1. SCOPE

Specification for construction of overhead lines between 1kV and 33kV with AAAC conductors, supported on single and "H" type wood poles.

This specification does not cover 33kV overhead lines above an altitude of 200m in Scotland and 300m in SPM. For these applications, a site specific design shall be undertaken.

2. ISSUE RECORD

This is a Reference document. The current version is held on the EN Document Library.

It is your responsibility to ensure you work to the current version.

Issue Date	Issue No.	Author	Amendment Details
May 2007	1	L Campbell	Initial Issue
Aug 2008	Amendment to issue 1	L Campbell	Drawing No. SP4009862 page 203 amended to include method for single stays attachment option
March 2018	2	Ewan Gilliland	Significant review to align with contemporary practices and editorial changes where necessary
December 2018	3	Ewan Gilliland	Significant review to rationalise pole drillings and update in line with ENA TS 43-40 where possible including technical revision by Threepwood Consulting
November 2024	4	Jamie McDonald	Minor editorial review

3. ISSUE AUTHORITY

Author	Owner	Issue Authority
Jamie McDonald Principal Engineer Overhead Lines	Frank Berry Circuits Manager	Fraser Ainslie Head of Engineering Design and Standards F Ainslie Digitally signed by Fraser Ainslie DN: cn=Fraser Ainslie, o=SPEnergyNetworks, ou=Processes and Technology, email=fraser.ainslie@spenergynetworks.co.uk, c=GB Date: 2024.11.12 15:03:38 Z

4. REVIEW

This is a Reference document which has a 5-year retention period after which a reminder will be issued to review and extend retention or archive.

5. DISTRIBUTION

This document is part of the Construction, SPD and SPM System Design Virtual Manuals maintained by Document Control but does not have a maintained distribution list. It is also published on the SP Energy Networks' website.

6. CONTENTS

7. DEFINITIONS

For the purpose of this specification the following definitions apply:

AAAC:	All Aluminium Alloy Conductor.
Approved:	Equipment Approved in accordance with SP Energy Networks' Equipment Approvals Procedure (ASSET-02-002), and which is considered suitable for installation on SP Energy Networks' networks.
Auxiliary Equipment:	Equipment other than that forming part of the line design which may be placed on supports such as transformers, fuse gear etc.
Average Span:	The arithmetic average of a number of spans in a line or section of line.
Basic Span:	The span length adopted for sag/tension calculations.
Creep:	Permanent long term elongation of the conductor.
Construction Terminal:	A support at which the line may be terminated temporarily on one side of the crossarm only on tension insulator sets.
Crossarm Assembly:	A descriptive term used to include all pole top crossarm components and fixings.
Downpull:	The vertical loading imposed by the conductors corresponding to a gradient measured between adjacent pole tops.
Engineer:	SP Energy Networks' nominated representative having authority over technical matters contained in this specification.
Intermediate Support:	A support in a straight run of line on which the conductors are supported on pin or post Insulators.
Maximum Span:	The maximum permitted length of any span.
Maximum Working Tension (MWT):	The conductor tension assessed at -5.6ºC with wind and ice loading, which may be limited by vibration considerations.
Normal Weather Area:	As defined in SP Energy Networks' Construction Policy for Distribution Overhead Lines (OHL-01-008).
OPPC:	Optical Phase Conductor.
Over-Tension:	Excess tension applied above normal tension at time of erection to compensate for conductor creep.
Recommended Span:	The average span length in any section to which the line should be planned.
Sag:	The vertical distance, under any system of conductor loading, between the conductor and a straight line joining adjacent supporting points, measured at mid-span.
Section Angle Support:	A support at which a line deviates and the conductors are made off on either side of the crossarm on tension insulators.

Section Support:	A support in a straight run of line on which the conductors are made off on either side of the crossarm on tension insulators.
Severe Weather Area:	As defined in SP Energy Networks' Construction Policy for Distribution Overhead Lines (OHL-01-008).
Span:	The horizontal distance between adjacent supports. Individual spans will normally be within 20% of the basic span.
SP Energy Networks (SPEN):	The brand name for the division of the ScottishPower group of companies that encompasses SP Distribution plc, SP Transmission plc, SP Manweb plc and SP Power Systems Ltd.
SP Distribution plc (SPD):	The Distribution Licence Holder for the distribution service area formerly known as ScottishPower.
SP Manweb plc (SPM):	The Distribution Licence Holder for the distribution service area formerly known as Manweb.
SP Transmission plc (SPT):	The Transmission Licence Holder for the transmission service area formerly known as ScottishPower.
Uplift:	When a line profile indicates a conductor attachment point is below the -5.6ºC curve when strung between two adjacent supports.
Wind Span:	Half the sum of the spans adjacent to the support.

8. REFERENCES

When designing or constructing overhead lines in accordance with this specification it is essential that the appropriate persons be in possession of the latest versions of the following documents.

Statutory Legislation

ESQCR	Electricity Safety, Quality and Continuity Regulations

British Standards (BS)

BS 3288	Insulator and conductor fittings for overhead power lines
BS EN ISO 1461	Hot dipped galvanised coatings on fabricated iron and steel articles – specifications and test methods

Energy Networks Association Technical Specifications (ENA TS)

ENA TS 43-15	Insulator Binds and Equivalent Helical Fittings for Overhead Lines
ENA TS 43-40	Specification for Single Circuit Overhead Lines on Wood Poles for use at High Voltage Up To and including 33kV
ENA TS 43-88	Selection and treatment of wood poles and associated timber for overhead lines
ENA TS 43-90	Anti-Climbing Devices and Safety Signs for HV Lines up to and including 400kV
ENA TS 43-91	Stay strands and stay fittings for overhead lines
ENA TS 43-92	Overhead Line Fittings
ENA TS 43-93	Line Insulators
ENA TS 43-95	Steelwork for overhead lines
ENA TS 43-96	Fasteners and washers for wood pole overhead lines

SP Energy Networks Documents

ASSET-02-002	SP Energy Networks Equipment Approvals Procedure
EPS-01-004	Policy for Signing and Guarding of Electrical Network Assets
ESDD-02-011	Overhead Line Protection and Switchgear Standard
OHL-01-008	Construction Policy for Distribution Overhead Lines
OHL-03-005	Wood Poles and Associated Timber for Overhead Lines
OHL-03-077	Prefabricated Helical Fittings
OHL-03-079	Overhead Line Steelwork and Associated Fittings
OHL-03-096	Specification for Overhead Line Conductor Incorporating Optical Fibres
OHL-03-108	Galvanised Stay Wire
OHL-14-005	Overhead Line Clearances
OHL-18-017	Termination of 11kV Cables on Poles
OHL-18-019	Termination of 33kV Cables on Poles
OHL-18-022	Erection of Optical Phase Conductors (OPPC) – Supplementary Guidance
OHL-21-001	Stays for Wood Poles
OHL-22-001	Installation of Transformers on Poles
OHL-22-006	Installation of Jumpers on Poles
OHL-22-010	Air-Break Switch Disconnector Installation
OHL-22-012	Installation and Commissioning Instructions for Metal Enclosed Pole Mounted Load Break Switch Disconnector
OHL-22-013	Installation of Pole Mounted Auto-Reclosers (PMARs)
OHL-22-020	Vermin Control Shrouds
OHL-22-026	Erection of Fuse Steelwork
OHL-23-002	Policy for Labelling of Wood Pole Overhead Line Apparatus in the SP Manweb plc Network Area
OHL-23-004	Policy for Labelling of Wood Pole OHL Plant in SP Distribution plc
OHL-25-001	Pole Top Bonding
OHL-25-002	Overhead Line PTE Earths and LV Neutral Earths
OHL-25-007	Earthing and Bonding Pole Mounted Equipment
TSE-03-037	Fasteners & Fixings

Approved Equipment Register

ScottishPower Safety Rules (Electrical & Mechanical) Fifth Edition

Iberdrola Network Specifications

INS 54.63.05	Overhead line conductors
INS 48.08.03	Overhead line insulators

9. INTRODUCTION

This specification is for high voltage overhead lines up to 33kV suitable for application within SP Energy Networks' licensed areas. They incorporate features of previously proven specifications, particularly with regard to conductors, maximum working tensions, span lengths and factors of safety.

Any new or proposed overhead line that does not comply with this specification (e.g., 33kV lines above an altitude of 200m in Scotland or 300m in SPM) shall be subject to approval by SP Energy Networks' Lead Engineer for Circuits Development and/or the Head of Engineering Design and Standards or their nominated representative. This approval shall be sought during the planning stage for the construction of any new overhead line.

This document is intended to be used as a "specification to build" and the policy document detailing "what and where to build" is OHL-01-008.

10. DESIGN DATA

10.1 Design Basis

The design basis for this specification follows ENA TS 43-40, utilising an empirical approach.

10.2 Conductors

The tension of any line conductor at a temperature of -5.6ºC and subjected to a design wind and ice loading appropriate to the environment in which the line will be situated, shall ensure that the conductor has a minimum factor of safety of 2.5 over the rated breaking strength of the conductor.

The basic span length is specific to the conductor and environment in which the line will be situated and is specified in Table 1 of the relevant appendices.

10.3 Crossarms

The minimum factor of safety on all crossarm assemblies and associated steelwork is either 2.5 or 3.5 as specified in the relevant appendix.

10.4 Supports

For the overwhelming majority of supplied poles, Scots Pine (Pinus Sylvestris), the average ultimate extreme fibre stress value used for all pole calculations is 54.24 N/mm². The average modulus of elasticity fibre stress is 9932.46 N/mm².

The stresses created in intermediate supports are bending stresses due to windage on conductors. All “in-line” intermediate and section poles have a minimum factor of safety of 3.5.

The loading point above pole top used for calculations is:

- 11kV pin insulators – 310mm
- 33kV pin insulators – 385mm
- 33kV polymeric post insulators – 510mm – assumed worst case used for all conductors except Hazel.

The stresses created in stayed supports are crippling stresses due to stay tension, steelwork and vertical conductor loads acting at the pole top. Angle and terminal poles have a minimum factor of safety of either 2.5 or 3.5 as specified in the relevant appendix.

Pole top horizontal loading has also to be maintained within specified limits to prevent pole top splitting. Poles shall be of a sufficient diameter to withstand the above-mentioned stresses. Therefore, the minimum pole grade allowable in Appendix 1 only shall be “Medium”, all other appendices require a minimum pole grade of “Stout” to ENA TS 43-88 for the purpose of this specification. The pole top diameter may exceed the minimum pole top diameter quoted.

In all cases, the appropriate pole strength has been calculated using a maximum taper of 11.25mm/m.

10.5 Stays

The minimum factor of safety on stay assemblies is either 2.5 or 3.5 as specified in the relevant appendix based on the minimum failing load of the assembly.

Installation depths shall be specified during the design stage. Further guidance is available in OHL-21-001.

11. MATERIALS

Only materials which have been SP Energy Networks Approved, as per ASSET-02-002 shall be used. Except where otherwise specified all materials used in the construction of lines to this specification shall comply with the relevant SP Energy Networks specification, Iberdrola Networks specification, ENA Technical Specifications or current British Standards as appropriate.

12. TECHNICAL REQUIREMENTS FOR THE ERECTION OF LINES

12.1 Structure Type and Capabilities

Table 2 of Appendices 1 to 6 contained within this specification provides details of the various structure types, limiting span length and angle of deviation detailed under gradient conditions as applicable, together with the appropriate SP Energy Networks' Drawing Numbers. The maximum span lengths indicated take account of conductor clashing and steelwork strength limitations.

Poles, which are subject to uplift at -5.6ºC, shall be sectioned.

12.2 Wood Poles

In all circumstances, wood poles shall comply with OHL-03-005 and ENA TS 43-88, from a supplier listed in the Approved Equipment Register. They shall be supplied drilled and scarfed. Pole blocks shall be fabricated to ENA TS 43-91 Drawing No. 439103 Type 3 and Drawing No. 439112 Type 1 & 2 as required.

12.2.1 Section, Section Angle and Terminal Supports

The gradient limitations quoted in Table 2 of Appendices 1 to 6 are derived from the conductor vertical load, which can be accommodated by the crossarm and is expressed as a downpull gradient measured between adjacent pole tops.

The gradient limitations quoted in Table 2 refer to the total downpull on the support and therefore it is acceptable to summate gradients on either side.

To summate different gradients on either side of the pole it is necessary to add the reciprocals of the downpull and then take the reciprocal of the result (like adding resistances in parallel) e.g.

$1{:}\,7 + 1{:}\,18$

$\frac{1}{7} + \frac{1}{18} = 0.143 + 0.056 = 0.199$

$\frac{1}{0.199} = 5.03 \text{ Therefore combined downpull is } 1{:}\,5.03$

Terminal supports are designed to allow for the appropriate value on one side of the structure only.

The uplift limits on section, section angle and terminal structures shall be taken as being the same as for downpull detailed in Table 2 of the relevant appendices.

12.2.2 Supports

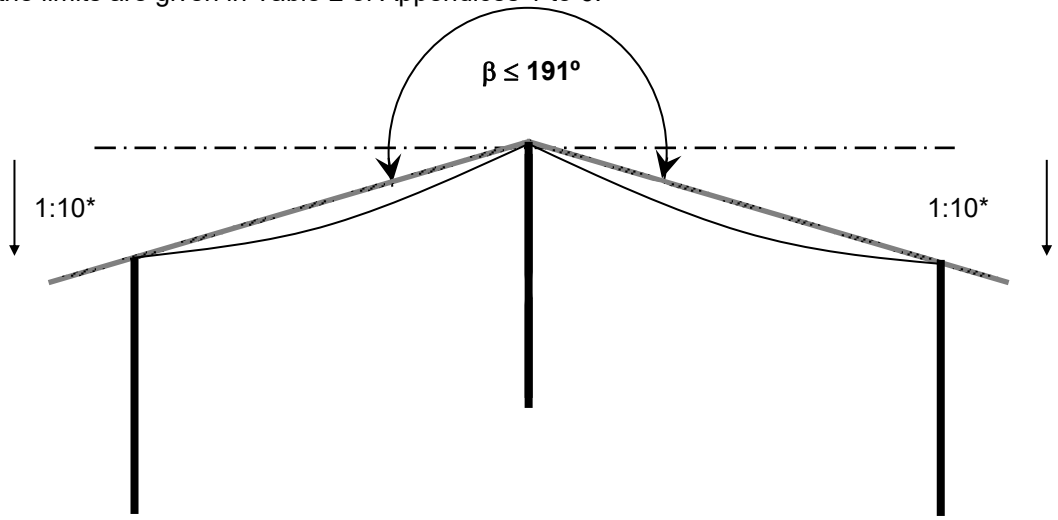
For section and intermediate structures, the maximum downpull shall be no greater than an equivalent gradient of 1:10 to the horizontal plane on either side of the structure. This equates to a total downpull of 1:5.

The stresses created in intermediate supports need to consider the transverse loading due to the wind on loaded conductors and pole, the second order transverse bending stresses (p-delta load) due to the

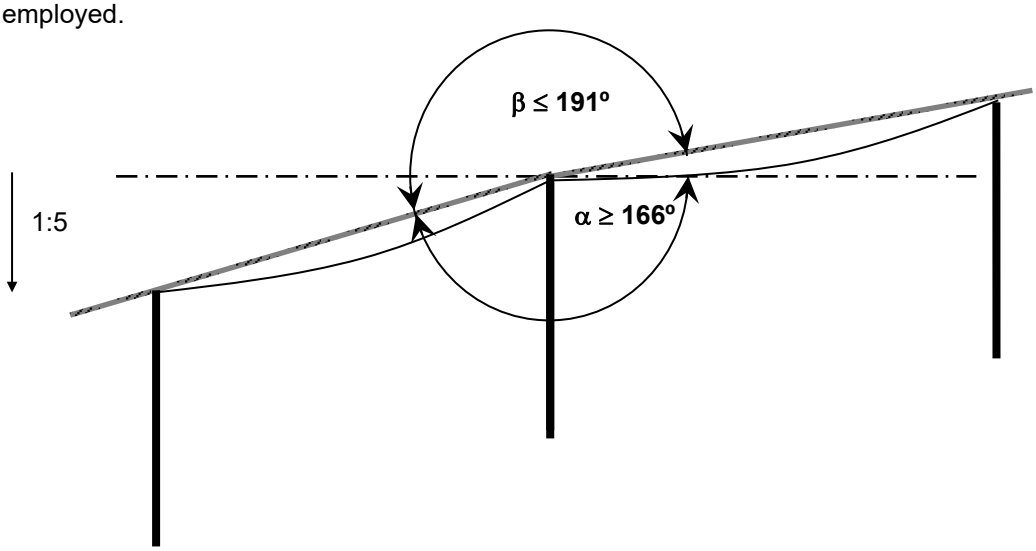
effect of vertical loads when subject to wind loads, and the vertical load as a crippling force. An increasing factor of safety shall be applied for greater applied downpull:

- Level ground – factor of safety of 2.5
- 1:10 downpull – factor of safety of 3.0
- 1:5 downpull – factor of safety of 3.5

All designs in this specification apply a factor of safety of 3.5 to unstayed supports and are therefore suitable for downpull up to 1:5. Crossarm loadings may further limit the downpull on larger conductors, the limits are given in Table 2 of Appendices 1 to 6.



For hillside applications, the maximum gradient quoted in Table 2 of Appendices 1 to 6 for intermediate supports is limited by the method of conductor attachment and is permitted only where angle $\alpha \geq$ **166º** and where angle $\beta \leq$ **191º**. Where these limitations cannot be satisfied a section structure should be employed.



For terminal structures, the maximum downpull shall be equivalent to a gradient of 1:5 to the horizontal plane on one side of the structure only.

It may be impractical to strictly adhere to these uplift and downpull constraints which can result in abnormally high structures being designed. This can introduce other risks that would be preferable to avoid. Designs that do not comply with the requirements set out above shall be subject to approval by SP Energy Networks' Lead Engineer for Circuits Development and/or the Head of Engineering Design and Standards or their nominated representative.

12.3 Pole Strut Loadings

The strut loading imposed on poles due to vertical components of stay and conductor tensions including any auxiliary equipment at specified angles of line deviation, stay angle and ground slope conditions are specified in Tables 8, 9, 10 & 11 of Appendices 1 to 5.

For all single pole 11kV structures an allowance of 600kg has been included for the attachment of auxiliary equipment.

During construction, section poles may be utilised as temporary terminals. Where a single pole section structure is required for this situation, the pole shall be graded such that it is capable of a terminal load condition as detailed in Table 15 of Appendices 1 to 5.

Temporary terminal stays shall be fitted in accordance with Approved staying methods and placed at the ends of the crossarm. The stay anchors shall be positioned no closer to the pole than two pole lengths. This may require to be increased significantly where conductors in excess of 100mm² are employed to limit the loading applied to the pole and crossarm assembly.

12.4 Wind Span and Foundation Requirements

Pole foundations shall be designed to withstand the overturning moment due to windage on conductors, poles, and insulators. Foundation design shall also take account of the rupturing capacity of the ground. In excavating foundation holes, the minimum amount of soil shall be disturbed in order to take advantage of the load bearing value of the virgin ground as far as possible. Backfilled soil shall be compacted using hand or mechanical compaction methods, not more than 150mm of loose soil shall be returned between each ramming operation.

All structures shall have the number of foundation blocks as specified in Table 7 in Appendices 1 to 5 fitted at a minimum of 500mm below ground level. Where an angle of deviation exists, the top foundation block shall be on the inside of the angle.

The values for wind span capabilities for unstayed intermediate and section structures quoted in the appendices have been calculated using a soil bearing capacity of 314 kN/m²/m (Average/Poor as defined in ENA TS 43-40).

Where the quality of backfill material is unsuitable, the excavated material shall be replaced with a suitable imported backfill. Alternatively, an Approved soil additive, e.g., Permasoil, may be used to improve the quality of poor soil.

The Engineer shall inspect holes and, where deemed necessary (soil conditions worse than Average/Poor), additional foundation blocks or bog shoes as detailed in SP Energy Networks' Drawing No. SP2146665 (Single Pole Bog Shoe) or SP2146682 ("H" Pole Bog Shoe) shall be installed.

In addition, it may be necessary to install wind stays in accordance with SP Energy Networks' Drawing No. SP4000336 to exposed sections of line.

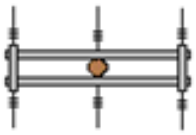
All foundations shall have a minimum factor of safety of 2.5 or 3.5 as found in the relevant appendix.

Appendices 1 to 5 also detail the planting depths appropriate to the various pole lengths.

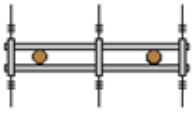
12.5 Failure Containment Requirements

All lines shall include supports, designed to contain a cascade failure. These shall be situated not more than 1000m apart. Supports which are considered adequate to provide failure containment, are:

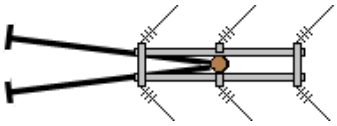
(i) Any Section Structure (minimum grade stout as defined in ENA TS 43-88).



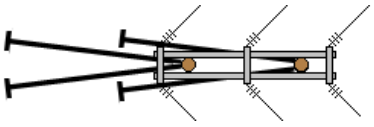
(ii) Any Straight Line "H" Pole Section Structure



(iii) Any Single Pole Section Angle Structure, which requires to be fitted with twin-splayed stays, with a stay slope of 45°.

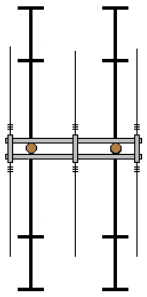


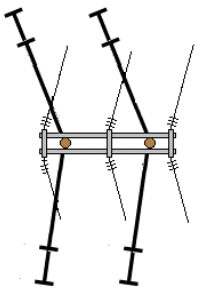
(iv) Any "H" Pole Section Angle Structure with line deviation in excess of 30° fitted with splayed stays with a stay slope of 45°.



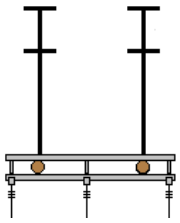
(v) Any "H" Pole Section Structure fitted with in-line stays on both sides of the Structure.

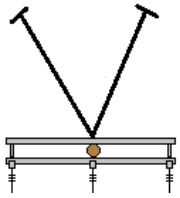
Straight Line and Angles Structures up to 30° deviation with tandem stays with a slope of 45°.





(vi) Any Terminal Structure with tandem or splayed stays





NOTE: The angles in the table below indicate the ***minimum*** angle of deviation required to satisfy option (iii) for the various conductor types.

Conductor	Acceptable Failure Containment Options					
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Hazel	✓	✓	45°	✓	✓	✓
Oak	-	✓	40°	✓	✓	✓
Ash	-	✓	29°	✓	✓	✓
Poplar	-	-	15°	✓	✓	✓
Upas	-	-	-	✓	✓	✓

12.6 Steelwork and Bolts

The steelwork for the structure types included in this specification shall, where practical, conform to the requirements of OHL-03-079 and ENA TS 43-95.

All intermediate, section, section angle and terminal supports shall have anti-split bolts fitted above and below the crossarm steelwork.

Bolts shall conform to TSE-03-037 and ENA TS 43-96. M20 High Yield Steel Pole Bolts (Stamped 8.8) are required for all structures for all applications.

Terminal Bracing Straps SP Energy Networks' Drawing No. SP4020576 for 200mm² construction and Drawing No. SP4015138 for 300mm² AAAC shall be substituted for item 9 in the "H" Pole Terminal Structure Drawing No. SP4147852.

12.7 Stays

Stay components shall comply with ENA TS 43-91. Design calculations have been based on galvanised steel stranding of 7/4.00mm, Grade 1150 as per OHL-03-108. Stay wires shall, unless specifically designed otherwise, be made off with helical fittings at the pole top, insulator positions and on the stay rods. Where conductors of 200mm² or 300mm² are employed, stay attachment at pole tops shall be as shown in SP Energy Networks' Drawing No. SP4009862.

Thimbles used for making off stay wire to stay rods shall conform to ENA TS 43-91 Drawing No. 439109 Type 1 for 7/4.00mm stays.

Stay blocks shall be cut from sawn timber to produce rectangular sections and shall conform to ENA TS 43-91 Drawing No. 439103 Type 2.

Stay rods shall be adjustable and in accordance with ENA TS 43-91 Drawing No. 439101 Type 2 for 7/4.00mm stays.

Tables 8, 9, 10 & 11 of Appendices 1 to 5 detail the maximum angles of deviation allowable for the varying stay slopes together with the relative pole sizes and to a number of stays. Terminal supports shall be stayed in accordance with the requirements for a 60º angle of deviation.

Where two stays are required, they can be installed either splayed or in tandem. When splayed, they shall be a minimum of 3m apart at ground level. When in tandem, the stay blocks shall be in separate holes with at least 3m undisturbed ground between them.

All stays shall be installed such that the stay wire is tight under normal working conditions. Where multiple stays are employed, the stay load shall be equally proportioned between all stays.

