4**
6	**Cable Tie Support**	**30210**	**As required**
7	**Cable Tie**		**As required**
8	**Stay Assembly**		**As required**

Fig 8 ABC Tee-Off Section Pole



Note:- Plastic Cable Guard can be used to protect cables down the pole in place of insulated supports as illustrated above.

Fig 9 ABC Fuse / Link Pole



Notes:-

1. **A maximum of two insulation piercing connectors can be fitted on either side of the pole. Where more connections are required a Service Connection Box shall be used.**

2. **Single phase cable connections are shown in fig 13 and 14.**

3. **Overhead service cables are to be attached to a bracket or coach screw insulator using a preformed dead end.**

Fig 10 Single Phase Service Connection from ABC Pole

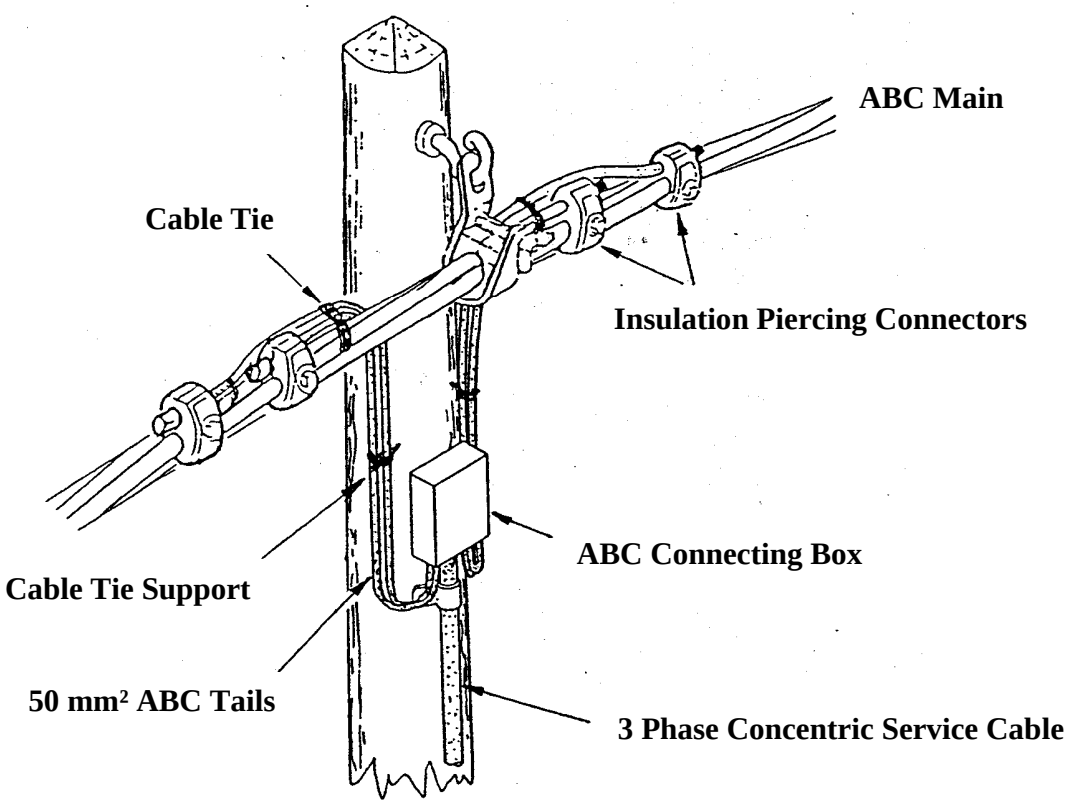
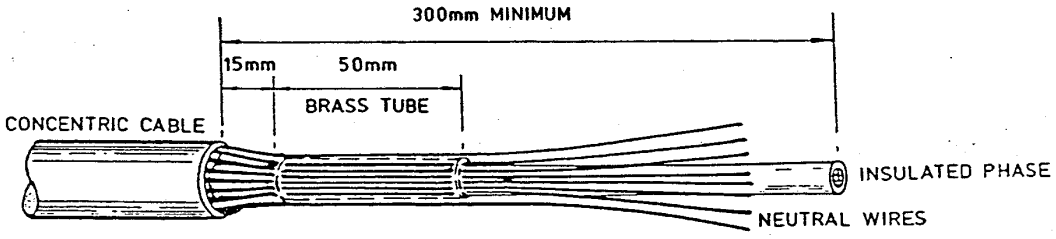
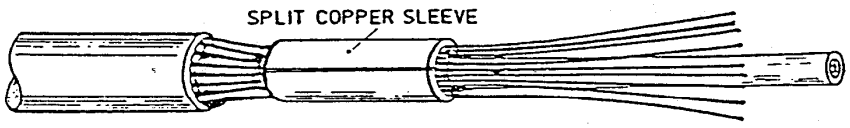