Stay insulators shall be as detailed with ENA TS 43-91 Drawing No. 439101 Type 1 for use at 11kV. For 33kV, two Type 2 insulators in an insulator link assembly as per Drawing No. 439108 shall be used. Insulators shall be inserted in every stay wire in such a position that, with the stay hanging down in a vertical position, the insulator shall be below the lowest bare conductor but in no circumstance less than 3m above ground. On poles with multiple stays, insulators shall be staggered to avoid clashing.

The method of installation of stays is detailed in OHL-21-001.

Rock stays and their method of installation shall be of an SP Energy Networks Approved type. The method of installation is detailed in OHL-21-001.

Power installed screw anchors may only be used with the agreement of the Engineer. The method of installation is detailed in OHL-21-001.

12.8 Line Conductors and Jumpers

The line conductors shall comply with INS 54.63.05 or OHL-03-096.

The use of PVC covered conductor for line conductor applications is not recommended and shall be subject to approval by SP Energy Networks' Lead Engineer for Circuits Development and/or the Head of Engineering Design and Standards or their nominated representative.

The minimum length of jumpers shall be 1.2m and the maximum length of unsupported jumpers shall be 2.0m. Jumpers in excess of 2.0m in length shall be bare conductor and supported by insulators.

All 33kV jumpers shall be bare conductor compressed directly onto a dead-end or the overhead line conductor with the appropriate fitting.

The method of installation of jumpers is detailed in OHL-22-006.

12.9 Insulators and Conductor Fittings

All insulators shall comply with INS 48.08.03, conductor fittings shall comply with ENA TS 43-92 or BS 3288.

Only polymeric tension insulators shall be used at section and terminal positions.

Where 300mm² conductor is used, all components in the tension string including the tension insulator shall be rated at a minimum value of 125kN. The tension string crossarm attachment components shall comprise of a BS 3288 Shackle Ref 28/29 and a BS 3288 Ball End Link Ref 28/30. Where required, Sag Adjuster Plates BS 3288 Ref 28/100 and an additional BS 3288 Shackle Ref 28/29 may be installed as shown in Appendix 6 in SP Energy Networks' Drawing No. SP4022218, Option B. These components shall be substituted as indicated on the section structure General Arrangement drawings.

Where the conductor cross sectional area is 200mm² or 300mm², only SP Energy Networks Approved polymeric post type insulators complying with INS 48.08.03 shall provide support at all intermediate structures. Where there is uplift these shall be fitted with a separate armour grip support clamp and armour rods complying with ENA TS 43-92. These may also be employed as support insulators at terminal and section structures. These post insulators shall be substituted for items 11 & 12 of the structure General Arrangement drawings.

All insulator and conductor fittings shall comply with ENA TS 43-92.

Arcing horns shall not be fitted to tension insulator sets and SP Energy Networks Approved tension dead-ends shall be helical type, to OHL-03-077.

Helical ties, to OHL-03-077, shall be used to bind conductors to intermediate, "pin" and groove-top post insulators. For 50mm² conductors, single ties shall be used, for 100mm² and larger conductors, double ties shall be fitted.

Full tension mid-span joints shall only be used in exceptional circumstances and any such joint shall be located at least 1 metre from any conductor dead-end, or conductor fitting. Non-tension joints shall be of the compression type.

12.10 Span Lengths

The basic span length adopted by this specification is dependent on the chosen conductor and the environment in which the line will be situated and as such is specified in the appropriate conductor appendices. Individual spans will normally be within ± 20% of the chosen basic span.

The average span length of every kilometre of line (not necessarily between section supports) shall not be greater than the basic span.

In extreme circumstances an occasional maximum span shall be permitted. In such cases the maximum span length for individual structures is given in Table 2 of Appendices 1 to 6.

No more than two adjacent maximum spans shall be permitted as detailed in Table 2 of Appendices 1 to 6.

12.11 Section Lengths

Section lengths, defined as the length between two section supports, shall not exceed 1000m.

12.12 Conductor Design/Erection Sags and Tensions

Ordinates for plotting uplift curves are based on conductor design tensions.

Ordinates for plotting ground clearance curves assume the use of new conductor and include an allowance for long term creep over a period of 25 years by applying a tension reduction of 5% @ 15°C for 50mm² AAAC and 10% @ 15°C for conductors of 100mm² AAAC and above.

Conductor design sags / tensions are given in Table 3 of Appendices 1 to 6.

Erection sags and tensions are given in Table 5 of Appendices 1 to 6 and are based on the conductor design tensions and have been subject to a 10% over-tension to accommodate the short term creep of the conductor during the life of the line.

The conductors shall be pre-tensioned for a minimum time of 60 minutes. At 15-minute intervals during this period, the tension or sag shall be adjusted in order to maintain the correct value.

Conductor pre-tension sags / tensions are given in Table 4 of Appendices 1 to 6.

12.13 Conductor Spacing and Clearances

The mid-span conductor phase spacing generally limits the maximum span lengths detailed in Table 2 of Appendices 1 to 6. The following values have been used to establish the values in Table 2

OHL-01-008 specifies weather areas for SPD and SPM. The Clashing Model is based on these characteristics from ENA TS 43-40. SP Energy Networks Normal Weather Area – 2D (50mph/380 N/m² & 20mm of radial ice) and Severe Weather Area – 4D (70mph/760 N/m² & 20mm of radial ice).

The wind/ice loading is used only for the conductor clashing model.

The standard conductor spacing is 1.2m on intermediate and terminal supports.

The conductor spacing for section angle supports ≤ 60º is 1.21m.

The conductor spacing for section angle supports ≥ 60º ≤ 75º is 1.11m.

The conductor spacing for long span "H" section angle supports ≤ 30º is 1.93m.

The likely maximum conductor temperature for the purpose of assessing clearances is specific to the chosen conductor and is specified in the relevant appendices.

The minimum electrical clearance between conductors and an insulator support, steelwork, stay wire (earthed or unearthed) or stay-bonding device shall not be less than 300mm as per rule A2.6 of the ScottishPower Safety Rules (Electrical & Mechanical) Fifth Edition.

The minimum electrical clearance between conductors shall be as per OHL-14-005.

12.13.1 Minimum Height of Line Conductors

The height above ground of any line conductor, or any wire or cable attached to a pole carrying any line conductor, shall not, at its likely maximum temperature, be less than the value specified in OHL-14-005 at any point. In order to calculate the height above ground of a line conductor, the appropriate sag for the span length and maximum operating temperature shall first be selected from Table 6 of Appendices 1 to 6 which has been calculated considering long term conductor creep over 25 years.

12.13.2 Summary of Statutory Ground Clearances and Obstacles

Minimum clearances shall be in accordance with OHL-14-005.

To ensure compliance with the above statutory clearances, an additional 450mm shall be added to the profile ground clearance (at maximum still air sag condition) to allow for minor variations in ground level due to farming activities.

12.14 Safety Signs and Number Plates

Safety signs shall be fitted to all supports in accordance with EPS-01-004.

All poles shall be labelled in accordance with OHL-23-002 or OHL-23-004.

12.15 Anti-Climbing Devices

Anti-climbing devices in accordance with ENA TS 43-90 shall be fitted to supports in accordance with EPS-01-004.

Anti-climbing devices shall be fitted to all stays.

Outrigger brackets shall conform to ENA TS 43-95 Drawing No. 439516. Barbed wire shall meet the requirements of ENA TS 43-90, galvanised steel with barbs of 85mm spacing. Similar wire but with the spacing of the barbs set at 50mm is commonly used and is also acceptable. In areas where there is the possibility of severe corrosion, stainless steel barbed wire is recommended. Wire staples shall be of sufficient size to firmly hold the wire in place and be galvanised to BS EN ISO 1461.

12.16 Bonding and Earthing

Steelwork on poles shall not be earthed except where transformers, ground-operated switchgear, cable terminations or surge arresters are to be fitted. Steelwork below the anti-climbing device shall not be bonded or earthed unless ground operated switchgear operating handles are installed below the anti-climbing device.

Pole top bonding shall be as per OHL-25-001.

Pole mounted equipment, including cable terminations with surge arresters, shall be earthed and bonded as per OHL-25-007.

Pole mounted transformers shall be earthed and bonded as per OHL-25-002.

The earthing and bonding conductor shall be stranded copper conductors of a minimum cross sectional area of 35mm² for 11kV and 70mm² for 33kV and shall be green/yellow PVC covered.

The top section of stays shall always be bonded to the adjacent steelwork, regardless of whether the steelwork itself is earthed. Pole bolts shall not be used for this purpose as pole shrinkage may result in a loose connection.

Where appropriate, deep driving of earth rods can be employed as an alternative to a multi-rod installation.

The earthing conductor shall be protected from the bottom of the pole to above the anti-climbing device by an insulated 3.0m long cable guard buried in the ground to a depth of 150mm.

Where there is a requirement to install a LV neutral earth on any structure the method of installation is detailed in OHL-25-002.

12.17 11kV Transformers

The methods of installation of transformers are detailed in OHL-22-001.

Transformers up to 1000kg can be mounted on single pole structures (Drawing No. SP4147878 or SP4147901). The capacity is dependent on the transformer manufacturer, and mounting arrangements available.

Transformers weighing more than 1000kg shall be mounted on “H” Poles (Drawing No. SP4147880) or a single pole and lay leg structure (Drawing No. SP4147881). Where a lay leg is the preferred method of installation, these poles should be obtained at the required length from the pole supplier. Poles shall not be cut to length on site.

All steelwork and other supporting metalwork mounted on the pole above the anti-climbing device shall be bonded and earthed in accordance with the requirements specified in Section 12.16.

The down dropper jumpers shall be installed in accordance with the requirements specified in Section 12.8.

The transformer LV neutral earth shall be installed in accordance with the requirements specified in Section 12.16.

LV fuses shall be installed on the opposite side of the pole from the transformer. The lowest LV fuse holder shall have its mounting coach bolt 500mm above the anti-climber. A distance of 300mm shall be maintained between centres of LV fuse holders. A minimum distance of 1250mm from the uppermost LV fuse holder to the transformer HV or LV bushings shall be maintained.

12.18 Switchgear

Where the equipment is to be operated from the ground using operating rods, for example HV fuses or hook stick air break switch disconnectors, the point of operation on the pole shall be a minimum of 4.3m from the ground and a maximum of 6m from the ground.

Surge arresters shall be installed as directed by the Engineer and shall be fitted in accordance with Section 12.21.

For 11kV applications the down dropper jumpers shall be installed in accordance with the requirements specified in OHL-22-006.

The methods of installation of Pole Mounted Switchgear are detailed in OHL-22-010, OHL-22-012, OHL-22-013 and OHL-22-026.

12.19 Air Break Switch Disconnectors (ABSD)

ABSDs shall be installed in accordance with ESDD-02-011. ABSDs shall be hook stick in operation, have polymeric insulators and can be installed on unearthed poles, or poles with an earthing system which complies with OHL-25-007.

The method of installation of ABSDs is detailed in OHL-22-010.

All steelwork and other supporting metalwork mounted on the pole above the anti-climbing device, if fitted, shall be bonded in accordance with the requirements specified in Section 12.16.

For 11kV applications the down dropper jumpers shall be installed in accordance with the requirements specified in OHL-22-006.

12.20 HV Cable Terminations

All HV cables shall be terminated using SP Energy Networks Approved terminations on poles below the conductors in accordance with OHL-18-017 and OHL-18-019.

The jumpers shall be installed in accordance with Section 12.8.

The HV cable shall be secured from 200mm below ground level up to the termination and it shall be protected from the bottom of the pole to above the anti-climbing device by an insulated 3.0m long cable guard buried in the ground to a depth of 150mm. Cognisance should be taken of the requirements of OHL-25-007 when considering the routing of the cable and associated earthing system.

All metalwork on the pole including the cable termination associated mounting steelwork and metallic cable sheath/screen above the anti-climbing device shall be bonded and earthed in accordance with Section 12.16. There may be exceptional circumstances where the bonding and earthing arrangements require a site specific solution, and this shall be clarified by the Engineer.

Surge arresters shall normally be incorporated in the cable termination and shall be fitted in accordance with Section 12.21.

12.21 Surge Arresters

SP Energy Networks Approved surge arresters shall be fitted to protect cables, metal enclosed switchgear, and as specified by the Engineer.

Where surge arresters are to be erected on a pole, whether incorporated in a cable termination or directly mounted on an item of plant, they shall be connected directly in the current path as close to the plant or cable termination lugs as possible.

Surge arresters shall be earthed and bonded, as described in OHL-25-007, using 70mm² copper earth conductor.

All other metalwork on the pole including the cable termination associated mounting steelwork above the anti-climbing device shall be bonded to the surge arrester earth by a 35mm² copper conductor for 11kV and a 70mm² copper conductor for 33kV applications. The bonding conductor shall be green/yellow PVC covered in accordance with Section 12.16. The earth electrode shall have a maximum resistance value of 10 Ohms.

12.22 Insulated Shrouding

Insulated shrouding shall be fitted to all 11kV plant and equipment as specified by the Engineer. Further guidance can be found in OHL-22-020.

13. APPENDICES SUMMARY

APPENDIX 1: 50mm² AAAC "HAZEL" CONDUCTOR

APPENDIX 2: 100mm² AAAC "OAK" CONDUCTOR

APPENDIX 3: 150mm² AAAC "ASH" CONDUCTOR

APPENDIX 4: 200mm² AAAC "POPLAR" CONDUCTOR

APPENDIX 5: 300mm² AAAC "UPAS" CONDUCTOR

APPENDIX 6: INSTALLATION REQUIREMENTS FOR CONDUCTORS INCORPORATING OPTICAL FIBRES

14. APPENDIX 1: 50mm² AAAC "HAZEL" CONDUCTOR

14.1 Table 1: Design Parameters, 50mm² HAZEL

Design Parameters		
Conductor Nominal Size	50 AAAC	
Code Name	Hazel	
BS EN 50182 Code	60-AL3	
Conductor Stranding	7/3.3	mm
Ungreased Conductor Weight	0.1634	kg/m
Weight of Grease	0.0014	kg/m
Conductor Greasing to ER-L38	CAT 4	
Data input into ENA TS 43-40 Spreadsheet		
Greased Conductor Weight	0.1648	kg/m
Cross Sectional Area of Conductor	59.9	mm²
Conductor Overall Diameter	9.9	mm
Coefficient of Linear Expansion	0.000023	/°C
Modulus of Elasticity	6016.3	kg/mm²
Rated Breaking Strength of Conductor (RBS)	1800.8	kgf (BS EN 50182 value)
Basic / Recommended Span	100	m
Wind Pressure on Conductor	380	N/m²
Radial Ice Thickness	5.0	mm
Ice Density	913	kg/m³
Absolute Maximum Working Tension (MWT) Limit	720.3	kgf (RBS / FoS of 2.5)
Temperature at MWT Limit	-5.6	°C
Maximum "Everyday" Tension (EDT) Limit	360.16	kgf (20% of RBS)
Temperature at EDT Limit	5	°C
Equipment Weight	600	kg
Wind Span	115	m
Results from ENA TS 43-40 Spreadsheet		
Actual Everyday Stress	20	% (Design ruled by EDT)
Maximum Conductor Tension @ -5.6°C (MCT)	666.2	kgf
Maximum Conductor Weight (MCW)	0.378	kg/m
Maximum Conductor Pressure (MCP)	0.771	kg/m
Freezing Point Tension (FPT) at 0°C	396.2	kgf
Minimum ENA TS 43-40 Conductor Factor of Safety	2.5	
Actual Conductor Factor of Safety Used	2.5	
Working FoS @ -5.6°C with Ice and Wind	2.70	
Working FoS @ -5.6°C without Ice and Wind	4.11	
Additional Design Parameters		
Erection Over-Tension @ 15°C (short term creep)	10	%
Ground Clearance Profile Ordinate Tension Reduction @ 15°C (long term creep)	-5	%
Weather Coordinates for Clashing Model	2 D	Normal Weather Area
Design Temperature		
Maximum Conductor Temperature for Assessing Ground Clearances	50°C	
Factors of Safety		
Unstayed Poles	3.5	
Pole Foundations	2.5	
Stayed Poles	2.5	
Stays	2.5	
Steelwork	2.5	
Pin Insulators	2.5	

14.2 Table 2: Support Types and Duties Table, 50mm² HAZEL

Structure Type		Max Span Length (m)	Max Wind / Weight Span (m)	Max Gradient	Angle of Line Deviation	SP Energy Networks' Reference
Intermediate	Single Pole *(Single crossarm)*	100	115	1:5	0°	Fig 8 – SP4147831
	"H" Pole *(Long Span)*	130	130	1:5	0°	Fig 10 – SP4147833
Pin Angle	Single Pole *(Single crossarm)*	100	115	1:5	10°	Fig 8 – SP4147831
Straight Section	Single Pole	110	115	1:5	0°	Fig 11 – SP4147834
	"H" Pole	110	115	1:5	0°	Fig 13 – SP4147836
	"H" Pole (*Long Span*)	130	130	1:5	0º	Fig 14 – SP4147837
Angle Section	Single Pole	100	115	1:5	60º	Fig 11 – SP4147834
	Single Pole	95	115	1:5	75º	Fig 11 – SP4147834
	"H" Pole	95	115	1:5	75º	Fig 13 – SP4147836
	"H" Pole *(Long Span)*	130	130	1:5	30º	Fig 14 – SP4147837
Double Terminal	Single Pole	100	115	1:5	100º	Fig 20 – SP4147853
Tee-Off	Single Pole	100	115	1:5	0º	Fig 21 – SP4147858
Terminal	Single Pole	100	60	1:5	0º	Fig 17 – SP4147840
	"H" Pole	100	60	1:5	0º	Fig 19 – SP4147852

NOTE: * See Section 12.2.2 for guidance on hillside applications.

14.3 Table 3: Conductor Design Table, 50mm² HAZEL

Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		50	60	70	80	90	100	110	120	130
-5.6	437.9	0.12	0.17	0.23	0.30	0.38	0.47	0.57	0.68	0.80
0	396.2	0.13	0.19	0.25	0.33	0.42	0.52	0.63	0.75	0.88
5	360.2	0.14	0.21	0.28	0.37	0.46	0.57	0.69	0.82	0.97
10	325.7	0.16	0.23	0.31	0.40	0.51	0.63	0.77	0.91	1.07
15	293.3	0.18	0.25	0.34	0.45	0.57	0.70	0.85	1.01	1.19
20	263.2	0.20	0.28	0.38	0.50	0.63	0.78	0.95	1.13	1.32
25	236.1	0.22	0.31	0.43	0.56	0.71	0.87	1.06	1.26	1.47
30	212.1	0.24	0.35	0.48	0.62	0.79	0.97	1.18	1.40	1.64
35	191.4	0.27	0.39	0.53	0.69	0.87	1.08	1.30	1.55	1.82
40	173.7	0.30	0.43	0.58	0.76	0.96	1.19	1.43	1.71	2.00
45	158.8	0.32	0.47	0.64	0.83	1.05	1.30	1.57	1.87	2.19
50	146.3	0.35	0.51	0.69	0.90	1.14	1.41	1.70	2.03	2.38
55	135.7	0.38	0.55	0.74	0.97	1.23	1.52	1.84	2.19	2.57
60	126.7	0.41	0.59	0.80	1.04	1.32	1.63	1.97	2.34	2.75
65	119.1	0.43	0.62	0.85	1.11	1.40	1.73	2.09	2.49	2.92
70	112.5	0.46	0.66	0.90	1.17	1.48	1.83	2.22	2.64	3.10
75	106.7	0.48	0.70	0.95	1.24	1.56	1.93	2.34	2.78	3.26
These are the calculated sags after 2 years of short term conductor creep.										

14.4 Table 4: Conductor Pre-Tension Table, 50mm² HAZEL

27.5% of Conductor RBS for 60 minutes									
Pre-tension at all temperatures (kgf)	Sag (m) for Span (m)								
	80	85	90	95	100	105	110	115	120
495	0.27	0.30	0.34	0.38	0.42	0.46	0.50	0.55	0.60

14.5 Table 5: Conductor Erection Table, 50mm² HAZEL

10% increase in tension @ 15°C										
Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		80	85	90	95	100	105	110	115	120
0	429.8	0.31	0.35	0.39	0.43	0.48	0.53	0.58	0.63	0.69
1	422.3	0.31	0.35	0.40	0.44	0.49	0.54	0.59	0.65	0.70
2	293.3	0.45	0.51	0.57	0.63	0.70	0.77	0.85	0.93	1.01
3	293.3	0.45	0.51	0.57	0.63	0.70	0.77	0.85	0.93	1.01
4	400.1	0.33	0.37	0.42	0.46	0.51	0.57	0.62	0.68	0.74
5	392.7	0.34	0.38	0.42	0.47	0.52	0.58	0.63	0.69	0.76
6	385.4	0.34	0.39	0.43	0.48	0.53	0.59	0.65	0.71	0.77
7	378.2	0.35	0.39	0.44	0.49	0.54	0.60	0.66	0.72	0.78
8	371.0	0.36	0.40	0.45	0.50	0.56	0.61	0.67	0.73	0.80
9	363.9	0.36	0.41	0.46	0.51	0.57	0.62	0.68	0.75	0.82
10	356.9	0.37	0.42	0.47	0.52	0.58	0.64	0.70	0.76	0.83
11	349.9	0.38	0.43	0.48	0.53	0.59	0.65	0.71	0.78	0.85
12	342.9	0.38	0.43	0.49	0.54	0.60	0.66	0.73	0.79	0.86
13	336.1	0.39	0.44	0.50	0.55	0.61	0.68	0.74	0.81	0.88
14	329.3	0.40	0.45	0.51	0.56	0.63	0.69	0.76	0.83	0.90
15	322.6	0.41	0.46	0.52	0.58	0.64	0.70	0.77	0.84	0.92
16	316.0	0.42	0.47	0.53	0.59	0.65	0.72	0.79	0.86	0.94
17	309.4	0.43	0.48	0.54	0.60	0.67	0.73	0.81	0.88	0.96
18	303.0	0.44	0.49	0.55	0.61	0.68	0.75	0.82	0.90	0.98
19	296.6	0.44	0.50	0.56	0.63	0.69	0.77	0.84	0.92	1.00
20	290.3	0.45	0.51	0.57	0.64	0.71	0.78	0.86	0.94	1.02
21	284.2	0.46	0.52	0.59	0.65	0.72	0.80	0.88	0.96	1.04
22	278.1	0.47	0.54	0.60	0.67	0.74	0.82	0.90	0.98	1.07
23	272.1	0.48	0.55	0.61	0.68	0.76	0.83	0.92	1.00	1.09
24	266.3	0.50	0.56	0.63	0.70	0.77	0.85	0.94	1.02	1.11
25	260.6	0.51	0.57	0.64	0.71	0.79	0.87	0.96	1.05	1.14
26	255.0	0.52	0.58	0.65	0.73	0.81	0.89	0.98	1.07	1.16
27	249.5	0.53	0.60	0.67	0.75	0.83	0.91	1.00	1.09	1.19
28	244.1	0.54	0.61	0.68	0.76	0.84	0.93	1.02	1.12	1.22
29	238.8	0.55	0.62	0.70	0.78	0.86	0.95	1.04	1.14	1.24
30	233.7	0.56	0.64	0.71	0.80	0.88	0.97	1.07	1.17	1.27

14.6 Table 6: Profile Table, 50mm² HAZEL

Ordinates for plotting Ground Clearance 5% @ 15°C										
Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		50	60	70	80	90	100	110	120	130
0	378.8	0.14	0.20	0.27	0.35	0.44	0.54	0.66	0.78	0.92
5	343.5	0.15	0.22	0.29	0.38	0.49	0.60	0.73	0.86	1.01
10	309.9	0.17	0.24	0.33	0.43	0.54	0.66	0.80	0.96	1.12
15	278.6	0.18	0.27	0.36	0.47	0.60	0.74	0.89	1.06	1.25
20	249.9	0.21	0.30	0.40	0.53	0.67	0.82	1.00	1.19	1.39
25	224.3	0.23	0.33	0.45	0.59	0.74	0.92	1.11	1.32	1.55
30	201.8	0.26	0.37	0.50	0.65	0.83	1.02	1.23	1.47	1.72
35	182.6	0.28	0.41	0.55	0.72	0.91	1.13	1.37	1.62	1.91
40	166.3	0.31	0.45	0.61	0.79	1.00	1.24	1.50	1.78	2.09
45	152.6	0.34	0.49	0.66	0.86	1.09	1.35	1.63	1.94	2.28
50	141.0	0.37	0.53	0.72	0.93	1.18	1.46	1.77	2.10	2.47
55	131.2	0.39	0.57	0.77	1.00	1.27	1.57	1.90	2.26	2.65
60	122.9	0.42	0.60	0.82	1.07	1.36	1.68	2.03	2.41	2.83
65	115.8	0.44	0.64	0.87	1.14	1.44	1.78	2.15	2.56	3.01
70	109.6	0.47	0.68	0.92	1.20	1.52	1.88	2.27	2.71	3.18
75	104.2	0.49	0.71	0.97	1.27	1.60	1.98	2.39	2.85	3.34
These are the calculated sags after 25 years of long term conductor creep.										

14.7 Table 7: Pole Sizing for Intermediate and Section Poles, 50mm² HAZEL

Pole Length (m)	Average / Poor Soil 314 kN/m²/m													
	Wind Span (m)													
	70		80		90		100		110		115 Maximum for single pole		130 "H" Pole	
	Class of Pole and Number of Blocks													
9	M	1	S	1	S	1	S	1	S	1	S	1	2 x M	1
10	M	1	S	1	S	1	S	1	S	1	S	1	2 x M	1
11	M	1	S	1	S	1	S	1	S	2	S	2	2 x M	1
12	M	1	S	1	S	1	S	1	S	1	S	1	2 x M	1
13	M	1	S	1	S	1	S	1	S	1	S	1	2 x M	1
14	M	1	M	1	S	1	S	1	S	2	S	2	2 x M	1
15 (NF)	M	0	M	1	M	1	S	1	S	1	S	1	2 x M	1
16	M	1	M	1	M	1	S	1	S	1	S	1	2 x M	1
17 (NF)	M	1	M	1	M	1	M	1	S	1	S	1	2 x M	1
18 (NF)	M	0	M	0	M	1	M	1	S	1	S	1	2 x M	1
20 (NF)	M	0	M	1	M	1	M	1	M	1	M	1	2 x M	1
22 (NF)	M	1	M	1	M	1	M	1	M	2	M	2	2 x M	1

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" pole

1 = upper 1500mm block 2 = upper & lower 1500mm blocks NF = Non Framework

Pole Length (m)	Foundation Depth (m)
9.0 – 11.0 inc.	1.8
12.0 – 14.0 inc.	2.0
15.0 – 17.0 inc.	2.2
18.0 – 22.0 inc.	2.4

14.8 Table 8: Pole and Stay Sizing for Angle & Terminal Poles, 50mm² HAZEL, 45° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
10°	Fig 8,11,13,14	M	1	M	1	S	1	S	1	S	1	S	1	S	1
15°	Fig 11,13,14	M	1	M	1	S	1	S	1	S	1	S	1	S	1
20°	Fig 11,13,14	M	1	S	1	S	1	S	1	S	1	S	1	S	1
25°	Fig 11,13,14	M	1	S	1	S	1	S	1	S	1	S	1	S	1
30°	Fig 11,13,14	M	1	S	1	S	1	S	1	S	1	S	1	S	1
40°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	S	1	S	1
45°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	S	1	S	1
50°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	S	1	S	1
55°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
60°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
75°	Fig 11,13	S	3	S	3	S	3	S	3	S	3	ES	3	ES	3
100°	Fig 20	S	3	S	3	S	3	ES	3	ES	3	ES	3	ES+	3
Terminal	Fig 17,19	S	2	S	2	S	2	S	2	S	2	S	2	ES	2
Downpull 1:5															
10°	Fig 8,11,13,14	M	1	S	1	S	1	S	1	S	1	S	1	S	1
15°	Fig 11,13,14	M	1	S	1	S	1	S	1	S	1	S	1	S	1
20°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
25°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
30°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
40°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	S	1	S	1
45°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
50°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
55°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
60°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
75°	Fig 11,13	S	3	S	3	S	3	ES	3	ES	3	ES	3	ES	3
100°	Fig 20	S	3	S	3	ES	3	ES	3	ES	3	ES	3	ES+	3
Terminal	Fig 17,19	S	2	S	2	S	2	S	2	S	2	ES	2	ES	2
Stay Spread @ 45°		7.0m		8.0m		9.0m		9.8m		10.8m		11.8m		13.6m	
Stay block distance @ 45°		8.4m		9.4m		10.4m		11.2m		12.2m		13.2m		15.0m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

14.9 Table 9: Pole and Stay Sizing for Angle & Terminal Poles, 50mm² HAZEL, 40° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
10°	Fig 8,11,13,14	M	1	M	1	S	1	S	1	S	1	S	1	S	1
15°	Fig 11,13,14	M	1	S	1	S	1	S	1	S	1	S	1	S	1
20°	Fig 11,13,14	M	1	S	1	S	1	S	1	S	1	S	1	S	1
25°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
30°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
40°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	S	1	S	1
45°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
50°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
55°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
60°	Fig 11,13	S	1	S	1	S	1	S	1	ES	1	ES	1	ES	1
75°	Fig 11,13	S	3	S	3	ES	3	ES	3	ES	3	ES	3	ES	3
100°	Fig 20	S	3	S	3	ES	3	ES	3	ES	3	ES	3	ES+	3
Terminal	Fig 17,19	S	2	S	2	S	2	S	2	ES	2	ES	2	ES	2
Downpull 1:5															
10°	Fig 8,11,13,14	M	1	S	1	S	1	S	1	S	1	S	1	S	1
15°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
20°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
25°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
30°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
40°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
45°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
50°	Fig 11,13	S	1	S	1	S	1	S	1	ES	1	ES	1	ES	1
55°	Fig 11,13	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
60°	Fig 11,13	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
75°	Fig 11,13	S	3	S	3	ES	3	ES	3	ES	3	ES	3	ES+	3
100°	Fig 20	S	3	S	3	ES	3	ES	3	ES	3	ES	3	ES+	3
Terminal	Fig 17,19	S	2	S	2	S	2	ES	2	ES	2	ES	2	ES	2
Stay Spread @ 40°		5.9m		6.7m		7.6m		8.2m		9.1m		9.9m		11.4m	
Stay block distance @ 40°		7.2m		8.0m		8.9m		9.5m		10.4m		11.2m		12.7m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

14.10 Table 10: Pole and Stay Sizing for Angle & Terminal Poles, 50mm² HAZEL, 35° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
10°	Fig 8,11,13,14	M	1	S	1	S	1	S	1	S	1	S	1	S	1
15°	Fig 11,13,14	M	1	S	1	S	1	S	1	S	1	S	1	S	1
20°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
25°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
30°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
40°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
45°	Fig 11,13	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
50°	Fig 11,13	S	1	S	1	S	1	S	1	ES	1	ES	1	ES	1
55°	Fig 11,13	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
60°	Fig 11,13	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES+	1
75°	Fig 11,13	S	3	S	3	ES	3	ES	3	ES	3	ES	3	ES+	3
100°	Fig 20	S	3	ES	3	ES	3	ES	3	ES+	3	ES+	3	ES+	3
Terminal	Fig 17,19	S	2	S	2	S	2	ES	2	ES	2	ES	2	ES+	2
Downpull 1:5															
10°	Fig 8,11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
15°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
20°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
25°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
30°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
40°	Fig 11,13	S	1	S	1	S	1	S	1	ES	1	ES	1	ES	1
45°	Fig 11,13	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
50°	Fig 11,13	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
55°	Fig 11,13	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES+	1
60°	Fig 11,13	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
75°	Fig 11,13	S	3	S	3	ES	3	ES	3	ES	3	ES	3	ES+	3
100°	Fig 20	S	3	ES	3	ES	3	ES+	3	ES+	3	ES+	3	ES+	3
Terminal	Fig 17,19	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
Stay Spread @ 35°		4.9m		5.6m		6.3m		6.9m		7.6m		8.3m		9.5m	
Stay block distance @ 35°		6.1m		6.8m		7.5m		8.0m		8.7m		9.4m		10.7m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

14.11 Table 11: Pole and Stay Sizing for Angle & Terminal Poles, 50mm² HAZEL, 30° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
10°	Fig 8,11,13,14	M	1	S	1	S	1	S	1	S	1	S	1	S	1
15°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
20°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
25°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
30°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
40°	Fig 11,13	S	1	S	1	S	1	S	1	ES	1	ES	1	ES	1
45°	Fig 11,13	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
50°	Fig 11,13	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES+	1
55°	Fig 11,13	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
60°	Fig 11,13	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
75°	Fig 11,13	S	3	ES	3	ES	3	ES	3	ES+	3	ES+	3	ES+	3
100°	Fig 20	S	3	ES	3	ES	3	ES+	3	ES+	3	ES+	3	ES+	3
Terminal	Fig 17,19	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
Downpull 1:5															
10°	Fig 8,11,13,14	M	1	S	1	S	1	S	1	S	1	S	1	S	1
15°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
20°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
25°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
30°	Fig 11,13,14	S	1	S	1	S	1	S	1	ES	1	ES	1	ES	1
40°	Fig 11,13	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES+	1
45°	Fig 11,13	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
50°	Fig 11,13	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
55°	Fig 11,13	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
60°	Fig 11,13	S	2	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
75°	Fig 11,13	S	3	ES	3	ES	3	ES+	3	ES+	3	ES+	3	ES+	3
100°	Fig 20	ES	3	ES	3	ES+	3	ES+	3	ES+	3	ES+	3	ES+	3
Terminal	Fig 17,19	S	2	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
Stay Spread @ 30°		4.1m		4.6m		5.2m		5.7m		6.2m		6.8m		7.9m	
Stay block distance @ 30°		5.1m		5.6m		6.2m		6.7m		7.2m		7.8m		8.9m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

14.12 Table 12: Strut Load in Single Poles 50mm² HAZEL, Single Pole, 1 or 2 Stays

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	10°	6,694	6,160	5,744	5,407
	15°	7,439	6,774	6,257	5,837
	20°	8,178	7,383	6,765	6,264
	25°	8,909	7,986	7,268	6,686
	30°	9,631	8,581	7,765	7,102
	40°	11,040	9,744	8,735	7,916
	45°	11,726	10,309	9,207	8,312
	50°	12,397	10,862	9,668	8,700
	55°	13,052	11,402	10,119	9,078
	60° & Terminal	13,690	11,928	10,558	9,446
	75°	15,489	13,411	11,796	10,485
	100°	18,038	15,513	13,549	11,956
Downpull 1:5	10°	7,660	7,125	6,710	6,373
	15°	8,405	7,740	7,222	6,803
	20°	9,144	8,349	7,731	7,229
	25°	9,874	8,952	8,234	7,651
	30°	10,596	9,547	8,730	8,068
	40°	12,006	10,709	9,700	8,882
	45°	12,692	11,274	10,172	9,278
	50°	13,362	11,828	10,634	9,665
	55°	14,018	12,368	11,084	10,043
	60° & Terminal	14,655	12,894	11,523	10,412
	75°	16,454	14,377	12,761	11,450
	100°	19,003	16,479	14,515	12,922
This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.					

14.13 Table 13: Strut Load in "H" Poles, 50mm² HAZEL, 3 or 5 Stays, 60:40 load

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	10°	3,768	3,427	3,162	2,947
	15°	4,215	3,796	3,470	3,205
	20°	4,659	4,161	3,775	3,461
	25°	5,097	4,523	4,076	3,714
	30°	5,530	4,880	4,374	3,964
	40°	6,376	5,577	4,956	4,452
	45°	6,787	5,917	5,239	4,690
	50°	7,190	6,249	5,516	4,922
	55°	7,583	6,573	5,787	5,149
	60° & Terminal	7,966	6,888	6,050	5,370
	75°	9,045	7,778	6,793	5,993
	100°	10,574	9,039	7,845	6,876
Downpull 1:5	10°	4,251	3,910	3,645	3,429
	15°	4,698	4,279	3,952	3,688
	20°	5,141	4,644	4,257	3,944
	25°	5,580	5,006	4,559	4,197
	30°	6,013	5,363	4,857	4,447
	40°	6,859	6,060	5,439	4,935
	45°	7,270	6,399	5,722	5,173
	50°	7,673	6,731	5,999	5,405
	55°	8,066	7,055	6,269	5,632
	60° & Terminal	8,448	7,371	6,533	5,853
	75°	9,528	8,261	7,275	6,476
	100°	11,057	9,522	8,328	7,359
This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.					

14.14 Table 14: Strut Load in "H" Poles, 50mm² HAZEL, 4 or 6 Stays, 50:50 load

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	10°	3,444	3,160	2,939	2,760
	15°	3,817	3,467	3,195	2,975
	20°	4,186	3,772	3,450	3,188
	25°	4,552	4,073	3,701	3,399
	30°	4,913	4,371	3,949	3,607
	40°	5,617	4,952	4,434	4,014
	45°	5,960	5,235	4,670	4,212
	50°	6,296	5,511	4,901	4,406
	55°	6,623	5,781	5,126	4,595
	60° & Terminal	6,942	6,044	5,346	4,779
	75°	7,842	6,786	5,965	5,299
	100°	9,116	7,837	6,842	6,034
Downpull 1:5	10°	3,927	3,643	3,422	3,242
	15°	4,300	3,950	3,678	3,458
	20°	4,669	4,255	3,932	3,671
	25°	5,034	4,556	4,184	3,882
	30°	5,395	4,853	4,432	4,090
	40°	6,100	5,435	4,917	4,497
	45°	6,443	5,717	5,153	4,695
	50°	6,778	5,994	5,384	4,889
	55°	7,106	6,264	5,609	5,078
	60° & Terminal	7,425	6,527	5,829	5,262
	75°	8,324	7,269	6,447	5,781
	100°	9,599	8,319	7,324	6,517
This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.					

14.15 Table 15: Construction Terminal 50mm² HAZEL

LINE ANGLE	Strut Load (Back Stay Angle 64°)	Pole Class		
		Length	Single Pole	"H" Pole
Downpull 1:10	6,477 kgf	9m – 18m 20m – 22m	S ES	2 x M 2 x M
Downpull 1:5	7,442 kgf	9m – 18m 20m – 22m	S ES	2 x M 2 x M
M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole				

14.16 Table 16: Stayed Pole Strut Capabilities, 50mm² HAZEL

Pole (m)	Grade	Pole Top Dia (mm)	Dia 1.5m from Butt (mm)	Planting Depth (mm)	Pole Strut Strength (kgf)
9	MEDIUM	150	220	1800	7,219
10	MEDIUM	150	230	1800	6,004
11	MEDIUM	150	240	1800	5,138
12	MEDIUM	150	250	2000	4,614
13	MEDIUM	160	260	2000	4,698
14	MEDIUM	160	275	2000	4,375
15 (NF)	MEDIUM	165	290	2200	4,476
16	MEDIUM	170	305	2200	4,509
17 (NF)	MEDIUM	180	320	2200	4,838
18 (NF)	MEDIUM	180	330	2400	4,568
20 (NF)	MEDIUM	180	360	2400	4,254
22 (NF)	MEDIUM	190	380	2400	4,259
9	STOUT	190	275	1800	18,146
10	STOUT	190	285	1800	14,849
11	STOUT	190	295	1800	12,509
12	STOUT	190	305	2000	11,077
13	STOUT	195	320	2000	10,554
14	STOUT	195	335	2000	9,643
15 (NF)	STOUT	195	350	2200	9,088
16	STOUT	200	365	2200	8,925
17 (NF)	STOUT	200	375	2200	8,172
18 (NF)	STOUT	200	390	2400	7,849
20 (NF)	STOUT	200	415	2400	6,985
22 (NF)	STOUT	200	435	2400	6,206
9	EXTRA STOUT	205	295	1800	24,338
10	EXTRA STOUT	210	305	1800	20,908
11	EXTRA STOUT	215	315	1800	18,461
12	EXTRA STOUT	215	325	2000	16,292
13	EXTRA STOUT	215	340	2000	14,572
14	EXTRA STOUT	220	365	2000	14,633
15 (NF)	EXTRA STOUT	220	370	2000	12,769
16	EXTRA STOUT	220	385	2000	11,849
17 (NF)	EXTRA STOUT	220	415	2000	11,924
18 (NF)	EXTRA STOUT	220	415	2400	10,768
20 (NF)	EXTRA STOUT	220	435	2400	9,280
22 (NF)	EXTRA STOUT	220	470	2400	8,754
9	EXTRA STOUT PLUS	230	315	1800	35,339
10	EXTRA STOUT PLUS	229	325	1800	28,375
11	EXTRA STOUT PLUS	228	335	1800	23,467
12	EXTRA STOUT PLUS	230	350	2000	21,592
13	EXTRA STOUT PLUS	240	370	2000	21,612
14	EXTRA STOUT PLUS	245	390	2000	20,856
15 (NF)	EXTRA STOUT PLUS	250	410	2000	20,318
16	EXTRA STOUT PLUS	255	430	2000	19,940
17 (NF)	EXTRA STOUT PLUS	260	435	2000	18,474
18 (NF)	EXTRA STOUT PLUS	254	440	2400	16,275
20 (NF)	EXTRA STOUT PLUS	260	465	2400	14,904
22 (NF)	EXTRA STOUT PLUS	270	485	2400	14,091

NF = Non Framework

This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.

15. APPENDIX 2: 100mm² AAAC "OAK" CONDUCTOR

15.1 Table 1: Design Parameters, 100mm² OAK

Design Parameters		
Conductor Nominal Size	100 AAAC	
Code Name	Oak	
BS EN 50182 Code	119-AL3	
Conductor Stranding	7/4.65	mm
Ungreased Conductor Weight	0.3245	kg/m
Weight of Grease	0.0028	kg/m
Conductor Greasing to ER-L38	CAT 4	
Data input into ENA TS 43-40 Spreadsheet		
Greased Conductor Weight	0.3273	kg/m
Cross Sectional Area of Conductor	118.9	mm²
Conductor Overall Diameter	14.0	mm
Coefficient of Linear Expansion	0.000023	/°C
Modulus of Elasticity	6016.3	kg/mm²
Rated Breaking Strength of Conductor (RBS)	3576.1	kgf (BS EN 50182 value)
Basic / Recommended Span	90	m
Wind Pressure on Conductor	380	N/m²
Radial Ice Thickness	9.5	mm
Ice Density	913	kg/m³
Absolute Maximum Working Tension (MWT) Limit	1151.0	kgf (MWT set by SPEN)
Temperature at MWT Limit	-5.6	°C
Maximum "Everyday" Tension (EDT) Limit	715.22	kgf (20% of RBS)
Temperature at EDT Limit	5	°C
Equipment Weight	600	kg
Wind Span	115	m
Results from ENA TS 43-40 Spreadsheet		
Actual Everyday Stress	16.3	% (Design ruled by MWT)
Maximum Conductor Tension @ -5.6°C (MCT)	1151.0	kgf
Maximum Conductor Weight (MCW)	0.968	kg/m
Maximum Conductor Pressure (MCP)	1.279	kg/m
Freezing Point Tension (FPT) at 0°C	651.2	kgf
Minimum ENA TS 43-40 Conductor Factor of Safety	2.5	
Actual Conductor Factor of Safety Used	3.11	
Working FoS @ -5.6°C with Ice and Wind	3.11	
Working FoS @ -5.6°C without Ice and Wind	4.89	
Additional Design Parameters		
Erection Over-Tension @ 15°C (short term creep)	10	%
Ground Clearance Profile Ordinate Tension Reduction @ 15°C (long term creep)	-10	%
Weather Coordinates for Clashing Model	4 D	Severe Weather Area
Design Temperature		
Maximum Conductor Temperature for Assessing Ground Clearances	50°C	
Factors of Safety		
Unstayed Poles	3.5	
Pole Foundations	2.5	
Stayed Poles	2.5	
Stays	2.5	
Steelwork	2.5	
Pin Insulators	2.5	

15.2 Table 2: Support Types and Duties Table, 100mm² OAK

Structure Type		Max Span Length (m)	Max Wind/ Weight Span (m)	Max Gradient	Angle of Line Deviation	SP Energy Networks' Reference
Intermediate	Single Pole *(Single crossarm)*	95	115	1:10	0°	Fig 8 – SP4147831
	Single Pole (*Double crossarm*)	95	115	1:5	0º	Fig 9 – SP4147832
	"H" Pole *(Long Span)*	125	130	1:5	0º	Fig 10 – SP4147833
Pin Angle	Single Pole (*Double crossarm*)	95	115	1:5	10º	Fig 9 – SP4147832
Straight Section	Single Pole	105	115	1:10	0º	Fig 11 – SP4147834
	Single Pole *(Long Tie Strap)*	95	115	1:5	0º	Fig 12 – SP4147835
	"H" Pole	105	115	1:5	0º	Fig 13 – SP4147836
	"H" Pole (*Long Span*)	125	130	1:5	0º	Fig 14 – SP4147837
Angle Section	Single Pole	95	115	1:10	60º	Fig 11 – SP4147834
	Single Pole *(Long Tie Strap)*	95	115	1:5	60º	Fig 12 – SP4147835
	"H" Pole	90	115	1:5	75º	Fig 13 – SP4147836
	"H" Pole *(Long Span)*	120	130	1:5	30º	Fig 14 – SP4147837
Tee-Off	Stub Leg	95	60	1:5	0º	Fig 23 – SP4147861
Terminal	Single Pole (*with crossarm brace ENA Drawing No. 434010)*	95	60	1:5	0º	Fig 18 – SP4147851
	"H" Pole	95	60	1:5	0º	Fig 19 – SP4147852

NOTE: * See Section 12.2.2 for guidance on hillside applications.

15.3 Table 3: Conductor Design Table, 100mm² OAK

Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		70	80	90	95	100	105	110	120	125
-5.6	730.8	0.27	0.36	0.45	0.51	0.56	0.62	0.68	0.81	0.87
0	651.2	0.31	0.40	0.51	0.57	0.63	0.69	0.76	0.90	0.98
5	583.9	0.34	0.45	0.57	0.63	0.70	0.77	0.85	1.01	1.09
10	521.0	0.38	0.50	0.64	0.71	0.79	0.87	0.95	1.13	1.23
15	463.7	0.43	0.56	0.71	0.80	0.88	0.97	1.07	1.27	1.38
20	412.9	0.49	0.63	0.80	0.89	0.99	1.09	1.20	1.43	1.55
25	368.9	0.54	0.71	0.90	1.00	1.11	1.22	1.34	1.60	1.73
30	331.7	0.60	0.79	1.00	1.11	1.23	1.36	1.49	1.78	1.93
35	300.6	0.67	0.87	1.10	1.23	1.36	1.50	1.65	1.96	2.13
40	274.7	0.73	0.95	1.21	1.34	1.49	1.64	1.80	2.14	2.33
45	253.2	0.79	1.03	1.31	1.46	1.62	1.78	1.95	2.33	2.52
50	235.2	0.85	1.11	1.41	1.57	1.74	1.92	2.10	2.50	2.72
55	219.9	0.91	1.19	1.51	1.68	1.86	2.05	2.25	2.68	2.91
60	207.0	0.97	1.27	1.60	1.78	1.98	2.18	2.39	2.85	3.09
65	195.8	1.02	1.34	1.69	1.89	2.09	2.30	2.53	3.01	3.27
70	186.0	1.08	1.41	1.78	1.98	2.20	2.42	2.66	3.17	3.44
75	177.5	1.13	1.48	1.87	2.08	2.31	2.54	2.79	3.32	3.60
These are the calculated sags after 2 years of short term conductor creep.										