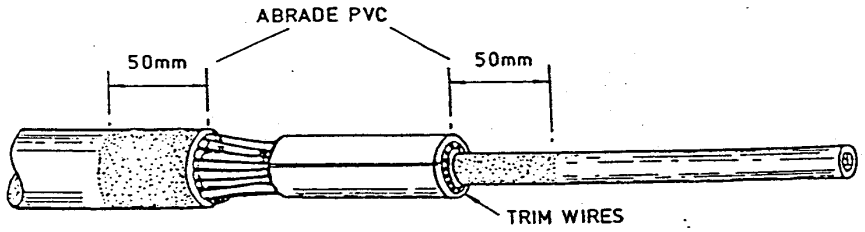
Fig 11 Three Phase Service from ABC Pole



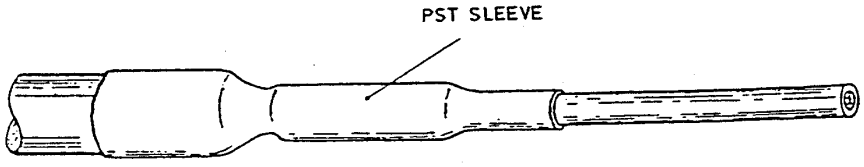
1 - Apply Brass Tube over Phase core and under Neutral wires



2 - Apply Split Sleeve over neutral wires and brass tube



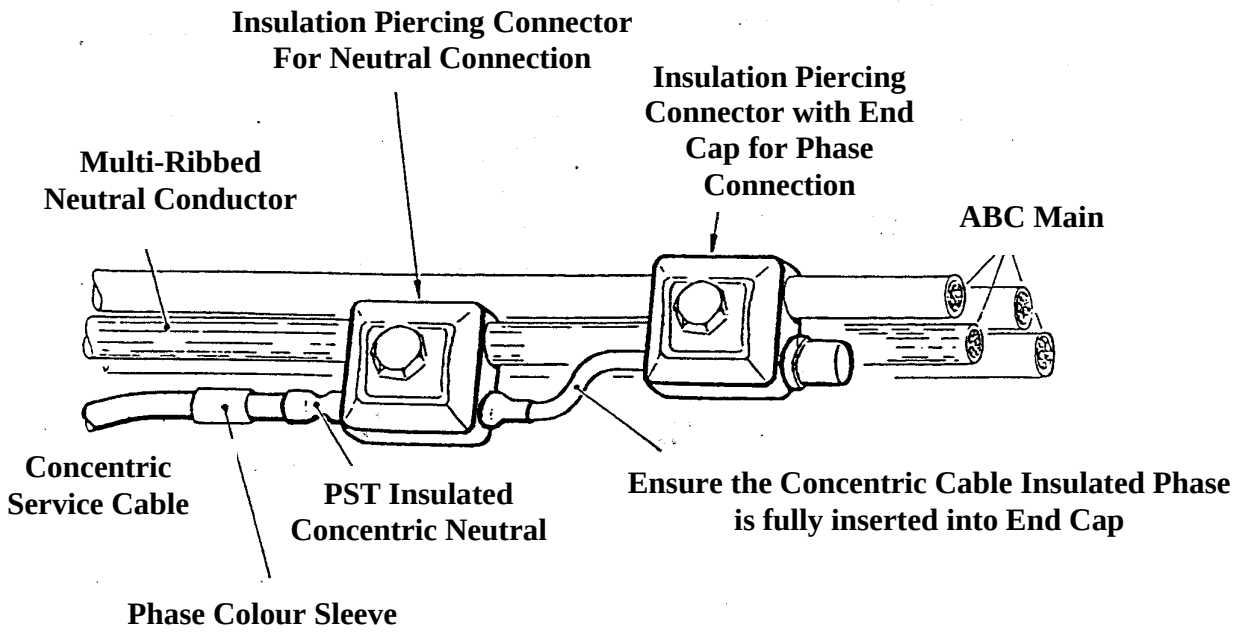
3 – Trim Neutral Ends and Abrade Insulation



4 – Apply PST Cold Silicon Shrink Insulation

Note:- For details of the complete joint see fig 13

Fig 12 Stripping Diagram for Concentric Service Cable



Note:- For stripping details see fig 12

Fig 13 Jointing Details for Single Phase Concentric Cable

APPENDIX D

SUPERSEDED DOCUMENTATION

This ST supersedes ST:OH4K dated September 2006 which should now be withdrawn.

APPENDIX E

ASSOCIATED DOCUMENTATION

POL: OH 1

ST: OH 6A

APPENDIX F

IMPACT ON COMPANY POLICY

Section 11.1 Planning - paragraph added to clarify the requirements when retaining 'G', 'S' and 'L' poles.

Section 11.2 Replacement of Poles - paragraph added to clarify why S and L poles shall normally be replaced.

APPENDIX G

IMPLEMENTATION OF POLICY

Team Managers to review clarifications with their staff.

APPENDIX H

KEY WORDS

ABC, Design

APPENDIX I

Page Revised 26th February 2013