15.4 Table 4: Conductor Pre-Tension Table, 100mm² OAK

23.2% of Conductor RBS for 60 minutes									
Pre-tension at all temperatures (kgf)	Sag (m) for Span (m)								
	70	75	80	85	90	95	100	105	110
828	0.24	0.28	0.32	0.36	0.40	0.45	0.49	0.54	0.60

15.5 Table 5: Conductor Erection Table, 100mm² OAK

10% increase in tension @ 15°C										
Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		70	75	80	85	90	95	100	105	110
0	709.0	0.28	0.32	0.37	0.42	0.47	0.52	0.58	0.64	0.70
1	694.6	0.29	0.33	0.38	0.43	0.48	0.53	0.59	0.65	0.71
2	463.7	0.43	0.50	0.56	0.64	0.71	0.80	0.88	0.97	1.07
3	463.7	0.43	0.50	0.56	0.64	0.71	0.80	0.88	0.97	1.07
4	652.4	0.31	0.35	0.40	0.45	0.51	0.57	0.63	0.69	0.76
5	638.6	0.31	0.36	0.41	0.46	0.52	0.58	0.64	0.71	0.78
6	625.0	0.32	0.37	0.42	0.47	0.53	0.59	0.65	0.72	0.79
7	611.5	0.33	0.38	0.43	0.48	0.54	0.60	0.67	0.74	0.81
8	598.2	0.34	0.38	0.44	0.49	0.55	0.62	0.68	0.75	0.83
9	585.0	0.34	0.39	0.45	0.51	0.57	0.63	0.70	0.77	0.85
10	572.0	0.35	0.40	0.46	0.52	0.58	0.65	0.72	0.79	0.87
11	559.2	0.36	0.41	0.47	0.53	0.59	0.66	0.73	0.81	0.89
12	546.6	0.37	0.42	0.48	0.54	0.61	0.68	0.75	0.83	0.91
13	534.2	0.38	0.43	0.49	0.55	0.62	0.69	0.77	0.84	0.93
14	522.1	0.38	0.44	0.50	0.57	0.63	0.71	0.78	0.86	0.95
15	510.1	0.39	0.45	0.51	0.58	0.65	0.72	0.80	0.88	0.97
16	498.4	0.40	0.46	0.53	0.59	0.66	0.74	0.82	0.91	0.99
17	486.9	0.41	0.47	0.54	0.61	0.68	0.76	0.84	0.93	1.02
18	475.7	0.42	0.48	0.55	0.62	0.70	0.78	0.86	0.95	1.04
19	464.7	0.43	0.50	0.56	0.64	0.71	0.79	0.88	0.97	1.07
20	453.9	0.44	0.51	0.58	0.65	0.73	0.81	0.90	0.99	1.09
21	443.5	0.45	0.52	0.59	0.67	0.75	0.83	0.92	1.02	1.12
22	433.3	0.46	0.53	0.60	0.68	0.76	0.85	0.94	1.04	1.14
23	423.4	0.47	0.54	0.62	0.70	0.78	0.87	0.97	1.07	1.17
24	413.7	0.48	0.56	0.63	0.71	0.80	0.89	0.99	1.09	1.20
25	404.4	0.50	0.57	0.65	0.73	0.82	0.91	1.01	1.12	1.22
26	395.3	0.51	0.58	0.66	0.75	0.84	0.93	1.04	1.14	1.25
27	386.4	0.52	0.60	0.68	0.76	0.86	0.96	1.06	1.17	1.28
28	377.9	0.53	0.61	0.69	0.78	0.88	0.98	1.08	1.19	1.31
29	369.6	0.54	0.62	0.71	0.80	0.90	1.00	1.11	1.22	1.34
30	361.7	0.55	0.64	0.72	0.82	0.92	1.02	1.13	1.25	1.37

15.6 Table 6: Profile Table, 100mm² OAK

Ordinates for plotting Ground Clearance 10% @ 15°C										
Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		70	80	90	95	100	105	110	120	125
0	590.0	0.34	0.44	0.56	0.63	0.69	0.76	0.84	1.00	1.08
5	526.6	0.38	0.50	0.63	0.70	0.78	0.86	0.94	1.12	1.21
10	468.8	0.43	0.56	0.71	0.79	0.87	0.96	1.06	1.26	1.36
15	417.4	0.48	0.63	0.79	0.88	0.98	1.08	1.19	1.41	1.53
20	372.7	0.54	0.70	0.89	0.99	1.10	1.21	1.33	1.58	1.71
25	334.9	0.60	0.78	0.99	1.10	1.22	1.35	1.48	1.76	1.91
30	303.3	0.66	0.86	1.09	1.22	1.35	1.49	1.63	1.94	2.11
35	277.0	0.72	0.95	1.20	1.33	1.48	1.63	1.79	2.13	2.31
40	255.1	0.79	1.03	1.30	1.45	1.60	1.77	1.94	2.31	2.51
45	236.7	0.85	1.11	1.40	1.56	1.73	1.91	2.09	2.49	2.70
50	221.3	0.91	1.18	1.50	1.67	1.85	2.04	2.24	2.66	2.89
55	208.1	0.96	1.26	1.59	1.77	1.97	2.17	2.38	2.83	3.07
60	196.7	1.02	1.33	1.68	1.88	2.08	2.29	2.52	2.99	3.25
65	186.9	1.07	1.40	1.77	1.98	2.19	2.41	2.65	3.15	3.42
70	178.2	1.12	1.47	1.86	2.07	2.30	2.53	2.78	3.31	3.59
75	170.6	1.18	1.54	1.94	2.16	2.40	2.64	2.90	3.45	3.75
These are the calculated sags after 25 years of long term conductor creep.										

15.7 Table 7: Pole Sizing for Intermediate and Section Poles, 100mm² OAK

Pole Length (m)	Average / Poor Soil 314 kN/m²/m													
	Wind Span (m)													
	70		80		90		100		110		115 Maximum for single pole		125 "H" Pole	
	Class of Pole and Number of Blocks													
9	S	1	S	1	S	1	ES	2	ES	2	ES	2	2 x S	1
10	S	1	S	1	S	1	ES	2	ES	2	ES	2	2 x S	1
11	S	1	S	1	S	1	ES	2	ES	2	ES	2	2 x S	1
12	S	1	S	1	S	1	ES	2	ES	2	ES+	2	2 x S	1
13	S	1	S	1	S	1	ES	2	ES	2	ES	2	2 x S	1
14	S	1	S	1	S	1	S	2	ES	2	ES	2	2 x S	1
15 (NF)	S	1	S	1	S	1	S	2	ES	2	ES	2	2 x S	1
16	S	1	S	1	S	1	S	2	ES	2	ES	2	2 x S	1
17 (NF)	S	1	S	1	S	1	S	2	ES	2	ES	2	2 x S	1
18 (NF)	S	0	S	0	S	0	S	2	S	2	ES	2	2 x S	1
20 (NF)	S	0	S	0	S	0	S	2	S	2	ES	2	2 x S	1
22 (NF)	S	0	S	0	S	0	S	2	ES	2	ES	2	2 x S	1

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" pole

1 = upper 1500mm block 2 = upper & lower 1500mm blocks NF = Non Framework

Pole Length (m)	Foundation Depth (m)
9.0 – 11.0 inc.	2.0
12.0 – 14.0 inc.	2.2
15.0 – 17.0 inc.	2.4
18.0 – 22.0 inc.	2.8

15.8 Table 8: Pole and Stay Sizing for Angle & Terminal Poles, 100mm² OAK, 45° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
10°	Fig 9,11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
15°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
20°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
25°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
30°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
35°	Fig 11,13	S	1	S	1	S	1	S	1	ES	1	ES	1	ES	1
40°	Fig 11,13	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
45°	Fig 11,13	S	2	S	2	S	2	ES	2	ES	2	ES	2	ES+	2
50°	Fig 11,13	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
55°	Fig 11,13	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
60°/Term	Fig 11,13,18	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
75°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4
H Terminal	Fig 19	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2
Downpull 1:5															
10°	Fig 9,12,13,14	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
15°	Fig 12,13,14	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
20°	Fig 12,13,14	S	1	S	1	S	1	S	1	ES	1	ES	1	ES	1
25°	Fig 12,13,14	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
30°	Fig 12,13,14	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES+	1
35°	Fig 12,13	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
40°	Fig 12,13	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
45°	Fig 12,13	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
50°	Fig 12,13	S	2	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
55°	Fig 12,13	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
60°	Fig 12,13	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
75°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4
H Terminal	Fig 19	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2
Stay Spread @ 45°		6.8m		7.8m		8.8m		9.6m		10.6m		11.6m		13.4m	
Stay block distance @ 45°		8.2m		9.2m		10.2m		11.0m		12.0m		13.0m		14.8m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

15.9 Table 9: Pole and Stay Sizing for Angle & Terminal Poles, 100mm² OAK, 40° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
10°	Fig 9,11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
15°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
20°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
25°	Fig 11,13,14	S	1	S	1	S	1	S	1	ES	1	ES	1	ES	1
30°	Fig 11,13,14	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
35°	Fig 11,13	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES+	1
40°	Fig 11,13	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
45°	Fig 11,13	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
50°	Fig 11,13	S	2	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
55°	Fig 11,13	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
60°/Term	Fig 11,13,18	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
75°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4
H Terminal	Fig 19	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2
Downpull 1:5															
10°	Fig 9,12,13,14	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
15°	Fig 12,13,14	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
20°	Fig 12,13,14	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
25°	Fig 12,13,14	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
30°	Fig 12,13,14	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
35°	Fig 12,13	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
40°	Fig 12,13	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
45°	Fig 12,13	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
50°	Fig 12,13	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
55°	Fig 12,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
60°	Fig 12,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
75°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4
H Terminal	Fig 19	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2
Stay Spread @ 40°		5.7m		6.6m		7.4m		8.1m		8.9m		9.8m		11.3m	
Stay block distance @ 40°		7.0m		7.9m		8.7m		9.4m		10.2m		11.0m		12.6m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

15.10 Table 10: Pole and Stay Sizing for Angle & Terminal Poles, 100mm² OAK, 35° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
10°	Fig 9,11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
15°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
20°	Fig 11,13,14	S	1	S	1	S	1	S	1	ES	1	ES	1	ES	1
25°	Fig 11,13,14	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
30°	Fig 11,13,14	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
35°	Fig 11,13	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
40°	Fig 11,13	S	2	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
45°	Fig 11,13	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
50°	Fig 11,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
55°	Fig 11,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
60°/Term	Fig 11,13,18	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
75°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4
H Terminal	Fig 19	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2
Downpull 1:5															
10°	Fig 9,12,13,14	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
15°	Fig 12,13,14	S	1	S	1	S	1	S	1	ES	1	ES	1	ES	1
20°	Fig 12,13,14	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES+	1
25°	Fig 12,13,14	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
30°	Fig 12,13,14	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
35°	Fig 12,13	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
40°	Fig 12,13	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
45°	Fig 12,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
50°	Fig 12,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
55°	Fig 12,13	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2	ES+	2
60°	Fig 12,13	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2	ES+	2
75°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4
H Terminal	Fig 19	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x ES	2	2 x ES	2
Stay Spread @ 35°		4.8m		5.5m		6.2m		6.7m		7.4m		8.1m		9.4m	
Stay block distance @ 35°		5.9m		6.6m		7.3m		7.9m		8.6m		9.3m		10.5m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

15.11 Table 11: Pole and Stay Sizing for Angle & Terminal Poles, 100mm² OAK, 30° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
10°	Fig 9,11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
15°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
20°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
25°	Fig 11,13,14	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
30°	Fig 11,13,14	S	2	S	2	S	2	ES	2	ES	2	ES	2	ES+	2
35°	Fig 11,13	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
40°	Fig 11,13	S	2	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
45°	Fig 11,13	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
50°	Fig 11,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
55°	Fig 11,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
60°/Term	Fig 11,13,18	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2	ES+	2
75°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4
H Terminal	Fig 19	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x S	2	2 x ES	2	2 x ES	2
Downpull 1:5															
10°	Fig 9,12,13,14	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
15°	Fig 12,13,14	S	1	S	1	S	1	S	1	ES	1	ES	1	ES	1
20°	Fig 12,13,14	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES+	1
25°	Fig 12,13,14	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
30°	Fig 12,13,14	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
35°	Fig 12,13	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
40°	Fig 12,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
45°	Fig 12,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
50°	Fig 12,13	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2	ES+	2
55°	Fig 12,13	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2	2 x ES	2
60°	Fig 12,13	ES	2	ES+	2	ES+	2	ES+	2	ES+	2	2 x ES	2	2 x ES	2
75°	Fig 13	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4
H Terminal	Fig 19	2 x S	2	2 x S	2	2 x S	2	2 x ES	2	2 x S	2	2 x ES	2	2 x ES	2
Stay Spread @ 30°		3.9m		4.5m		5.1m		5.6m		6.1m		6.7m		7.8m	
Stay block distance @ 30°		4.9m		5.5m		6.1m		6.6m		7.1m		7.7m		8.8m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

15.12 Table 12: Strut Load in Single Poles, 100mm² OAK, Single Pole, 1 or 2 Stays

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	10°	9,779	8,920	8,251	7,709
	15°	11,067	9,982	9,137	8,452
	20°	12,344	11,034	10,016	9,190
	25°	13,607	12,076	10,885	9,919
	30°	14,855	13,105	11,743	10,639
	35°	16,084	14,118	12,589	11,349
	40°	17,293	15,115	13,421	12,047
	45°	18,478	16,093	14,237	12,731
	50°	19,639	17,050	15,035	13,401
	55°	20,772	17,984	15,815	14,056
	60° & Terminal	21,876	18,894	16,575	14,693
	75°	24,990	21,461	18,717	16,491
Downpull 1:5	10°	11,447	10,588	9,919	9,377
	15°	12,735	11,650	10,805	10,120
	20°	14,012	12,702	11,684	10,858
	25°	15,275	13,744	12,553	11,587
	30°	16,523	14,773	13,411	12,307
	35°	17,752	15,786	14,257	13,017
	40°	18,961	16,783	15,089	13,715
	45°	20,146	17,761	15,905	14,399
	50°	21,307	18,718	16,703	15,069
	55°	22,440	19,652	17,483	15,724
	60° & Terminal	23,544	20,562	18,243	16,361
	75°	26,658	23,129	20,385	18,159
This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.					

15.13 Table 13: Strut Load in "H" Poles, 100mm² OAK, 3 or 5 Stays, 60:40 load

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	10°	5,496	4,960	4,543	4,205
	15°	6,269	5,597	5,075	4,651
	20°	7,035	6,229	5,602	5,093
	25°	7,793	6,854	6,123	5,531
	30°	8,541	7,471	6,638	5,963
	35°	9,279	8,079	7,146	6,389
	40°	10,004	8,677	7,645	6,807
	45°	10,716	9,264	8,134	7,218
	50°	11,412	9,838	8,613	7,620
	55°	12,092	10,398	9,081	8,013
	60° & Terminal	12,754	10,945	9,537	8,395
	75°	14,622	12,485	10,822	9,474
Downpull 1:5	10°	6,330	5,794	5,377	5,039
	15°	7,103	6,431	5,909	5,485
	20°	7,869	7,063	6,436	5,927
	25°	8,627	7,688	6,957	6,365
	30°	9,375	8,305	7,472	6,797
	35°	10,113	8,913	7,980	7,223
	40°	10,838	9,511	8,479	7,641
	45°	11,550	10,098	8,968	8,052
	50°	12,246	10,672	9,447	8,454
	55°	12,926	11,232	9,915	8,847
	60° & Terminal	13,588	11,779	10,371	9,229
	75°	15,456	13,319	11,656	10,308
This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.					

15.14 Table 14: Strut Load in "H" Poles, 100mm² OAK, 4 or 6 Stays, 50:50 load

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	10°	4,987	4,540	4,192	3,911
	15°	5,631	5,071	4,636	4,282
	20°	6,269	5,597	5,075	4,651
	25°	6,901	6,118	5,509	5,016
	30°	7,525	6,632	5,939	5,376
	35°	8,139	7,139	6,361	5,731
	40°	8,743	7,638	6,777	6,079
	45°	9,336	8,126	7,185	6,422
	50°	9,917	8,605	7,585	6,757
	55°	10,483	9,072	7,974	7,084
	60° & Terminal	11,035	9,527	8,354	7,403
	75°	12,592	10,811	9,425	8,301
Downpull 1:5	10°	5,821	5,374	5,026	4,745
	15°	6,465	5,905	5,470	5,116
	20°	7,103	6,431	5,909	5,485
	25°	7,735	6,952	6,343	5,850
	30°	8,359	7,466	6,773	6,210
	35°	8,973	7,973	7,195	6,565
	40°	9,577	8,472	7,611	6,914
	45°	10,170	8,960	8,019	7,256
	50°	10,751	9,439	8,419	7,591
	55°	11,317	9,906	8,808	7,918
	60° & Terminal	11,869	10,361	9,188	8,237
	75°	13,426	11,645	10,259	9,135
This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.					

15.15 Table 15: Construction Terminal, 100mm² OAK

LINE ANGLE	Strut Load (Back Stay Angle 64°)	Pole Class		
		Length	Single Pole	"H" Pole
Downpull 1:10	9,667 kgf	9m – 14m 15m – 18m 19m – 22m	S ES ES+	2 x S 2 x S 2 x S
Downpull 1:5	11,335 kgf	9m – 12m 12m – 17m 18m – 22m	S ES ES+	2 x S 2 x S 2 x S
M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole				

15.16 Table 16: Stayed Pole Strut Capabilities, 100mm² OAK

Pole (m)	Grade	Pole Top Dia (mm)	Dia 1.5m from Butt (mm)	Planting Depth (mm)	Pole Strut Strength (kgf)
9	STOUT	190	275	2000	18,938
10	STOUT	190	285	2000	15,392
11	STOUT	190	295	2000	12,902
12	STOUT	190	305	2200	11,388
13	STOUT	195	320	2200	10,817
14	STOUT	195	335	2200	9,852
15 (NF)	STOUT	195	350	2400	9,263
16	STOUT	200	365	2400	9,080
17 (NF)	STOUT	200	375	2400	8,300
18 (NF)	STOUT	200	390	2800	8,076
20 (NF)	STOUT	200	415	2800	7,148
22 (NF)	STOUT	200	435	2800	6,326
9	EXTRA STOUT	205	295	2000	25,403
10	EXTRA STOUT	210	305	2000	21,698
11	EXTRA STOUT	215	315	2000	19,076
12	EXTRA STOUT	215	325	2200	16,777
13	EXTRA STOUT	215	340	2200	14,949
14	EXTRA STOUT	220	365	2200	14,962
15 (NF)	EXTRA STOUT	220	370	2400	13,296
16	EXTRA STOUT	220	385	2400	12,282
17 (NF)	EXTRA STOUT	220	415	2400	12,294
18 (NF)	EXTRA STOUT	220	415	2800	11,095
20 (NF)	EXTRA STOUT	220	435	2800	9,512
22 (NF)	EXTRA STOUT	220	470	2800	8,929
9	EXTRA STOUT PLUS	230	315	2000	36,959
10	EXTRA STOUT PLUS	229	325	2000	29,473
11	EXTRA STOUT PLUS	228	335	2000	24,246
12	EXTRA STOUT PLUS	230	350	2200	22,232
13	EXTRA STOUT PLUS	240	370	2200	22,182
14	EXTRA STOUT PLUS	245	390	2200	21,345
15 (NF)	EXTRA STOUT PLUS	250	410	2400	21,184
16	EXTRA STOUT PLUS	255	430	2400	20,702
17 (NF)	EXTRA STOUT PLUS	260	435	2400	19,137
18 (NF)	EXTRA STOUT PLUS	254	440	2800	16,820
20 (NF)	EXTRA STOUT PLUS	260	465	2800	15,325
22 (NF)	EXTRA STOUT PLUS	270	485	2800	14,445

NF = Non Framework

This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.

16. APPENDIX 3: 150mm² AAAC "ASH" CONDUCTOR

16.1 Table 1: Design Parameters, 150mm² ASH

Design Parameters		
Conductor Nominal Size	150 AAAC	
Code Name	Ash	
BS EN 50182 Code	181-AL3	
Conductor Stranding	19/3.48	mm
Ungreased Conductor Weight	0.4961	kg/m
Weight of Grease	0.011	kg/m
Conductor Greasing to ER-L38	CAT 3	
Data input into ENA TS 43-40 Spreadsheet		
Greased Conductor Weight	0.5071	kg/m
Cross Sectional Area of Conductor	180.7	mm²
Conductor Overall Diameter	17.4	mm
Coefficient of Linear Expansion	0.000023	/°C
Modulus of Elasticity	5700	kg/mm²
Rated Breaking Strength of Conductor (RBS)	5436.1	kgf (BS EN 50182 value)
Basic / Recommended Span	90	m
Wind Pressure on Conductor	380	N/m²
Radial Ice Thickness	9.5	mm
Ice Density	913	kg/m³
Absolute Maximum Working Tension (MWT) Limit	1532.0	kgf (MWT set by SPEN)
Temperature at MWT Limit	-5.6	°C
Maximum "Everyday" Tension (EDT) Limit	1087.22	kgf (20% of RBS)
Temperature at EDT Limit	5	°C
Equipment Weight	600	kg
Wind Span	115	m
Results from ENA TS 43-40 Spreadsheet		
Actual Everyday Stress	16.1	% (Design ruled by MWT)
Maximum Conductor Tension @ -5.6°C (MCT)	1532.0	kgf
Maximum Conductor Weight (MCW)	1.24	kg/m
Maximum Conductor Pressure (MCP)	1.41	kg/m
Freezing Point Tension (FPT) at 0°C	971.6	kgf
Minimum ENA TS 43-40 Conductor Factor of Safety	2.5	
Actual Conductor Factor of Safety Used	3.55	
Working FoS @ -5.6°C with Ice and Wind	3.55	
Working FoS @ -5.6°C without Ice and Wind	5.01	
Additional Design Parameters		
Erection Over-Tension @ 15°C (short term creep)	10	%
Ground Clearance Profile Ordinate Tension Reduction @ 15°C (long term creep)	-10	%
Weather Coordinates for Clashing Model	2 D	Normal Weather Area
Design Temperature		
Maximum Conductor Temperature for Assessing Ground Clearances	50ºC	
Factors of Safety		
Unstayed Poles	3.5	
Pole Foundations	3.5	
Stayed Poles	2.5	
Stays	2.5	
Steelwork	2.5	
Pin Insulators	2.5	

16.2 Table 2: Support Types and Duties Table, 150mm² ASH

Structure Type		Max Span Length (m)	Max Wind/ Weight Span (m)	Max Gradient	Angle of Line Deviation	SP Energy Networks' Reference
Intermediate	Single Pole (Single *crossarm*)	110	115	1:10	0º	Fig 8 – SP4147831
	Single Pole (*Double crossarm*)	110	115	1:5	0º	Fig 9 – SP4147832
	"H" Pole *(Long Span)*	130	130	1:5	0º	Fig 10 – SP4147833
Pin Angle	Single Pole (*Double crossarm*)	110	115	1:5	5º	Fig 9 – SP4147832
Straight Section	Single Pole	110	105	1:10	0º	Fig 11 – SP4147834
	Single Pole *(Long Tie Strap)*	95	115	1:5	0º	Fig 12 – SP4147835
	"H" Pole	110	115	1:5	0º	Fig 13 – SP4147836
	"H" Pole (*Long Span*)	130	130	1:5	0º	Fig 14 – SP4147837
Angle Section	Single Pole	110	100	1:10	15º	Fig 11 – SP4147834
	Single Pole *(Long Tie Strap)*	110	115	1:5	45º	Fig 12 – SP4147835
	"H" Pole	110	115	1:5	75º	Fig 13 – SP4147836
	"H" Pole *(Long Span)*	130	130	1:5	30º	Fig 14 – SP4147837
Tee-Off	Stub Leg	110	60	1:5	0º	Fig 23 – SP4147861
Terminal	"H" Pole	110	60	1:5	0º	Fig 19 – SP4147852

NOTE: * See Section 12.2.2 for guidance on hillside applications.

16.3 Table 3: Conductor Design Table, 150mm² ASH

Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		70	80	90	95	100	105	110	120	130
-5.6	1085.4	0.29	0.37	0.47	0.53	0.58	0.64	0.71	0.84	0.99
0	971.6	0.32	0.42	0.53	0.59	0.65	0.72	0.79	0.94	1.10
5	875.2	0.35	0.46	0.59	0.65	0.72	0.80	0.88	1.04	1.22
10	785.1	0.40	0.52	0.65	0.73	0.81	0.89	0.98	1.16	1.36
15	702.6	0.44	0.58	0.73	0.81	0.90	0.99	1.09	1.30	1.52
20	629.0	0.49	0.64	0.82	0.91	1.01	1.11	1.22	1.45	1.70
25	564.8	0.55	0.72	0.91	1.01	1.12	1.24	1.36	1.62	1.90
30	510.0	0.61	0.80	1.01	1.12	1.24	1.37	1.50	1.79	2.10
35	463.6	0.67	0.88	1.11	1.23	1.37	1.51	1.65	1.97	2.31
40	424.8	0.73	0.96	1.21	1.35	1.49	1.65	1.81	2.15	2.52
45	392.2	0.79	1.03	1.31	1.46	1.62	1.78	1.96	2.33	2.73
50	364.7	0.85	1.11	1.41	1.57	1.74	1.92	2.10	2.50	2.94
55	341.3	0.91	1.19	1.50	1.68	1.86	2.05	2.25	2.67	3.14
60	321.3	0.97	1.26	1.60	1.78	1.97	2.17	2.39	2.84	3.33
65	304.0	1.02	1.33	1.69	1.88	2.08	2.30	2.52	3.00	3.52
70	289.0	1.07	1.40	1.78	1.98	2.19	2.42	2.65	3.16	3.71
75	275.8	1.13	1.47	1.86	2.07	2.30	2.53	2.78	3.31	3.88
These are the calculated sags after 2 years of short term conductor creep.										

16.4 Table 4: Conductor Pre-Tension Table, 150mm² ASH

22.7% of Conductor RBS for 60 minutes									
Pre-tension at all temperatures (kgf)	Sag (m) for Span (m)								
	70	75	80	85	90	95	100	105	110
1231	0.25	0.29	0.33	0.37	0.42	0.46	0.51	0.57	0.62

16.5 Table 5: Conductor Erection Table, 150mm² ASH

10% increase in tension @ 15°C										
Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		70	75	80	85	90	95	100	105	110
0	1058.4	0.29	0.34	0.38	0.43	0.49	0.54	0.60	0.66	0.72
1	1037.9	0.30	0.34	0.39	0.44	0.49	0.55	0.61	0.67	0.74
2	702.6	0.44	0.51	0.58	0.65	0.73	0.81	0.90	0.99	1.09
3	702.6	0.44	0.51	0.58	0.65	0.73	0.81	0.90	0.99	1.09
4	977.4	0.32	0.36	0.42	0.47	0.53	0.59	0.65	0.71	0.78
5	957.6	0.32	0.37	0.42	0.48	0.54	0.60	0.66	0.73	0.80
6	938.0	0.33	0.38	0.43	0.49	0.55	0.61	0.68	0.75	0.82
7	918.7	0.34	0.39	0.44	0.50	0.56	0.62	0.69	0.76	0.83
8	899.6	0.35	0.40	0.45	0.51	0.57	0.64	0.70	0.78	0.85
9	880.7	0.35	0.40	0.46	0.52	0.58	0.65	0.72	0.79	0.87
10	862.0	0.36	0.41	0.47	0.53	0.60	0.66	0.74	0.81	0.89
11	843.6	0.37	0.42	0.48	0.54	0.61	0.68	0.75	0.83	0.91
12	825.5	0.38	0.43	0.49	0.55	0.62	0.69	0.77	0.85	0.93
13	807.7	0.38	0.44	0.50	0.57	0.64	0.71	0.78	0.87	0.95
14	790.1	0.39	0.45	0.51	0.58	0.65	0.72	0.80	0.88	0.97
15	772.9	0.40	0.46	0.52	0.59	0.66	0.74	0.82	0.90	0.99
16	756.0	0.41	0.47	0.54	0.61	0.68	0.76	0.84	0.92	1.01
17	739.4	0.42	0.48	0.55	0.62	0.69	0.77	0.86	0.95	1.04
18	723.1	0.43	0.49	0.56	0.63	0.71	0.79	0.88	0.97	1.06
19	707.2	0.44	0.50	0.57	0.65	0.73	0.81	0.90	0.99	1.08
20	691.7	0.45	0.52	0.59	0.66	0.74	0.83	0.92	1.01	1.11
21	676.5	0.46	0.53	0.60	0.68	0.76	0.85	0.94	1.03	1.13
22	661.6	0.47	0.54	0.61	0.69	0.78	0.86	0.96	1.06	1.16
23	647.2	0.48	0.55	0.63	0.71	0.79	0.88	0.98	1.08	1.19
24	633.1	0.49	0.56	0.64	0.72	0.81	0.90	1.00	1.10	1.21
25	619.4	0.50	0.58	0.65	0.74	0.83	0.92	1.02	1.13	1.24
26	606.0	0.51	0.59	0.67	0.76	0.85	0.94	1.05	1.15	1.27
27	593.1	0.52	0.60	0.68	0.77	0.87	0.96	1.07	1.18	1.29
28	580.5	0.54	0.61	0.70	0.79	0.88	0.99	1.09	1.20	1.32
29	568.3	0.55	0.63	0.71	0.81	0.90	1.01	1.12	1.23	1.35
30	556.5	0.56	0.64	0.73	0.82	0.92	1.03	1.14	1.26	1.38

16.6 Table 6: Profile Table, 150mm² ASH

Ordinates for plotting Ground Clearance 10% @ 15°C										
Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		70	80	90	95	100	105	110	120	130
0	879.7	0.35	0.46	0.58	0.65	0.72	0.79	0.87	1.04	1.22
5	789.2	0.39	0.51	0.65	0.72	0.80	0.89	0.97	1.16	1.36
10	706.4	0.44	0.57	0.73	0.81	0.90	0.99	1.09	1.29	1.52
15	632.4	0.49	0.64	0.81	0.90	1.00	1.11	1.21	1.44	1.69
20	567.7	0.55	0.71	0.90	1.01	1.12	1.23	1.35	1.61	1.89
25	512.4	0.61	0.79	1.00	1.12	1.24	1.36	1.50	1.78	2.09
30	465.7	0.67	0.87	1.10	1.23	1.36	1.50	1.65	1.96	2.30
35	426.5	0.73	0.95	1.20	1.34	1.49	1.64	1.80	2.14	2.51
40	393.6	0.79	1.03	1.30	1.45	1.61	1.78	1.95	2.32	2.72
45	365.9	0.85	1.11	1.40	1.56	1.73	1.91	2.10	2.49	2.93
50	342.4	0.91	1.18	1.50	1.67	1.85	2.04	2.24	2.67	3.13
55	322.2	0.96	1.26	1.59	1.78	1.97	2.17	2.38	2.83	3.32
60	304.8	1.02	1.33	1.68	1.88	2.08	2.29	2.52	2.99	3.51
65	289.7	1.07	1.40	1.77	1.97	2.19	2.41	2.65	3.15	3.70
70	276.4	1.12	1.47	1.86	2.07	2.29	2.53	2.78	3.30	3.88
75	264.6	1.17	1.53	1.94	2.16	2.40	2.64	2.90	3.45	4.05
These are the calculated sags after 25 years of long term conductor creep.										

16.7 Table 7: Pole Sizing for Intermediate and Section Poles, 150mm² ASH

Pole Length (m)	Average / Poor Soil 314 kN/m²/m													
	Wind Span (m)													
	70		80		90		100		110		115 Maximum for single pole		130 "H" Pole	
	Class of Pole and Number of Blocks													
9	S	1	S	1	S	1	ES	2	ES	2	ES+	2	2 x S	1
10	S	1	S	1	ES	1	ES	2	ES+	2	ES+	2	2 x S	1
11	S	1	S	1	ES	1	ES	2	ES+	2	ES+	2	2 x S	1
12	S	1	S	1	ES	1	ES	2	ES+	2	ES+	2	2 x S	1
13	S	1	S	1	ES	2	ES	2	ES+	2	ES+	2	2 x S	1
14	S	1	S	1	S	2	ES	2	ES	2	ES	2	2 x S	1
15 (NF)	S	1	S	1	S	2	ES	2	ES	2	ES	2	2 x S	1
16	S	1	S	1	S	2	ES	2	ES	2	ES	2	2 x S	1
17 (NF)	S	1	S	1	S	2	ES	2	ES	2	ES	2	2 x S	1
18 (NF)	S	0	S	0	S	0	ES	1	ES	1	ES	2	2 x S	1
20 (NF)	S	0	S	0	S	0	S	1	ES	1	ES	2	2 x S	1
22 (NF)	S	0	S	0	S	1	ES	1	ES	1	ES	2	2 x S	1

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" pole

1 = upper 1500mm block 2 = upper & lower 1500mm blocks NF = Non Framework

Pole Length (m)	Foundation Depth (m)
9.0 – 11.0 inc.	2.0
12.0 – 14.0 inc.	2.2
15.0 – 17.0 inc.	2.4
18.0 – 22.0 inc.	2.8

16.8 Table 8: Pole and Stay Sizing for Angle & Terminal Poles, 150mm² ASH, 45° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
5°	Fig 9,11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
15°	Fig 11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
20°	Fig 13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
25°	Fig 13,14	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
30°	Fig 13,14	S	2	S	2	S	2	S	2	S	2	ES	2	ES	2
35°	Fig 13	S	2	S	2	S	2	ES	2	ES	2	ES	2	ES	2
40°	Fig 13	S	2	S	2	S	2	ES	2	ES	2	ES	2	ES+	2
45°	Fig 13	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
50°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3
55°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3
60°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3
75°	Fig 13	2 x ES	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x ES	4
H Terminal	Fig 19	2 x ES	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x ES	4
Downpull 1:5															
5°	Fig 9,12,13,14	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
15°	Fig 12,13,14	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES+	1
20°	Fig 12,13,14	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
25°	Fig 12,13,14	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
30°	Fig 12,13,14	S	2	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
35°	Fig 12,13	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
40°	Fig 12,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
45°	Fig 12,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
50°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3
55°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3
60°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3
75°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4
H Terminal	Fig 19	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4
Stay Spread @ 45°		6.8m		7.8m		8.8m		9.6m		10.6m		11.6m		13.4m	
Stay block distance @ 45°		8.2m		9.2m		10.2m		11.0m		12.0m		13.0m		14.8m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used.

16.9 Table 9: Pole and Stay Sizing for Angle & Terminal Poles, 150mm² ASH, 40° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
5°	Fig 9,11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	S	1
15°	Fig 11,13,14	S	1	S	1	S	1	S	1	ES	1	ES	1	ES	1
20°	Fig 13,14	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
25°	Fig 13,14	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
30°	Fig 13,14	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
35°	Fig 13	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
40°	Fig 13	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
45°	Fig 13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
50°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3
55°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3
60°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3
75°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4
H Terminal	Fig 19	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4
Downpull 1:5															
5°	Fig 9,12,13,14	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
15°	Fig 12,13,14	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
20°	Fig 12,13,14	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
25°	Fig 12,13,14	S	1	ES	1	ES	1	ES	1	ES+	1	ES+	1	ES+	1
30°	Fig 12,13,14	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
35°	Fig 12,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
40°	Fig 12,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
45°	Fig 12,13	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2	ES+	2
50°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3
55°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
60°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
75°	Fig 13	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4
H Terminal	Fig 19	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4
Stay Spread @ 40°		5.7m		6.6m		7.4m		8.1m		8.9m		9.8m		11.3m	
Stay block distance @ 40°		7.0m		7.9m		8.7m		9.4m		10.2m		11.0m		12.6m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

16.10 Table 10: Pole and Stay Sizing for Angle & Terminal Poles, 150mm² ASH, 35° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
5°	Fig 9,11,13,14	S	1	S	1	S	1	S	1	S	1	S	1	ES	1
15°	Fig 11,13,14	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
20°	Fig 13,14	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
25°	Fig 13,14	S	2	S	2	ES	2	ES	2	ES	2	ES	2	ES+	2
30°	Fig 13,14	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
35°	Fig 13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
40°	Fig 13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
45°	Fig 13	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2	ES+	2
50°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
55°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
60°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
75°	Fig 13	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4
H Terminal	Fig 19	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4
Downpull 1:5															
5°	Fig 9,12,13,14	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
15°	Fig 12,13,14	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
20°	Fig 12,13,14	S	1	ES	1	ES	1	ES	1	ES+	1	ES+	1	ES+	1
25°	Fig 12,13,14	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
30°	Fig 12,13,14	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
35°	Fig 12,13	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2	ES+	2
40°	Fig 12,13	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2	2 x ES	3
45°	Fig 12,13	ES	2	ES+	2	ES+	2	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
50°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
55°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
60°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
75°	Fig 13	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4
H Terminal	Fig 19	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4
Stay Spread @ 35°		4.8m		5.5m		6.2m		6.7m		7.4m		8.1m		9.4m	
Stay block distance @ 35°		5.9m		6.6m		7.3m		7.9m		8.6m		9.3m		10.5m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

16.11 Table 11: Pole and Stay Sizing for Angle & Terminal Poles, 150mm² ASH, 30° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
5°	Fig 9,11,13,14	S	1	S	1	S	1	S	1	S	1	ES	1	ES	1
15°	Fig 11,13,14	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
20°	Fig 13,14	S	2	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
25°	Fig 13,14	S	2	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2
30°	Fig 13,14	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
35°	Fig 13	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2	ES+	2
40°	Fig 13	ES	2	ES	2	ES+	2	ES+	2	ES+	2	2 x ES	3	2 x ES+	3
45°	Fig 13	ES	3	ES+	3	ES+	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
50°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
55°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
60°	Fig 13	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
75°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	n	2 x ES+	n	2 x ES+	n
H Terminal	Fig 19	2 x S	4	2 x S	4	4	3	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4
Downpull 1:5															
5°	Fig 9,12,13,14	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
15°	Fig 12,13,14	S	1	ES	1	ES	1	ES	1	ES+	1	ES+	1	ES+	1
20°	Fig 12,13,14	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
25°	Fig 12,13,14	ES	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
30°	Fig 12,13,14	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2	ES+	2
35°	Fig 12,13	ES	2	ES+	2	ES+	2	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
40°	Fig 12,13	ES	2	ES+	2	ES+	2	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
45°	Fig 12,13	ES+	3	ES+	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
50°	Fig 13	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
55°	Fig 13	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
60°	Fig 13	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
75°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
H Terminal	Fig 19	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
Stay Spread @ 30°		3.9m		4.5m		5.1m		5.6m		6.1m		6.7m		7.8m	
Stay block distance @ 30°		4.9m		5.5m		6.1m		6.6m		7.1m		7.7m		8.8m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

16.12 Table 12: Strut Load in Single Poles, 150mm² ASH, Single Pole 1 or 2 Stays

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	5°	9,915	9,172	8,595	6,876
	15°	13,358	12,011	10,964	7,845
	20°	15,060	13,415	12,135	8,325
	25°	16,745	14,805	13,295	8,799
	30°	18,410	16,177	14,441	9,268
	35°	20,052	17,531	15,570	9,730
	40°	21,667	18,862	16,681	10,185
	45°	23,252	20,170	17,772	10,631
	50°	24,804	21,450	18,840	11,068
	55°	26,321	22,700	19,884	11,496
	60° & Terminal	27,799	23,919	20,901	11,912
	75°	31,975	27,362	23,774	13,088
Downpull 1:5	5°	12,135	11,393	10,815	9,096
	15°	15,578	14,232	13,184	10,065
	20°	17,280	15,635	14,356	10,545
	25°	18,966	17,025	15,515	11,019
	30°	20,630	18,398	16,661	11,488
	35°	22,272	19,751	17,790	11,950
	40°	23,887	21,083	18,901	12,405
	45°	25,472	22,390	19,992	12,851
	50°	27,024	23,670	21,060	13,289
	55°	28,541	24,920	22,104	13,716
	60° & Terminal	30,020	26,139	23,121	14,132
	75°	34,195	29,582	25,994	15,308
This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.					

16.13 Table 13: Strut Load in "H" Poles, 150mm² ASH, 3 or 5 Stays, 60:40 load

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	5°	5,497	5,031	4,669	4,375
	15°	7,563	6,735	6,090	5,568
	20°	8,584	7,577	6,793	6,157
	25°	9,595	8,411	7,489	6,741
	30°	10,594	9,234	8,176	7,318
	35°	11,579	10,046	8,854	7,887
	40°	12,548	10,845	9,521	8,446
	45°	13,499	11,629	10,175	8,995
	50°	14,431	12,398	10,816	9,533
	55°	15,341	13,148	11,442	10,058
	60° & Terminal	16,228	13,879	12,052	10,570
	75°	18,733	15,945	13,776	12,017
Downpull 1:5	5°	6,607	6,141	5,779	5,485
	15°	8,673	7,845	7,200	6,678
	20°	9,694	8,687	7,903	7,267
	25°	10,706	9,521	8,599	7,851
	30°	11,704	10,344	9,286	8,428
	35°	12,689	11,156	9,964	8,997
	40°	13,658	11,955	10,631	9,556
	45°	14,609	12,740	11,285	10,105
	50°	15,541	13,508	11,926	10,643
	55°	16,451	14,258	12,552	11,168
	60° & Terminal	17,338	14,989	13,162	11,681
	75°	19,843	17,055	14,886	13,127
This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.					

16.14 Table 14: Strut Load in "H" Poles, 150mm² ASH, 4 or 6 Stays, 50:50 load

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	5°	5,055	4,666	4,364	4,120
	15°	6,776	6,086	5,549	5,113
	20°	7,627	6,788	6,135	5,605
	25°	8,470	7,482	6,714	6,091
	30°	9,302	8,169	7,287	6,572
	35°	10,123	8,846	7,852	7,046
	40°	10,931	9,511	8,407	7,512
	45°	11,723	10,165	8,953	7,970
	50°	12,499	10,805	9,487	8,418
	55°	13,258	11,430	10,009	8,856
	60° & Terminal	13,997	12,040	10,517	9,282
	75°	16,085	13,761	11,954	10,488
Downpull 1:5	5°	6,165	5,776	5,475	5,230
	15°	7,886	7,196	6,659	6,224
	20°	8,737	7,898	7,245	6,715
	25°	9,580	8,593	7,824	7,201
	30°	10,412	9,279	8,397	7,682
	35°	11,233	9,956	8,962	8,156
	40°	12,041	10,621	9,518	8,622
	45°	12,833	11,275	10,063	9,080
	50°	13,609	11,915	10,597	9,528
	55°	14,368	12,540	11,119	9,966
	60° & Terminal	15,107	13,150	11,627	10,392
	75°	17,195	14,871	13,064	11,598
This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.					

16.15 Table 15: Construction Terminal, 150mm² ASH

LINE ANGLE	Strut Load (Back Stay Angle 64°)	Pole Class		
		Length	Single Pole	"H" Pole
Downpull 1:10	11,912 kgf	9m – 11m 12m – 17m 18m – 22m	S ES ES+	- 2 x S or 2 x ES
Downpull 1:5	14,132 kgf	9m – 14m 15m – 22m	ES ES+	2 x S 2 x S
M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole				

16.16 Table 16: Stayed Pole Strut Capabilities, 150mm² ASH

Pole (m)	Grade	Pole Top Dia (mm)	Dia 1.5m from Butt (mm)	Planting Depth (mm)	Pole Strut Strength (kgf)
9	STOUT	190	275	2000	18,938
10	STOUT	190	285	2000	15,392
11	STOUT	190	295	2000	12,902
12	STOUT	190	305	2200	11,388
13	STOUT	195	320	2200	10,817
14	STOUT	195	335	2200	9,852
15 (NF)	STOUT	195	350	2400	9,263
16	STOUT	200	365	2400	9,080
17 (NF)	STOUT	200	375	2400	8,300
18 (NF)	STOUT	200	390	2800	8,076
20 (NF)	STOUT	200	415	2800	7,148
22 (NF)	STOUT	200	435	2800	6,326
9	EXTRA STOUT	205	295	2000	25,403
10	EXTRA STOUT	210	305	2000	21,698
11	EXTRA STOUT	215	315	2000	19,076
12	EXTRA STOUT	215	325	2200	16,777
13	EXTRA STOUT	215	340	2200	14,949
14	EXTRA STOUT	220	365	2200	14,962
15 (NF)	EXTRA STOUT	220	370	2400	13,296
16	EXTRA STOUT	220	385	2400	12,282
17 (NF)	EXTRA STOUT	220	415	2400	12,294
18 (NF)	EXTRA STOUT	220	415	2800	11,095
20 (NF)	EXTRA STOUT	220	435	2800	9,512
22 (NF)	EXTRA STOUT	220	470	2800	8,929
9	EXTRA STOUT PLUS	230	315	2000	36,959
10	EXTRA STOUT PLUS	229	325	2000	29,473
11	EXTRA STOUT PLUS	228	335	2000	24,246
12	EXTRA STOUT PLUS	230	350	2200	22,232
13	EXTRA STOUT PLUS	240	370	2200	22,182
14	EXTRA STOUT PLUS	245	390	2200	21,345
15 (NF)	EXTRA STOUT PLUS	250	410	2400	21,184
16	EXTRA STOUT PLUS	255	430	2400	20,702
17 (NF)	EXTRA STOUT PLUS	260	435	2400	19,137
18 (NF)	EXTRA STOUT PLUS	254	440	2800	16,820
20 (NF)	EXTRA STOUT PLUS	260	465	2800	15,325
22 (NF)	EXTRA STOUT PLUS	270	485	2800	14,445

NF = Non Framework

This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.

17. APPENDIX 4: 200mm² AAAC "POPLAR" CONDUCTOR

17.1 Table 1: Design Parameters, 200mm² POPLAR

Design Parameters		
Conductor Nominal Size	200 AAAC	
Code Name	Poplar	
BS EN 50182 Code	239-AL3	
Conductor Stranding	37/2.87	mm
Ungreased Conductor Weight	0.6594	kg/m
Weight of Grease	0.0218	kg/m
Conductor Greasing to ER-L38	CAT 3	
Data input into ENA TS 43-40 Spreadsheet		
Greased Conductor Weight	0.6812	kg/m
Cross Sectional Area of Conductor	239.4	mm²
Conductor Overall Diameter	20.09	mm
Coefficient of Linear Expansion	0.000023	/°C
Modulus of Elasticity	5700	kg/mm²
Rated Breaking Strength of Conductor (RBS)	7200.0	kgf (BS EN 50182 value)
Basic / Recommended Span	80	m
Wind Pressure on Conductor	380	N/m²
Radial Ice Thickness	9.5	mm
Ice Density	913	kg/m³
Absolute Maximum Working Tension (MWT) Limit	1887.0	kgf (MWT set by SPEN)
Temperature at MWT Limit	-5.6	°C
Maximum "Everyday" Tension (EDT) Limit	1440.0	kgf (20% of RBS)
Temperature at EDT Limit	5	°C
Equipment Weight	600	kg
Wind Span	115	m
Results from ENA TS 43-40 Spreadsheet		
Actual Everyday Stress	16.8	% (Design ruled by MWT)
Maximum Conductor Tension @ -5.6°C (MCT)	1887.0	kgf
Maximum Conductor Weight (MCW)	1.487	kg/m
Maximum Conductor Pressure (MCP)	1.515	kg/m
Freezing Point Tension (FPT) at 0°C	1344.1	kgf
Minimum ENA TS 43-40 Conductor Factor of Safety	2.5	
Actual Conductor Factor of Safety Used	3.82	
Working FoS @ -5.6°C with Ice and Wind	3.82	
Working FoS @ -5.6°C without Ice and Wind	4.80	
Additional Design Parameters		
Erection Over-Tension @ 15°C (short term creep)	10	%
Ground Clearance Profile Ordinate Tension Reduction @ 15°C (long term creep)	-10	%
Weather Coordinates for Clashing Model	4 D	Severe Weather Area
Design Temperature		
Maximum Conductor Temperature for Assessing Ground Clearances	65ºC	
Factors of Safety		
Unstayed Poles	3.5	
Pole Foundations	3.5	
Stayed Poles	3.5	
Stays	3.5	
Steelwork	3.5	
Pin Insulators	3.5	

17.2 Table 2: Support Types and Duties Table, 200mm² POPLAR

Structure Type		Max Span Length (m)	Max Wind/ Weight Span (m)	Max Gradient	Angle of Line Deviation	SP Energy Networks' Reference
Intermediate	Single Pole (*Double crossarm*)	100	115	1:10	0º	Fig 9 – SP4147832
	"H" Pole *(With pin insulators)*	100	115	1:5	0º	Fig 13 – SP4147836
	"H" Pole *(Long Span)*	130	130	1:10	0º	Fig 10 – SP4147833
Pin Angle	Single Pole (*Double crossarm*)	100	115	1:10	3º	Fig 9 – SP4147832
Straight Section	Single Pole *(Long Tie Strap)*	100	115	1:10	0º	Fig 12 – SP4147835
	"H" Pole	100	115	1:5	0º	Fig 13 – SP4147836
	"H" Pole (*Long Span*)	130	130	1:10	0º	Fig 14 – SP4147837
	"H" Pole Delta	130	130	1:5	0º	Fig 15 – SP4147838
Angle Section	Single Pole *(Long Tie Strap)*	100	115	1:10	30º	Fig 12 – SP4147835
	"H" Pole	100	115	1:5	60º	Fig 13 – SP4147836
	"H" Pole Delta	130	130	1:5	60º	Fig 15 – SP4147838
Tee-Off	Stub Leg	100	60	1:10	0º	Fig 23 – SP4147861
Terminal	"H" Pole	100	60	1:10	0º	Fig 19 – SP4147852

NOTE: * See Section 12.2.2 for guidance on hillside applications.

17.3 Table 3: Conductor Design Table, 200mm² POPLAR

Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		70	80	90	95	100	105	110	120	130
-5.6	1501.3	0.28	0.36	0.46	0.51	0.57	0.63	0.69	0.82	0.96
0	1344.1	0.31	0.41	0.51	0.57	0.63	0.70	0.77	0.91	1.07
5	1209.2	0.35	0.45	0.57	0.64	0.70	0.78	0.85	1.01	1.19
10	1081.2	0.39	0.50	0.64	0.71	0.79	0.87	0.95	1.13	1.33
15	962.2	0.43	0.57	0.72	0.80	0.88	0.98	1.07	1.27	1.50
20	854.3	0.49	0.64	0.81	0.90	1.00	1.10	1.21	1.44	1.68
25	759.1	0.55	0.72	0.91	1.01	1.12	1.24	1.36	1.62	1.90
30	677.2	0.62	0.80	1.02	1.13	1.26	1.39	1.52	1.81	2.12
35	608.4	0.69	0.90	1.13	1.26	1.40	1.54	1.69	2.02	2.37
40	551.1	0.76	0.99	1.25	1.39	1.54	1.70	1.87	2.22	2.61
45	503.7	0.83	1.08	1.37	1.53	1.69	1.86	2.05	2.43	2.86
50	464.4	0.90	1.17	1.49	1.65	1.83	2.02	2.22	2.64	3.10
55	431.5	0.97	1.26	1.60	1.78	1.97	2.18	2.39	2.84	3.34
60	403.7	1.03	1.35	1.71	1.90	2.11	2.33	2.55	3.04	3.56
65	380.0	1.10	1.43	1.82	2.02	2.24	2.47	2.71	3.23	3.79
70	359.6	1.16	1.52	1.92	2.14	2.37	2.61	2.87	3.41	4.00
75	341.8	1.22	1.59	2.02	2.25	2.49	2.75	3.01	3.59	4.21
These are the calculated sags after 2 years of short term conductor creep.										

17.4 Table 4: Conductor Pre-Tension Table, 200mm² POPLAR

23.5% of Conductor RBS for 60 minutes									
Pre-tension at all temperatures (kgf)	Sag (m) for Span (m)								
	60	65	70	75	80	85	90	95	100
1695	0.18	0.21	0.25	0.28	0.32	0.36	0.41	0.45	0.50

17.5 Table 5: Conductor Erection Table, 200mm² POPLAR

10% increase in tension @ 15°C										
Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		60	65	70	75	80	85	90	95	100
0	1458.0	0.21	0.25	0.29	0.33	0.37	0.42	0.47	0.53	0.58
1	1429.8	0.21	0.25	0.29	0.34	0.38	0.43	0.48	0.54	0.60
2	962.2	0.32	0.37	0.43	0.50	0.57	0.64	0.72	0.80	0.88
3	962.2	0.32	0.37	0.43	0.50	0.57	0.64	0.72	0.80	0.88
4	1346.2	0.23	0.27	0.31	0.36	0.40	0.46	0.51	0.57	0.63
5	1318.7	0.23	0.27	0.32	0.36	0.41	0.47	0.52	0.58	0.65
6	1291.5	0.24	0.28	0.32	0.37	0.42	0.48	0.53	0.60	0.66
7	1264.4	0.24	0.28	0.33	0.38	0.43	0.49	0.55	0.61	0.67
8	1237.7	0.25	0.29	0.34	0.39	0.44	0.50	0.56	0.62	0.69
9	1211.2	0.25	0.30	0.34	0.40	0.45	0.51	0.57	0.63	0.70
10	1184.9	0.26	0.30	0.35	0.40	0.46	0.52	0.58	0.65	0.72
11	1159.0	0.26	0.31	0.36	0.41	0.47	0.53	0.60	0.66	0.73
12	1133.4	0.27	0.32	0.37	0.42	0.48	0.54	0.61	0.68	0.75
13	1108.1	0.28	0.32	0.38	0.43	0.49	0.56	0.62	0.69	0.77
14	1083.1	0.28	0.33	0.39	0.44	0.50	0.57	0.64	0.71	0.79
15	1058.5	0.29	0.34	0.39	0.45	0.51	0.58	0.65	0.73	0.80
16	1034.2	0.30	0.35	0.40	0.46	0.53	0.59	0.67	0.74	0.82
17	1010.4	0.30	0.36	0.41	0.47	0.54	0.61	0.68	0.76	0.84
18	987.0	0.31	0.36	0.42	0.49	0.55	0.62	0.70	0.78	0.86
19	963.9	0.32	0.37	0.43	0.50	0.57	0.64	0.72	0.80	0.88
20	941.4	0.33	0.38	0.44	0.51	0.58	0.65	0.73	0.82	0.90
21	919.3	0.33	0.39	0.45	0.52	0.59	0.67	0.75	0.84	0.93
22	897.6	0.34	0.40	0.46	0.53	0.61	0.69	0.77	0.86	0.95
23	876.5	0.35	0.41	0.48	0.55	0.62	0.70	0.79	0.88	0.97
24	855.8	0.36	0.42	0.49	0.56	0.64	0.72	0.81	0.90	0.99
25	835.7	0.37	0.43	0.50	0.57	0.65	0.74	0.83	0.92	1.02
26	816.1	0.38	0.44	0.51	0.59	0.67	0.75	0.85	0.94	1.04
27	797.0	0.38	0.45	0.52	0.60	0.68	0.77	0.87	0.96	1.07
28	778.4	0.39	0.46	0.54	0.62	0.70	0.79	0.89	0.99	1.09
29	760.4	0.40	0.47	0.55	0.63	0.72	0.81	0.91	1.01	1.12
30	742.9	0.41	0.48	0.56	0.64	0.73	0.83	0.93	1.03	1.15

17.6 Table 6: Profile Table, 200mm² POPLAR

Ordinates for plotting Ground Clearance 10% @ 15°C										
Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		70	80	90	95	100	105	110	120	130
0	1224.3	0.34	0.45	0.56	0.63	0.70	0.77	0.84	1.00	1.18
5	1095.4	0.38	0.50	0.63	0.70	0.78	0.86	0.94	1.12	1.31
10	975.3	0.43	0.56	0.71	0.79	0.87	0.96	1.06	1.26	1.48
15	866.0	0.48	0.63	0.80	0.89	0.98	1.08	1.19	1.42	1.66
20	769.3	0.54	0.71	0.90	1.00	1.11	1.22	1.34	1.59	1.87
25	685.9	0.61	0.79	1.01	1.12	1.24	1.37	1.50	1.79	2.10
30	615.6	0.68	0.89	1.12	1.25	1.38	1.52	1.67	1.99	2.34
35	557.1	0.75	0.98	1.24	1.38	1.53	1.68	1.85	2.20	2.58
40	508.7	0.82	1.07	1.36	1.51	1.67	1.85	2.03	2.41	2.83
45	468.5	0.89	1.16	1.47	1.64	1.82	2.00	2.20	2.62	3.07
50	435.0	0.96	1.25	1.59	1.77	1.96	2.16	2.37	2.82	3.31
55	406.6	1.03	1.34	1.70	1.89	2.09	2.31	2.53	3.02	3.54
60	382.5	1.09	1.42	1.80	2.01	2.23	2.45	2.69	3.21	3.76
65	361.8	1.15	1.51	1.91	2.12	2.35	2.59	2.85	3.39	3.98
70	343.7	1.21	1.59	2.01	2.24	2.48	2.73	3.00	3.57	4.19
75	327.9	1.27	1.66	2.10	2.34	2.60	2.86	3.14	3.74	4.39
These are the calculated sags after 25 years of long term conductor creep.										

17.7 Table 7: Pole Sizing for Intermediate and Section Poles, 200mm² POPLAR

Pole Length (m)	Average / Poor Soil 314 kN/m²/m													
	Wind Span (m)													
	70		80		90		100		110		115 Maximum for single pole		130 "H" Pole	
	Class of Pole and Number of Blocks													
9	S	1	S	1	ES	2	ES	2	ES+	2	ES+	2	2 x S	1
10	S	1	S	2	ES	2	ES	2	ES+	2	ES+	2	2 x S	1
11	S	1	S	2	ES	2	ES+	2	ES+	2	ES+	2	2 x S	1
12	S	1	S	2	ES	2	ES+	2	ES+	2	ES+	2	2 x S	1
13	S	1	S	2	ES	2	ES	2	ES+	2	ES+	2	2 x S	1
14	S	1	S	2	ES	2	ES	2	ES	2	ES+	2	2 x S	1
15 (NF)	S	0	S	1	ES	1	ES	2	ES+	2	ES+	2	2 x S	1
16	S	0	S	1	S	1	ES	2	ES	2	ES+	2	2 x S	1
17 (NF)	S	0	S	1	S	1	ES	2	ES	2	ES	2	2 x S	1
18 (NF)	S	0	S	1	S	1	ES	2	ES	2	ES	2	2 x S	1
20 (NF)	S	0	S	1	S	1	ES	2	ES	2	ES+	2	2 x S	1
22 (NF)	S	0	S	1	S	2	ES	2	ES	2	ES	2	2 x S	1

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" pole

1 = upper 1500mm block 2 = upper & lower 1500mm blocks NF = Non Framework

Pole Length (m)	Foundation Depth (m)
9.0 – 11.0 inc.	2.2
12.0 – 14.0 inc.	2.4
15.0 – 17.0 inc.	2.8
18.0 – 22.0 inc.	3.0

17.8 Table 8: Pole and Stay Sizing for Angle & Terminal Poles, 200mm² POPLAR, 45° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
3°	Fig 9,12,13,15	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES	1
6°	Fig 12,13,15	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES+	1
10°	Fig 12,13,15	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
20°	Fig 12,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
25°	Fig 12,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
30°	Fig 12,13	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2	ES+	2
35°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3
40°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
45°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
50°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
55°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
60°	Fig 13	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
H Terminal	Fig 19	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
Downpull 1:5															
3°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3
6°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3
10°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3
20°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3
25°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4
30°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4
35°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x ES	4
40°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4
45°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4
50°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4
55°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4
60°	Fig 13	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4
H Terminal	Fig 19	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
Stay Spread @ 45°		6.6m		7.6m		8.6m		9.4m		10.4m		11.4m		13.0m	
Stay block distance @ 45°		8.0m		9.0m		10.0m		10.8m		11.8m		12.8m		14.4m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

17.9 Table 9: Pole and Stay Sizing for Angle & Terminal Poles, 200mm² POPLAR, 40° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
3°	Fig 9,12,13,15	S	1	S	1	S	1	ES	1	ES	1	ES	1	ES+	1
6°	Fig 12,13,15	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
10°	Fig 12,13,15	S	1	S	1	ES	1	ES	1	ES+	1	ES+	1	ES+	1
20°	Fig 12,13	S	2	ES	2	ES	2	ES+	2	ES+	2	ES+	2	ES+	2
25°	Fig 12,13	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3
30°	Fig 12,13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
35°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
40°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
45°	Fig 13	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
50°	Fig 13	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
55°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
60°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
H Terminal	Fig 19	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
Downpull 1:5															
3°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3
6°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3
10°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3
20°	Fig 13	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
25°	Fig 13	2 x S	4	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4
30°	Fig 13	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4
35°	Fig 13	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4
40°	Fig 13	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
45°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
50°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
55°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
60°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
H Terminal	Fig 19	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
Stay Spread @ 40°		5.6m		6.4m		7.2m		7.9m		8.7m		9.6m		10.9m	
Stay block distance @ 40°		6.8m		7.7m		8.5m		9.2m		10.0m		10.9m		12.2m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

17.10 Table 10: Pole and Stay Sizing for Angle & Terminal Poles, 200mm² POPLAR, 35° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
3°	Fig 9,12,13,15	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
6°	Fig 12,13,15	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
10°	Fig 12,13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3
20°	Fig 12,13	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3
25°	Fig 12,13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
30°	Fig 12,13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
35°	Fig 13	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
40°	Fig 13	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
45°	Fig 13	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
50°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
55°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
60°	Fig 13	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
H Terminal	Fig 19	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
Downpull 1:5															
3°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3
6°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3
10°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3
20°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
25°	Fig 13	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4
30°	Fig 13	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4
35°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
40°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
45°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
50°	Fig 13	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
55°	Fig 13	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
60°	Fig 13	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	n	n	n	n
H Terminal	Fig 19	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	n	n	n	n
Stay Spread @ 35°		4.6m		5.3m		6.0m		6.6m		7.3m		8.0m		9.1m	
Stay block distance @ 35°		5.8m		6.5m		7.2m		7.7m		8.4m		9.1m		10.3m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

17.11 Table 11: Pole and Stay Sizing for Angle & Terminal Poles, 200mm² POPLAR, 30° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
3°	Fig 9,12,13,15	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
6°	Fig 12,13,15	S	1	ES	1	ES	1	ES	1	ES+	1	ES+	1	ES+	1
10°	Fig 12,13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3
20°	Fig 12,13	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3
25°	Fig 12,13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
30°	Fig 12,13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
35°	Fig 13	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
40°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
45°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
50°	Fig 13	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
55°	Fig 13	2 x ES	5	2 x ES	5	2 x ES+	5	2 x ES+	5	2 x ES+	5	n	n	n	n
60°	Fig 13	2 x ES	5	2 x ES+	5	2 x ES+	5	n	n	n	n	n	n	n	n
H Terminal	Fig 19	2 x ES	6	2 x ES	6	2 x ES+	6	n	n	n	n	n	n	n	n
Downpull 1:5															
3°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3
6°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3
10°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3
20°	Fig 13	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
25°	Fig 13	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4
30°	Fig 13	2 x S	4	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4
35°	Fig 13	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
40°	Fig 13	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
45°	Fig 13	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
50°	Fig 13	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	n	n	n	n
55°	Fig 13	2 x ES	5	2 x ES+	5	2 x ES+	5	n	n	n	n	n	n	n	n
60°	Fig 13	2 x ES	5	2 x ES+	5	n	n	n	n	n	n	n	n	n	n
H Terminal	Fig 19	2 x ES	6	2 x ES+	6	n	n	n	n	n	n	n	n	n	n
Stay Spread @ 30°		3.8m		4.4m		5.0m		5.4m		6.0m		6.6m		7.5m	
Stay block distance @ 30°		4.8m		5.4m		6.0m		6.4m		7.0m		7.6m		8.5m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

17.12 Table 12: Strut Load in Single Poles, 200mm² POPLAR, Single Pole, 1 or 2 Stays

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	3°	14,507	13,540	12,789	12,179
	6°	16,299	15,018	14,022	13,214
	10°	18,681	16,982	15,661	14,589
	20°	24,582	21,847	19,721	17,996
	25°	27,492	24,247	21,723	19,676
	30°	30,368	26,618	23,702	21,336
	35°	33,204	28,957	25,653	22,974
	40°	35,995	31,258	27,574	24,585
	45°	38,736	33,518	29,460	26,168
	50°	41,421	35,732	31,307	27,718
	55°	44,046	37,897	33,113	29,233
	60° & Terminal	46,605	40,006	34,874	30,711
Downpull 1:5	3°	18,335	17,369	16,617	16,007
	6°	20,127	18,847	17,850	17,042
	10°	22,510	20,811	19,489	18,417
	20°	28,410	25,676	23,549	21,824
	25°	31,320	28,075	25,551	23,504
	30°	34,196	30,447	27,530	25,165
	35°	37,032	32,785	29,482	26,802
	40°	39,823	35,087	31,402	28,414
	45°	42,564	37,347	33,288	29,996
	50°	45,250	39,561	35,136	31,546
	55°	47,874	41,725	36,942	33,062
	60° & Terminal	50,433	43,835	38,702	34,539
This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.					

17.13 Table 13: Strut Load in "H" Poles, 200mm² POPLAR, 3 or 5 Stays, 60:40 load

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	3°	7,968	7,359	6,886	6,502
	6°	9,043	8,246	7,626	7,123
	10°	10,472	9,424	8,609	7,948
	20°	14,012	12,343	11,045	9,992
	25°	15,758	13,783	12,246	11,000
	30°	17,484	15,206	13,434	11,996
	35°	19,186	16,609	14,604	12,979
	40°	20,860	17,990	15,757	13,945
	45°	22,505	19,346	16,888	14,895
	50°	24,116	20,674	17,997	15,825
	55°	25,691	21,973	19,080	16,734
	60° & Terminal	27,226	23,239	20,137	17,621
Downpull 1:5	3°	9,882	9,273	8,800	8,416
	6°	10,957	10,160	9,540	9,037
	10°	12,386	11,338	10,523	9,862
	20°	15,927	14,258	12,959	11,906
	25°	17,673	15,697	14,161	12,914
	30°	19,398	17,120	15,348	13,910
	35°	21,100	18,523	16,519	14,893
	40°	22,775	19,904	17,671	15,860
	45°	24,419	21,260	18,803	16,809
	50°	26,030	22,588	19,911	17,739
	55°	27,605	23,887	20,995	18,649
	60° & Terminal	29,141	25,153	22,051	19,535
This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.					

17.14 Table 14: Strut Load in "H" Poles, 200mm² POPLAR, 4 or 6 Stays, 50:50 load

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	3°	7,390	6,882	6,488	6,168
	6°	8,286	7,621	7,105	6,685
	10°	9,477	8,603	7,924	7,373
	20°	12,427	11,036	9,954	9,076
	25°	13,882	12,236	10,955	9,916
	30°	15,320	13,421	11,945	10,747
	35°	16,738	14,591	12,920	11,565
	40°	18,134	15,741	13,881	12,371
	45°	19,504	16,871	14,823	13,162
	50°	20,847	17,978	15,747	13,938
	55°	22,159	19,060	16,650	14,695
	60° & Terminal	23,438	20,115	17,531	15,434
Downpull 1:5	3°	9,304	8,797	8,402	8,082
	6°	10,200	9,536	9,019	8,600
	10°	11,391	10,518	9,838	9,287
	20°	14,341	12,950	11,868	10,991
	25°	15,796	14,150	12,869	11,831
	30°	17,234	15,336	13,859	12,661
	35°	18,652	16,505	14,835	13,480
	40°	20,048	17,656	15,795	14,285
	45°	21,418	18,786	16,738	15,077
	50°	22,761	19,893	17,662	15,852
	55°	24,073	20,975	18,564	16,609
	60° & Terminal	25,353	22,030	19,445	17,348

This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.

17.15 Table 15: Construction Terminal, 200mm² POPLAR

LINE ANGLE	Strut Load (Back Stay Angle 64°)	Pole Class		
		Length	Single Pole	"H" Pole
Downpull 1:10	19,588 kgf	9m 10m – 11m 12m – 17m 18m – 22m	S ES ES+ -	- 2 x S or 2 x ES 2 x ES+
Downpull 1:5	23,417 kgf	9m 10m – 11m 12m – 17m 18m – 22m	ES ES+ - -	2 x S 2 x S 2 x ES 2 x ES+
M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole				

17.16 Table 16: Stayed Pole Strut Capabilities, 200mm² POPLAR

Pole (m)	Grade	Pole Top Dia (mm)	Dia 1.5m from Butt (mm)	Planting Depth (mm)	Pole Strut Strength (kgf)
9	STOUT	190	275	2200	19,792
10	STOUT	190	285	2200	15,978
11	STOUT	190	295	2200	13,320
12	STOUT	190	305	2400	11,717
13	STOUT	195	320	2400	11,091
14	STOUT	195	335	2400	10,069
15 (NF)	STOUT	195	350	2800	9,637
16	STOUT	200	365	2800	9,413
17 (NF)	STOUT	200	375	2800	8,571
18 (NF)	STOUT	200	390	3000	8,197
20 (NF)	STOUT	200	415	3000	7,234
22 (NF)	STOUT	200	435	3000	6,389
9	EXTRA STOUT	205	295	2200	26,557
10	EXTRA STOUT	210	305	2200	22,548
11	EXTRA STOUT	215	315	2200	19,730
12	EXTRA STOUT	215	325	2400	17,290
13	EXTRA STOUT	215	340	2400	15,343
14	EXTRA STOUT	220	365	2400	15,306
15 (NF)	EXTRA STOUT	220	370	2800	13,874
16	EXTRA STOUT	220	385	2800	12,754
17 (NF)	EXTRA STOUT	220	415	2800	12,695
18 (NF)	EXTRA STOUT	220	415	3000	11,266
20 (NF)	EXTRA STOUT	220	435	3000	9,634
22 (NF)	EXTRA STOUT	220	470	3000	9,020
9	EXTRA STOUT PLUS	230	315	2200	38,709
10	EXTRA STOUT PLUS	229	325	2200	30,651
11	EXTRA STOUT PLUS	228	335	2200	25,075
12	EXTRA STOUT PLUS	230	350	2400	22,905
13	EXTRA STOUT PLUS	240	370	2400	22,785
14	EXTRA STOUT PLUS	245	390	2400	21,857
15 (NF)	EXTRA STOUT PLUS	250	410	2800	22,128
16	EXTRA STOUT PLUS	255	430	2800	21,527
17 (NF)	EXTRA STOUT PLUS	260	435	2800	19,850
18 (NF)	EXTRA STOUT PLUS	254	440	3000	17,107
20 (NF)	EXTRA STOUT PLUS	260	465	3000	15,547
22 (NF)	EXTRA STOUT PLUS	270	485	3000	14,630

NF = Non Framework

This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.

18. APPENDIX 5: 300mm² AAAC "UPAS" CONDUCTOR

18.1 Table 1: Design Parameters, 300mm² UPAS

Design Parameters		
Conductor Nominal Size	300 AAAC	
Code Name	Upas	
BS EN 50182 Code	362-AL3	
Conductor Stranding	37/3.53	mm
Ungreased Conductor Weight	0.9975	kg/m
Weight of Grease	0.033	kg/m
Conductor Greasing to ER-L38	CAT 3	
Data input into ENA TS 43-40 Spreadsheet		
Greased Conductor Weight	1.0305	kg/m
Cross Sectional Area of Conductor	362.1	mm²
Conductor Overall Diameter	24.71	mm
Coefficient of Linear Expansion	0.000023	/°C
Modulus of Elasticity	5700	kg/mm²
Rated Breaking Strength of Conductor (RBS)	10892.6	kgf (BS EN 50182 value)
Basic / Recommended Span	80	m
Wind Pressure on Conductor	380	N/m²
Radial Ice Thickness	9.5	mm
Ice Density	913	kg/m³
Absolute Maximum Working Tension (MWT) Limit	2100	kgf (MWT set by SPEN)
Temperature at MWT Limit	-5.6	°C
Maximum "Everyday" Tension (EDT) Limit	2178.52	kgf (20% of RBS)
Temperature at EDT Limit	5	°C
Equipment Weight	600	kg
Wind Span	115	m
Results from ENA TS 43-40 Spreadsheet		
Actual Everyday Stress	10.8	% (Design ruled by MWT)
Maximum Conductor Tension @ -5.6°C (MCT)	2100.0	kgf
Maximum Conductor Weight (MCW)	1.963	kg/m
Maximum Conductor Pressure (MCP)	1.694	kg/m
Freezing Point Tension (FPT) at 0°C	1327.2	kgf
Minimum ENA TS 43-40 Conductor Factor of Safety	2.5	
Actual Conductor Factor of Safety Used	5.19	
Working FoS @ -5.6°C with Ice and Wind	5.19	
Working FoS @ -5.6°C without Ice and Wind	7.19	
Additional Design Parameters		
Erection Over-Tension @ 15°C (short term creep)	10	%
Ground Clearance Profile Ordinate Tension Reduction @ 15°C (long term creep)	-10	%
Weather Coordinates for Clashing Model	4 D	Severe Weather Area
Design Temperature		
Maximum Conductor Temperature for Assessing Ground Clearances	65ºC	
Factors of Safety		
Unstayed Poles	3.5	
Pole Foundations	3.5	
Stayed Poles	3.5	
Stays	3.5	
Steelwork	3.5	
Pin Insulators	3.5	

18.2 Table 2: Support Types and Duties Table, 300mm² UPAS

Structure Type		Max Span Length (m)	Max Wind / Weight Span (m)	Max Gradient	Angle of Line Deviation	SP Energy Networks' Reference
Intermediate	Single Pole (*Double crossarm*)	100	110	1:10	0º	Fig 9 – SP4147832
	"H" Pole *(With pin insulators)*	100	115	1:5	0º	Fig 13 – SP4147836
	"H" Pole Delta *(With pin insulators)*	130	115	1:5	0º	Fig 15 – SP4147838
Pin Angle	Single Pole (*Double crossarm*)	100	100	1:10	3º	Fig 9 – SP4147832
Straight Section	Single Pole	N/A	N/A	N/A	N/A	N/A
	"H" Pole	100	115	1:5	0º	Fig 13 – SP4147836
	"H" Pole (*Long Span*)	130	130	1:10	0º	Fig 14 – SP4147837
	"H" Pole Delta	130	130	1:5	0º	Fig 15 – SP4147838
Angle Section	Single Pole	N/A	N/A	N/A	N/A	N/A
	"H" Pole	100	115	1:5	60º	Fig 13 – SP4147836
	"H" Pole Delta	130	130	1:5	60º	Fig 15 – SP4147838
Tee-Off	Stub Leg	100	60	1:10	0º	Fig 23 – SP4147861
Terminal	"H" Pole	100	60	1:10	0º	Fig 19 – SP4147852

NOTE: * See Section 12.2.2 for guidance on hillside applications.

18.3 Table 3: Conductor Design Table, 300mm² UPAS

Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		70	80	90	95	100	105	110	120	130
-5.6	1515.6	0.42	0.54	0.69	0.77	0.85	0.94	1.03	1.22	1.44
0	1327.2	0.48	0.62	0.79	0.88	0.97	1.07	1.17	1.40	1.64
5	1178.7	0.54	0.70	0.89	0.99	1.09	1.20	1.32	1.57	1.85
10	1050.4	0.60	0.78	0.99	1.11	1.23	1.35	1.48	1.77	2.07
15	942.0	0.67	0.88	1.11	1.23	1.37	1.51	1.65	1.97	2.31
20	851.7	0.74	0.97	1.23	1.36	1.51	1.67	1.83	2.18	2.56
25	776.9	0.81	1.06	1.34	1.50	1.66	1.83	2.01	2.39	2.80
30	714.9	0.88	1.15	1.46	1.63	1.80	1.99	2.18	2.59	3.05
35	663.1	0.95	1.24	1.57	1.75	1.94	2.14	2.35	2.80	3.28
40	619.5	1.02	1.33	1.68	1.88	2.08	2.29	2.52	2.99	3.51
45	582.4	1.08	1.42	1.79	2.00	2.21	2.44	2.68	3.18	3.74
50	550.5	1.15	1.50	1.90	2.11	2.34	2.58	2.83	3.37	3.95
55	522.8	1.21	1.58	2.00	2.22	2.46	2.72	2.98	3.55	4.16
60	498.6	1.27	1.65	2.09	2.33	2.58	2.85	3.13	3.72	4.37
65	477.1	1.32	1.73	2.19	2.44	2.70	2.98	3.27	3.89	4.56
70	458.1	1.38	1.80	2.28	2.54	2.81	3.10	3.40	4.05	4.75
75	441.0	1.43	1.87	2.37	2.64	2.92	3.22	3.53	4.21	4.94
These are the calculated sags after 2 years of short term conductor creep.										

18.4 Table 4: Conductor Pre-Tension Table, 300mm² UPAS

17.9% of Conductor RBS for 60 minutes									
Pre-tension at all temperatures (kgf)	Sag (m) for Span (m)								
	60	65	70	75	80	85	90	95	100
1950	0.24	0.28	0.32	0.37	0.42	0.48	0.54	0.60	0.66

18.5 Table 5: Conductor Erection Table, 300mm² UPAS

10% increase in tension @ 15°C										
Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		60	65	70	75	80	85	90	95	100
0	1473.2	0.31	0.37	0.43	0.49	0.56	0.63	0.71	0.79	0.87
1	1438.8	0.32	0.38	0.44	0.50	0.57	0.65	0.73	0.81	0.90
2	942.0	0.49	0.58	0.67	0.77	0.88	0.99	1.11	1.23	1.37
3	942.0	0.49	0.58	0.67	0.77	0.88	0.99	1.11	1.23	1.37
4	1339.7	0.35	0.41	0.47	0.54	0.62	0.69	0.78	0.87	0.96
5	1308.1	0.35	0.42	0.48	0.55	0.63	0.71	0.80	0.89	0.98
6	1277.3	0.36	0.43	0.49	0.57	0.65	0.73	0.82	0.91	1.01
7	1247.3	0.37	0.44	0.51	0.58	0.66	0.75	0.84	0.93	1.03
8	1218.1	0.38	0.45	0.52	0.59	0.68	0.76	0.86	0.95	1.06
9	1189.6	0.39	0.46	0.53	0.61	0.69	0.78	0.88	0.98	1.08
10	1162.0	0.40	0.47	0.54	0.62	0.71	0.80	0.90	1.00	1.11
11	1135.2	0.41	0.48	0.56	0.64	0.73	0.82	0.92	1.02	1.13
12	1109.2	0.42	0.49	0.57	0.65	0.74	0.84	0.94	1.05	1.16
13	1084.1	0.43	0.50	0.58	0.67	0.76	0.86	0.96	1.07	1.19
14	1059.7	0.44	0.51	0.60	0.68	0.78	0.88	0.98	1.10	1.22
15	1036.2	0.45	0.53	0.61	0.70	0.80	0.90	1.01	1.12	1.24
16	1013.4	0.46	0.54	0.62	0.71	0.81	0.92	1.03	1.15	1.27
17	991.5	0.47	0.55	0.64	0.73	0.83	0.94	1.05	1.17	1.30
18	970.3	0.48	0.56	0.65	0.75	0.85	0.96	1.08	1.20	1.33
19	949.8	0.49	0.57	0.66	0.76	0.87	0.98	1.10	1.22	1.36
20	930.1	0.50	0.59	0.68	0.78	0.89	1.00	1.12	1.25	1.38
21	911.1	0.51	0.60	0.69	0.80	0.90	1.02	1.15	1.28	1.41
22	892.8	0.52	0.61	0.71	0.81	0.92	1.04	1.17	1.30	1.44
23	875.2	0.53	0.62	0.72	0.83	0.94	1.06	1.19	1.33	1.47
24	858.2	0.54	0.63	0.74	0.84	0.96	1.08	1.22	1.35	1.50
25	841.8	0.55	0.65	0.75	0.86	0.98	1.11	1.24	1.38	1.53
26	826.1	0.56	0.66	0.76	0.88	1.00	1.13	1.26	1.41	1.56
27	810.9	0.57	0.67	0.78	0.89	1.02	1.15	1.29	1.43	1.59
28	796.3	0.58	0.68	0.79	0.91	1.04	1.17	1.31	1.46	1.62
29	782.3	0.59	0.70	0.81	0.93	1.05	1.19	1.33	1.49	1.65
30	768.7	0.60	0.71	0.82	0.94	1.07	1.21	1.36	1.51	1.68

18.6 Table 6: Profile Table, 300mm² UPAS

Ordinates for plotting Ground Clearance 10% @ 15°C										
Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		70	80	90	95	100	105	110	120	130
0	1172.1	0.54	0.70	0.89	0.99	1.10	1.21	1.33	1.58	1.86
5	1044.8	0.60	0.79	1.00	1.11	1.23	1.36	1.49	1.78	2.08
10	937.3	0.67	0.88	1.11	1.24	1.37	1.52	1.66	1.98	2.32
15	847.8	0.74	0.97	1.23	1.37	1.52	1.68	1.84	2.19	2.57
20	773.7	0.82	1.07	1.35	1.50	1.66	1.84	2.01	2.40	2.81
25	712.2	0.89	1.16	1.47	1.63	1.81	1.99	2.19	2.60	3.06
30	660.8	0.96	1.25	1.58	1.76	1.95	2.15	2.36	2.81	3.29
35	617.6	1.02	1.33	1.69	1.88	2.09	2.30	2.52	3.00	3.52
40	580.8	1.09	1.42	1.80	2.00	2.22	2.45	2.68	3.19	3.75
45	549.1	1.15	1.50	1.90	2.12	2.35	2.59	2.84	3.38	3.96
50	521.6	1.21	1.58	2.00	2.23	2.47	2.72	2.99	3.56	4.17
55	497.5	1.27	1.66	2.10	2.34	2.59	2.85	3.13	3.73	4.38
60	476.2	1.33	1.73	2.19	2.44	2.71	2.98	3.27	3.90	4.57
65	457.2	1.38	1.80	2.28	2.54	2.82	3.11	3.41	4.06	4.76
70	440.2	1.43	1.87	2.37	2.64	2.93	3.23	3.54	4.21	4.95
75	424.8	1.49	1.94	2.46	2.74	3.03	3.34	3.67	4.37	5.12
These are the calculated sags after 25 years of long term conductor creep.										

18.7 Table 7: Pole Sizing for Intermediate and Section Poles, 300mm² UPAS

Pole Length (m)	Average / Poor Soil 314 kN/m²/m													
	Wind Span (m)													
	70		80		90		100		110 Maximum for single pole		120 "H" Pole		130 "H" Pole	
	Class of Pole and Number of Blocks													
9	S	1	ES	1	ES	2	ES+	2	ES+	2	2 x S	1	2 x S	1
10	S	2	ES	2	ES	2	ES+	2	ES+	2	2 x S	1	2 x S	1
11	S	2	ES	2	ES+	2	ES+	2	ES+	2	2 x S	1	2 x S	1
12	S	2	ES	2	ES+	2	ES+	2	ES+	2	2 x S	1	2 x S	1
13	S	2	ES	2	ES	2	ES+	2	ES+	2	2 x S	1	2 x S	1
14	S	2	ES	2	ES	2	ES	2	ES+	2	2 x S	1	2 x S	1
15 (NF)	S	1	ES	1	ES	2	ES+	2	ES+	2	2 x S	1	2 x S	1
16	S	1	S	1	ES	2	ES+	2	ES+	2	2 x S	1	2 x S	1
17 (NF)	S	1	S	1	ES	2	ES	2	ES+	2	2 x S	1	2 x S	1
18 (NF)	S	1	S	1	ES	2	ES	2	ES+	2	2 x S	1	2 x S	1
20 (NF)	S	1	S	1	ES	2	ES	2	ES+	2	2 x S	1	2 x S	1
22 (NF)	S	1	S	1	ES	2	ES	2	ES+	2	2 x S	1	2 x S	1
M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" pole 1 = upper 1500mm block 2 = upper & lower 1500mm blocks NF = Non Framework														

Pole Length (m)	Foundation Depth (m)
9.0 – 11.0 inc.	2.2
12.0 – 14.0 inc.	2.4
15.0 – 17.0 inc.	2.8
18.0 – 22.0 inc.	3.0

18.8 Table 8: Pole and Stay Sizing for Angle & Terminal Poles, 300mm² UPAS, 45° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
3°	Fig 9,13,15	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
6°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3
10°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3
20°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3
25°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3
30°	Fig 13,15	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
35°	Fig 13,15	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
40°	Fig 13,15	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
45°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
50°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
55°	Fig 13,15	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
60°	Fig 13,15	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
H Terminal	Fig 19	2 x S	4	2 x ES	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
Downpull 1:5															
3°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3
6°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3
10°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3
20°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
25°	Fig 13,15	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
30°	Fig 13,15	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
35°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
40°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
45°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
50°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
55°	Fig 13,15	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
60°	Fig 13,15	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
H Terminal	Fig 19	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
Stay Spread @ 45°		6.6m		7.6m		8.6m		8.5m		10.5m		11.5m		13.0m	
Stay block distance @ 45°		8.0m		9.0m		10.0m		10.8m		11.8m		12.8m		14.4m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

18.9 Table 9: Pole and Stay Sizing for Angle & Terminal Poles, 300mm² UPAS, 40° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
3°	Fig 9,13,15	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
6°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3
10°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3
20°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3
25°	Fig 13,15	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
30°	Fig 13,15	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
35°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
40°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
45°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
50°	Fig 13,15	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
55°	Fig 13,15	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
60°	Fig 13,15	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
H Terminal	Fig 19	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
Downpull 1:5															
3°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3
6°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3
10°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3
20°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3
25°	Fig 13,15	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
30°	Fig 13,15	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
35°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
40°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
45°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
50°	Fig 13,15	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
55°	Fig 13,15	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
60°	Fig 13,15	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	n	n
H Terminal	Fig 19	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	n	n
Stay Spread @ 40°		5.6m		6.4m		7.3m		8.0m		8.8m		9.6m		11.0m	
Stay block distance @ 40°		6.8m		7.7m		8.5m		9.2m		10.0m		10.9m		12.2m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

18.10 Table 10: Pole and Stay Sizing for Angle & Terminal Poles, 300mm² UPAS, 35° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
3°	Fig 9,13,15	S	1	S	1	ES	1	ES	1	ES	1	ES	1	ES+	1
6°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3
10°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3
20°	Fig 13,15	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
25°	Fig 13,15	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
30°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
35°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
40°	Fig 13,15	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
45°	Fig 13,15	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
50°	Fig 13,15	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
55°	Fig 13,15	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
60°	Fig 13,15	2 x ES	5	2 x ES	5	2 x ES+	5	2 x ES+	5	2 x ES+	5	n	n	n	n
H Terminal	Fig 19	2 x ES	6	2 x ES	6	2 x ES+	6	2 x ES+	6	2 x ES+	6	n	n	n	n
Downpull 1:5															
3°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3
6°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3
10°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3
20°	Fig 13,15	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
25°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
30°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
35°	Fig 13,15	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
40°	Fig 13,15	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
45°	Fig 13,15	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
50°	Fig 13,15	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	n	4	n	n
55°	Fig 13,15	2 x ES	4	2 x ES+	4	2 x ES+	4	n	n	n	n	n	n	n	n
60°	Fig 13,15	2 x ES	5	2 x ES+	5	2 x ES+	5	n	n	n	n	n	n	n	n
H Terminal	Fig 19	2 x ES	6	2 x ES+	6	2 x ES+	6	n	n	n	n	n	n	n	n
Stay Spread @ 35°		4.6m		5.3m		6.0m		6.6m		7.3m		8.0m		9.1m	
Stay block distance @ 35°		5.8m		6.5m		7.2m		7.7m		8.4m		9.1m		10.3m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

18.11 Table 11: Pole and Stay Sizing for Angle & Terminal Poles, 300mm² UPAS, 30° Stay Spread

Level Conditions		Pole Size & Class and number of 7/4mm Stays													
Line Angle	Structure Type	9m		10m		11m		12m		13m		14m		16m	
		Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St	Pole	St
Downpull 1:10															
3°	Fig 9,13,15	S	1	ES	1	ES	1	ES	1	ES+	1	ES+	1	ES+	1
6°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3
10°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3
20°	Fig 13,15	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
25°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
30°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
35°	Fig 13,15	2 x S	4	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
40°	Fig 13,15	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
45°	Fig 13,15	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	n	n
50°	Fig 13,15	2 x ES	5	2 x ES+	5	2 x ES+	5	n	n	n	n	n	n	n	n
55°	Fig 13,15	2 x ES	5	2 x ES+	5	2 x ES+	5	n	n	n	n	n	n	n	n
60°	Fig 13,15	2 x ES	5	2 x ES+	5	n	n	n	n	n	n	n	n	n	n
H Terminal	Fig 19	2 x ES	6	2 x ES+	6	n	n	n	n	n	n	n	n	n	n
Downpull 1:5															
3°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3
6°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3
10°	Fig 13,15	2 x S	3	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3
20°	Fig 13,15	2 x S	3	2 x S	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES	3	2 x ES+	3
25°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
30°	Fig 13,15	2 x S	3	2 x ES	3	2 x ES	3	2 x ES+	3	2 x ES+	3	2 x ES+	3	2 x ES+	3
35°	Fig 13,15	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	2 x ES+	4
40°	Fig 13,15	2 x ES	4	2 x ES	4	2 x ES+	4	2 x ES+	4	2 x ES+	4	n	n	n	n
45°	Fig 13,15	2 x ES	4	2 x ES+	4	2 x ES+	4	n	n	n	n	n	n	n	n
50°	Fig 13,15	2 x ES	5	2 x ES+	5	n	n	n	n	n	n	n	n	n	n
55°	Fig 13,15	2 x ES+	5	2 x ES+	5	n	n	n	n	n	n	n	n	n	n
60°	Fig 13,15	2 x ES+	5	2 x ES+	5	n	n	n	n	n	n	n	n	n	n
H Terminal	Fig 19	2 x ES+	6	2 x ES+	6	n	n	n	n	n	n	n	n	n	n
Stay Spread @ 30°		3.8m		4.4m		5.0m		5.4m		6.0m		6.6m		7.5m	
Stay block distance @ 30°		4.8m		5.4m		6.0m		6.4m		7.0m		7.6m		8.5m	

M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole n = strut loading too high.

Where "H" poles are used instead of single poles the next pole class down may be used

18.12 Table 12: Strut Load in Single Poles, 300mm² UPAS, Single Pole, 1 or 2 Stays

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	3°	16,103	15,035	14,205	13,531
	6°	18,097	16,680	15,577	14,682
	10°	20,748	18,865	17,401	16,213
	20°	27,315	24,280	21,919	20,004
	25°	30,553	26,950	24,147	21,874
	30°	33,753	29,589	26,349	23,721
	35°	36,909	32,191	28,521	25,544
	40°	40,016	34,752	30,658	27,337
	45°	43,066	37,267	32,757	29,098
	50°	46,054	39,731	34,813	30,823
	55°	48,974	42,139	36,822	32,509
	60° & Terminal	51,822	44,487	38,781	34,153
Downpull 1:5	3°	20,363	19,296	18,465	17,791
	6°	22,358	20,940	19,837	18,943
	10°	25,009	23,126	21,662	20,474
	20°	31,575	28,540	26,180	24,265
	25°	34,814	31,210	28,408	26,134
	30°	38,014	33,849	30,610	27,982
	35°	41,170	36,452	32,781	29,804
	40°	44,276	39,013	34,919	31,598
	45°	47,326	41,528	37,017	33,358
	50°	50,314	43,991	39,073	35,084
	55°	53,235	46,400	41,083	36,770
	60° & Terminal	56,082	48,747	43,042	38,414
This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.					

18.13 Table 13: Strut Load in "H" Poles, 300mm² UPAS, 3 or 5 Stays, 60:40 load

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	3°	8,823	8,154	7,633	7,211
	6°	10,020	9,141	8,457	7,902
	10°	11,611	10,452	9,551	8,820
	20°	15,550	13,701	12,262	11,095
	25°	17,493	15,303	13,599	12,217
	30°	19,414	16,886	14,920	13,325
	35°	21,307	18,448	16,223	14,419
	40°	23,171	19,984	17,505	15,495
	45°	25,001	21,493	18,765	16,551
	50°	26,794	22,971	19,998	17,586
	55°	28,546	24,416	21,204	18,598
	60° & Terminal	30,255	25,825	22,379	19,584
Downpull 1:5	3°	10,954	10,284	9,764	9,341
	6°	12,150	11,271	10,587	10,032
	10°	13,741	12,583	11,681	10,951
	20°	17,681	15,831	14,392	13,225
	25°	19,624	17,433	15,729	14,347
	30°	21,544	19,016	17,050	15,456
	35°	23,438	20,578	18,353	16,549
	40°	25,301	22,115	19,636	17,625
	45°	27,131	23,623	20,895	18,682
	50°	28,924	25,102	22,128	19,717
	55°	30,676	26,547	23,334	20,728
	60° & Terminal	32,385	27,955	24,510	21,715
This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.					

18.14 Table 14: Strut Load in "H" Poles, 300mm² UPAS, 4 or 6 Stays, 50:50 load

LINE ANGLE		Stay Angle			
		30°	35°	40°	45°
		Strut Load (kgf)			
Downpull 1:10	3°	8,187	7,630	7,196	6,844
	6°	9,185	8,452	7,882	7,420
	10°	10,510	9,545	8,794	8,185
	20°	13,793	12,252	11,053	10,081
	25°	15,413	13,587	12,167	11,015
	30°	17,013	14,907	13,268	11,939
	35°	18,591	16,208	14,354	12,850
	40°	20,144	17,488	15,423	13,747
	45°	21,669	18,746	16,472	14,628
	50°	23,163	19,978	17,500	15,490
	55°	24,623	21,182	18,505	16,333
	60° & Terminal	26,047	22,356	19,484	17,155
Downpull 1:5	3°	10,318	9,760	9,326	8,974
	6°	11,315	10,582	10,012	9,550
	10°	12,641	11,675	10,924	10,315
	20°	15,924	14,382	13,183	12,211
	25°	17,543	15,717	14,298	13,146
	30°	19,143	17,037	15,399	14,070
	35°	20,721	18,338	16,484	14,981
	40°	22,274	19,619	17,553	15,877
	45°	23,799	20,876	18,602	16,758
	50°	25,293	22,108	19,630	17,620
	55°	26,754	23,312	20,635	18,464
	60° & Terminal	28,177	24,486	21,615	19,285
This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.					

18.15 Table 15: Construction Terminal, 300mm² UPAS

LINE ANGLE	Strut Load (Back Stay Angle 64°)	Pole Class		
		Length	Single Pole	"H" Pole
Downpull 1:10	21,789 kgf	9m – 10m 11m – 14m 15m – 18m 19m – 22m	ES ES+ - -	2 x S 2 x S 2 x ES 2 x ES+
Downpull 1:5	26,050 kgf	9m 10m – 11m 12m – 15m 16m – 22m	ES ES+ - -	2 x S 2 x S 2 x ES 2 x ES+
M = Medium Pole S = Stout Pole ES = Extra Stout Pole ES+ = Extra Stout Plus 2 x = "H" Pole				

18.16 Table 16: Stayed Pole Strut Capabilities, 300mm² UPAS

Pole (m)	Grade	Pole Top Dia (mm)	Dia 1.5m from Butt (mm)	Planting Depth (mm)	Pole Strut Strength (kgf)
9	STOUT	190	275	2200	19,792
10	STOUT	190	285	2200	15,978
11	STOUT	190	295	2200	13,320
12	STOUT	190	305	2400	11,717
13	STOUT	195	320	2400	11,091
14	STOUT	195	335	2400	10,069
15 (NF)	STOUT	195	350	2800	9,637
16	STOUT	200	365	2800	9,413
17 (NF)	STOUT	200	375	2800	8,571
18 (NF)	STOUT	200	390	3000	8,197
20 (NF)	STOUT	200	415	3000	7,234
22 (NF)	STOUT	200	435	3000	6,389
9	EXTRA STOUT	205	295	2200	26,557
10	EXTRA STOUT	210	305	2200	22,548
11	EXTRA STOUT	215	315	2200	19,730
12	EXTRA STOUT	215	325	2400	17,290
13	EXTRA STOUT	215	340	2400	15,343
14	EXTRA STOUT	220	365	2400	15,306
15 (NF)	EXTRA STOUT	220	370	2800	13,874
16	EXTRA STOUT	220	385	2800	12,754
17 (NF)	EXTRA STOUT	220	415	2800	12,695
18 (NF)	EXTRA STOUT	220	415	3000	11,266
20 (NF)	EXTRA STOUT	220	435	3000	9,634
22 (NF)	EXTRA STOUT	220	470	3000	9,020
9	EXTRA STOUT PLUS	230	315	2200	38,709
10	EXTRA STOUT PLUS	229	325	2200	30,651
11	EXTRA STOUT PLUS	228	335	2200	25,075
12	EXTRA STOUT PLUS	230	350	2400	22,905
13	EXTRA STOUT PLUS	240	370	2400	22,785
14	EXTRA STOUT PLUS	245	390	2400	21,857
15 (NF)	EXTRA STOUT PLUS	250	410	2800	22,128
16	EXTRA STOUT PLUS	255	430	2800	21,527
17 (NF)	EXTRA STOUT PLUS	260	435	2800	19,850
18 (NF)	EXTRA STOUT PLUS	254	440	3000	17,107
20 (NF)	EXTRA STOUT PLUS	260	465	3000	15,547
22 (NF)	EXTRA STOUT PLUS	270	485	3000	14,630

NF = Non Framework

This table is provided for reference only – refer to tables 8 to 11 for pole sizes and stay number to be employed on angle and terminal poles.

19. APPENDIX 6: INSTALLATION REQUIREMENTS FOR CONDUCTORS INCORPORATING OPTICAL FIBRES

19.1 Introduction

This appendix has been prepared to provide a design for 33kV overhead lines suitable for installation on SP Energy Networks' network, utilising optical fibre communication cores embedded within the phase conductors.

The optical fibres are enclosed within two separate stainless steel tubes in a phase conductor. This appendix is complementary to the equivalent standard conductor installation requirements and should be read in conjunction with it.

This appendix details the specific stringing requirements for:

200mm² AAAC Poplar Equivalent OPPC

300mm² AAAC Upas Equivalent OPPC

19.2 General

When compared to a standard overhead line construction, lines incorporating optical fibres shall have the centre phase conductors substituted with an equivalent OPPC.

All overhead line components and design parameters shall comply with the requirements of the standard conductor as specified in the relevant appendix with the exception of those specified in the following sections.

There are specific installation techniques, which require to be employed when installing lines incorporating optical fibres within the conductors. Supplementary guidance for the erection of OPPC, to be used in conjunction with conventional conductor installation guidance, is documented in OHL-18-022.

19.2.1 OPPC

The maximum working tension of an equivalent OPPC is designed to be the same as for a standard AAAC conductor. However, due to the difference in physical construction of the OPPC when compared with standard AAAC conductor, the maximum sag of the OPPC will be marginally less than standard conductor. Using the same tension for both AAAC and OPPC will therefore result in marginally less sag on the OPPC. To counter this difference in sag characteristics, the stringing tensions for OPPC conductors in this Appendix have been adjusted to match, as closely as possible, the sag characteristic of the corresponding standard AAAC conductor.

19.2.2 Crossarms, Supports and Stays

As the loadings for the equivalent OPPC are almost identical to the standard conductor, structure sizing, stay strength and their deployment, and crossarm sizing shall be in accordance with the corresponding standard conductor appendix.

19.3 Materials

Except where otherwise specified, all materials used in the construction of lines to this appendix shall comply with current British Standards, ENA Technical Specifications and international standards where appropriate. Only SP Energy Networks Approved materials shall be used.

19.3.1 OPPC

The optical conductor's physical and electrical parameters considered by this specification are detailed in OHL-03-096. Each conductor shall incorporate two stainless steel buffer tubes each containing a minimum of 12 single mode optical fibres.

19.3.2 Vibration Damper

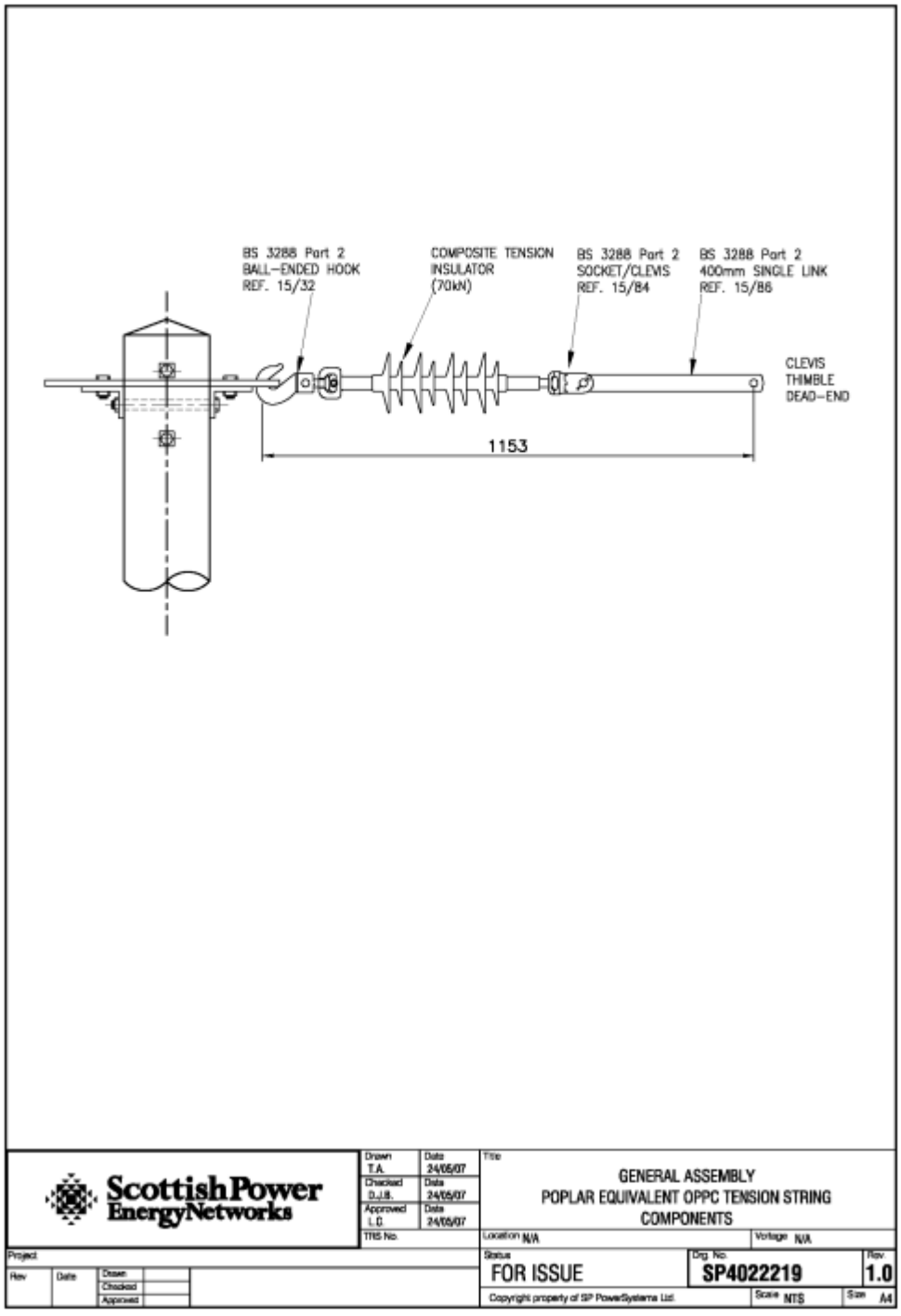
As for standard 33kV line construction, no vibration dampers are normally required to be employed on the OPPC.

19.3.3 Suspension Components

33kV polymeric post insulators, armour grip support clamps and armour rods shall be used at all intermediate insulator positions (including non OPPC phases). The proposed suspension arrangements are not designed to take any uplift load. Where the structure is deemed to be in uplift, the line should be sectioned, and tension support components employed.

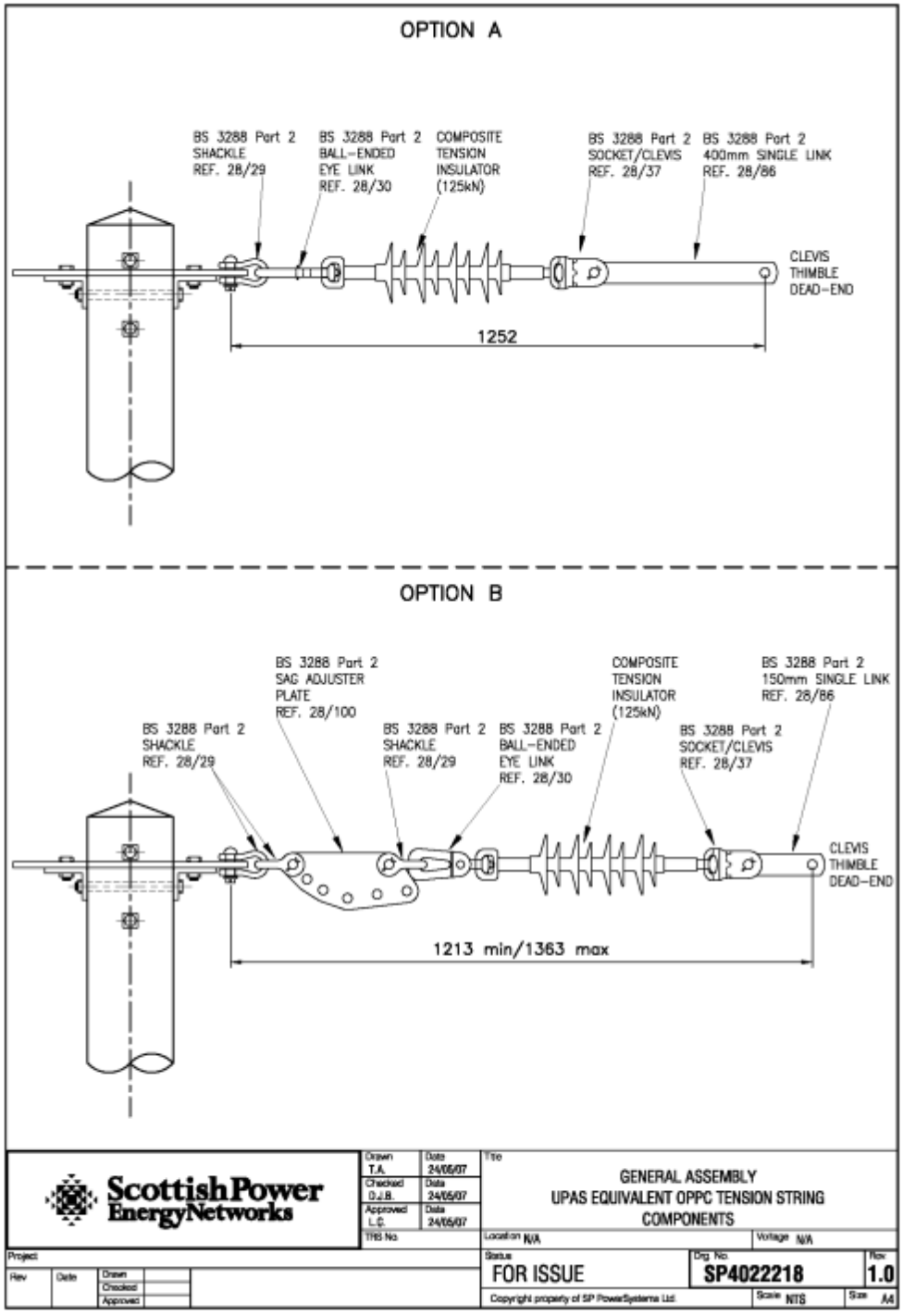
19.3.4 POPLAR Equivalent OPPC Tension String Components (Drawing No. SP4022219)

From termination strap on the crossarm, the following components are required for POPLAR OPPC:



19.3.5 UPAS Equivalent OPPC Tension String Components (Drawing No. SP4022218)

From termination strap on the crossarm, the following components are required for termination of the OPPC:



19.4 Optical Splice Enclosures

At OPPC in-line splice and terminal positions, only SP Energy Networks Approved fibre optic splice enclosures may be installed. These fittings comprise of a rigid stand-off composite insulator and one or two fibre optic splice chambers where appropriate.

At terminal positions these will be mounted on two “H” Pole carryover channels as detailed in SP Energy Networks’ Drawing No. SP4008885 and secured using two transformer clamping plates as detailed in ENA TS Drawing No. 439529.

At in-line splice positions, on “H” Pole section structures, the unit shall be mounted on the centre phase conductor section strap. On Single pole section structures, the unit shall be mounted on the outside of the angle on the section crossarm. This component shall be substituted for items 11 & 13 of the General Arrangement drawings.

They shall be located on section and terminal structures as indicated on SP Energy Networks’ Drawing No. SP4019865.

In order to prevent damage to the stainless steel buffer tubes containing the optical fibres the line conductor should be dressed directly from the dead-end fitting directly to the splice enclosures and should be installed in such a manner to ensure the minimum bending radius of the conductor is not compromised. Only competent persons who have been appointed by SP Energy Networks shall carry out the splicing of the optical fibres.

19.4.1 Electrical Connections

At terminal positions where a load carrying electrical connection is required, for example, to a cable termination, these should be connected to the splice enclosure jumper by one or two 3-bolt parallel groove clamps. (See also General Arrangement drawings and associated component listings). Parallel groove clamps should be used for all electrical connections associated with the OPPC.

It is essential that all conductors are thoroughly cleaned using a suitable wire brush and an Approved conductive paste should be applied to the conductor prior to the application of the parallel groove clamps. The clamps should be tightened with a suitable torque wrench to the manufacturer’s recommended torque. Compression fittings shall not be applied to the OPPC conductor. At splice enclosures, the termination connecting rod should be cleaned using 150-grade abrasive paper and an Approved conductive paste should be applied to the conductor and connecting rod prior to the application of the parallel groove clamp(s).

19.5 Earthing

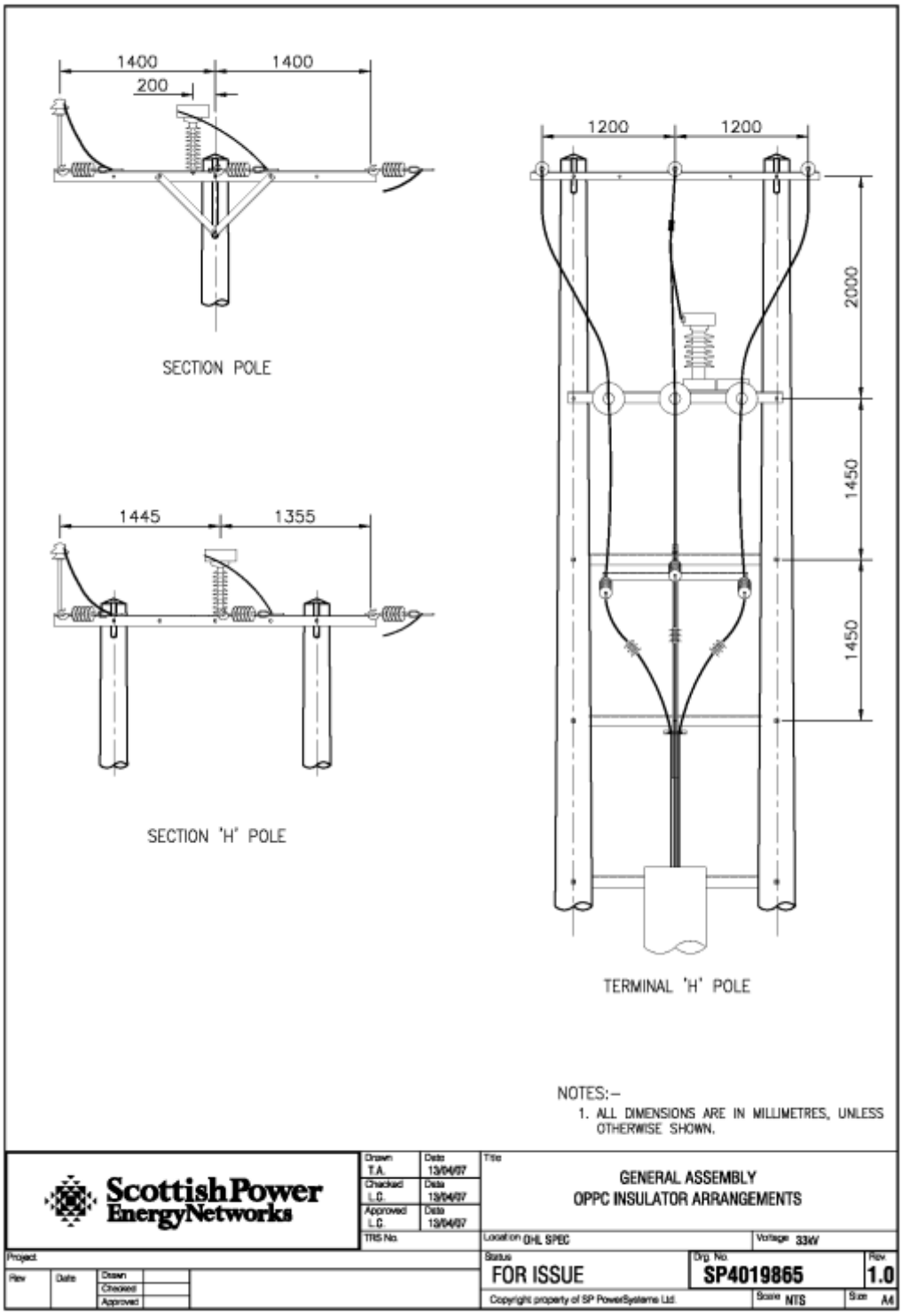
As is normal practise, all metalwork including optical splice enclosures on all structures shall be bonded and/or earthed in accordance with OHL-25-001.

A connection hole is provided on the base plate of the optical termination unit to which the earth-bonding lug should be connected.

19.6 Optical Fibre Cable Connections

The fibre optic underground cables shall be secured every 500mm down the pole and protected at the bottom of the pole by cable guards 3.0m long sunk 150mm into the ground.

19.7 General Arrangement OPPC Splice Enclosures (Drawing No. SP4019865)



20. APPENDIX 6A: 200mm² POPLAR EQUIVALENT OPPC

20.1 Table 1: Design Parameters, 200mm² POPLAR OPPC

Design Parameters		
Conductor Nominal Size	200 AAAC	
Code Name	Poplar OPPC	
BS EN 50182 Code	239-AL3	
Conductor Stranding	37/2.87	mm
Ungreased Conductor Weight	0.6562	kg/m
Weight of Grease	0.0218	kg/m
Conductor Greasing to ER-L38	CAT 3	
Data input into ENA TS 43-40 Spreadsheet		
Greased Conductor Weight	0.678	kg/m
Cross Sectional Area of Conductor	226.42	mm²
Conductor Overall Diameter	20.09	mm
Coefficient of Linear Expansion	0.000023	/°C
Modulus of Elasticity	5700.0	kg/mm²
Rated Breaking Strength of Conductor (RBS)	6810.0	kgf (BS EN 50182 value)
Basic / Recommended Span	80	m
Wind Pressure on Conductor	380	N/m²
Radial Ice Thickness	9.5	mm
Ice Density	913	kg/m³
Absolute Maximum Working Tension (MWT) Limit	1830.0	kgf (MWT set to match sag of non OPPC)
Temperature at MWT Limit	-5.6	°C
Maximum "Everyday" Tension (EDT) Limit	1362.0	kgf (20% of RBS)
Temperature at EDT Limit	5	°C
Equipment Weight	600	kg
Wind Span	115	m
Results from ENA TS 43-40 Spreadsheet		
Actual Everyday Stress	17.2	% (Design ruled by MWT)
Maximum Conductor Tension @ -5.6°C (MCT)	1830.0	kgf
Maximum Conductor Weight (MCW)	1.484	kg/m
Maximum Conductor Pressure (MCP)	1.515	kg/m
Freezing Point Tension (FPT) at 0°C	1295.8	kgf
Minimum ENA TS 43-40 Conductor Factor of Safety	2.5	
Actual Conductor Factor of Safety Used	3.72	
Working FoS @ -5.6°C with Ice and Wind	3.72	
Working FoS @ -5.6°C without Ice and Wind	4.72	
Additional Design Parameters		
Erection Over-Tension @ 15°C (short term creep)	10	%
Ground Clearance Profile Ordinate Tension Reduction @ 15°C (long term creep)	-10	%
Weather Coordinates for Clashing Model	4 D	Severe Weather Area
Design Temperature		
Maximum Conductor Temperature for Assessing Ground Clearances	65ºC	
Factors of Safety		
Unstayed Poles	3.5	
Pole Foundations	3.5	
Stayed Poles	3.5	
Stays	3.5	
Steelwork	3.5	
Pin Insulators	3.5	

20.2 Table 2: Support Types and Duties Table, 200mm² POPLAR OPPC

Structure Type		Max Span Length (m)	Max Wind/ Weight Span (m)	Max Gradient	Angle of Line Deviation	SP Energy Networks' Reference
Intermediate	Single Pole (*Double crossarm*)	100	115	1:10	0º	Fig 9 – SP4147832
	"H" Pole *(With pin insulators)*	100	115	1:5	0º	Fig 13 – SP4147836
	"H" Pole *(Long Span)*	130	130	1:10	0º	Fig 10 – SP4147833
Pin Angle	Single Pole (*Double crossarm*)	100	115	1:10	3º	Fig 9 – SP4147832
Straight Section	Single Pole *(Long Tie Strap)*	100	115	1:10	0º	Fig 12 – SP4147835
	"H" Pole	100	115	1:5	0º	Fig 13 – SP4147836
	"H" Pole (*Long Span*)	130	130	1:10	0º	Fig 14 – SP4147837
	"H" Pole Delta	130	130	1:5	0º	Fig 15 – SP4147838
Angle Section	Single Pole *(Long Tie Strap)*	100	115	1:10	30º	Fig 12 – SP4147835
	"H" Pole	100	115	1:5	60º	Fig 13 – SP4147836
	"H" Pole Delta	130	130	1:5	10º	Fig 15 – SP4147838
Tee-Off	Stub Leg	100	60	1:10	0º	Fig 23 – SP4147861
Terminal	"H" Pole	100	60	1:10	0º	Fig 19 – SP4147852

NOTE: * See Section 12.2.2 for guidance on hillside applications.

20.3 Table 3: Conductor Design Table, 200mm² POPLAR OPPC

Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		70	80	90	95	100	105	110	120	130
-5.6	1443.7	0.29	0.38	0.48	0.53	0.59	0.65	0.71	0.85	0.99
0	1295.8	0.32	0.42	0.53	0.59	0.65	0.72	0.79	0.94	1.11
5	1168.9	0.36	0.46	0.59	0.65	0.73	0.80	0.88	1.04	1.23
10	1048.6	0.40	0.52	0.65	0.73	0.81	0.89	0.98	1.16	1.37
15	936.7	0.44	0.58	0.73	0.82	0.90	1.00	1.09	1.30	1.53
20	834.9	0.50	0.65	0.82	0.92	1.02	1.12	1.23	1.46	1.72
25	744.7	0.56	0.73	0.92	1.03	1.14	1.25	1.38	1.64	1.92
30	666.8	0.62	0.81	1.03	1.15	1.27	1.40	1.54	1.83	2.15
35	600.9	0.69	0.90	1.14	1.27	1.41	1.56	1.71	2.03	2.38
40	545.6	0.76	0.99	1.26	1.40	1.55	1.71	1.88	2.24	2.62
45	499.6	0.83	1.09	1.37	1.53	1.70	1.87	2.05	2.44	2.87
50	461.2	0.90	1.18	1.49	1.66	1.84	2.03	2.22	2.65	3.11
55	428.9	0.97	1.26	1.60	1.78	1.98	2.18	2.39	2.85	3.34
60	401.6	1.03	1.35	1.71	1.90	2.11	2.33	2.55	3.04	3.57
65	378.2	1.10	1.43	1.82	2.02	2.24	2.47	2.71	3.23	3.79
70	358.0	1.16	1.52	1.92	2.14	2.37	2.61	2.86	3.41	4.00
75	340.4	1.22	1.59	2.02	2.25	2.49	2.74	3.01	3.58	4.21
These are the calculated sags after 2 years of short term conductor creep.										

20.4 Table 4: Conductor Pre-Tension Table, 200mm² POPLAR OPPC

24.9% of Conductor RBS for 60 minutes									
Pre-tension at all temperatures (kgf)	Sag (m) for Span (m)								
	60	65	70	75	80	85	90	95	100
1695	0.18	0.21	0.25	0.28	0.32	0.36	0.41	0.45	0.50

20.5 Table 5: Conductor Erection Table, 200mm² POPLAR OPPC

10% increase in tension @ 15°C										
Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		60	65	70	75	80	85	90	95	100
0	1406.5	0.22	0.25	0.30	0.34	0.39	0.44	0.49	0.54	0.60
1	1379.9	0.22	0.26	0.30	0.35	0.39	0.44	0.50	0.55	0.61
2	936.7	0.33	0.38	0.44	0.51	0.58	0.65	0.73	0.82	0.90
3	936.7	0.33	0.38	0.44	0.51	0.58	0.65	0.73	0.82	0.90
4	1301.2	0.23	0.28	0.32	0.37	0.42	0.47	0.53	0.59	0.65
5	1275.4	0.24	0.28	0.33	0.37	0.43	0.48	0.54	0.60	0.66
6	1249.7	0.24	0.29	0.33	0.38	0.43	0.49	0.55	0.61	0.68
7	1224.3	0.25	0.29	0.34	0.39	0.44	0.50	0.56	0.62	0.69
8	1199.1	0.25	0.30	0.35	0.40	0.45	0.51	0.57	0.64	0.71
9	1174.1	0.26	0.30	0.35	0.41	0.46	0.52	0.58	0.65	0.72
10	1149.4	0.27	0.31	0.36	0.41	0.47	0.53	0.60	0.67	0.74
11	1125.0	0.27	0.32	0.37	0.42	0.48	0.54	0.61	0.68	0.75
12	1100.9	0.28	0.33	0.38	0.43	0.49	0.56	0.62	0.69	0.77
13	1077.0	0.28	0.33	0.39	0.44	0.50	0.57	0.64	0.71	0.79
14	1053.5	0.29	0.34	0.39	0.45	0.51	0.58	0.65	0.73	0.80
15	1030.3	0.30	0.35	0.40	0.46	0.53	0.59	0.67	0.74	0.82
16	1007.5	0.30	0.36	0.41	0.47	0.54	0.61	0.68	0.76	0.84
17	985.0	0.31	0.36	0.42	0.48	0.55	0.62	0.70	0.78	0.86
18	962.9	0.32	0.37	0.43	0.50	0.56	0.64	0.71	0.79	0.88
19	941.2	0.32	0.38	0.44	0.51	0.58	0.65	0.73	0.81	0.90
20	919.8	0.33	0.39	0.45	0.52	0.59	0.67	0.75	0.83	0.92
21	899.0	0.34	0.40	0.46	0.53	0.60	0.68	0.76	0.85	0.94
22	878.5	0.35	0.41	0.47	0.54	0.62	0.70	0.78	0.87	0.96
23	858.5	0.36	0.42	0.48	0.56	0.63	0.71	0.80	0.89	0.99
24	838.9	0.36	0.43	0.50	0.57	0.65	0.73	0.82	0.91	1.01
25	819.8	0.37	0.44	0.51	0.58	0.66	0.75	0.84	0.93	1.03
26	801.2	0.38	0.45	0.52	0.59	0.68	0.76	0.86	0.95	1.06
27	783.1	0.39	0.46	0.53	0.61	0.69	0.78	0.88	0.98	1.08
28	765.4	0.40	0.47	0.54	0.62	0.71	0.80	0.90	1.00	1.11
29	748.3	0.41	0.48	0.55	0.64	0.72	0.82	0.92	1.02	1.13
30	731.6	0.42	0.49	0.57	0.65	0.74	0.84	0.94	1.05	1.16

20.6 Table 6: Profile Table, 200mm² POPLAR OPPC

Ordinates for plotting Ground Clearance 10% @ 15°C										
Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		70	80	90	95	100	105	110	120	130
0	1179.4	0.35	0.46	0.58	0.65	0.72	0.79	0.87	1.03	1.21
5	1058.4	0.39	0.51	0.65	0.72	0.80	0.88	0.97	1.15	1.35
10	945.7	0.44	0.57	0.73	0.81	0.90	0.99	1.08	1.29	1.51
15	843.0	0.49	0.64	0.81	0.91	1.01	1.11	1.22	1.45	1.70
20	751.8	0.55	0.72	0.91	1.02	1.13	1.24	1.36	1.62	1.91
25	672.9	0.62	0.81	1.02	1.14	1.26	1.39	1.52	1.81	2.13
30	606.0	0.69	0.90	1.13	1.26	1.40	1.54	1.69	2.01	2.36
35	549.9	0.76	0.99	1.25	1.39	1.54	1.70	1.86	2.22	2.60
40	503.2	0.83	1.08	1.36	1.52	1.68	1.86	2.04	2.43	2.85
45	464.2	0.89	1.17	1.48	1.65	1.83	2.01	2.21	2.63	3.09
50	431.4	0.96	1.26	1.59	1.77	1.96	2.17	2.38	2.83	3.32
55	403.7	1.03	1.34	1.70	1.89	2.10	2.31	2.54	3.02	3.55
60	380.0	1.09	1.43	1.81	2.01	2.23	2.46	2.70	3.21	3.77
65	359.6	1.15	1.51	1.91	2.13	2.36	2.60	2.85	3.39	3.98
70	341.8	1.21	1.59	2.01	2.24	2.48	2.73	3.00	3.57	4.19
75	326.2	1.27	1.66	2.10	2.34	2.60	2.86	3.14	3.74	4.39
These are the calculated sags after 25 years of long term conductor creep.										

21. APPENDIX 6B: 300mm² UPAS EQUIVALENT OPPC

21.1 Table 1: Design Parameters, 300mm² UPAS OPPC

Design Parameters		
Conductor Nominal Size	300 AAAC	
Code Name	Upas OPPC	
BS EN 50182 Code	362-AL3	
Conductor Stranding	37/3.53	mm
Ungreased Conductor Weight	0.989	kg/m
Weight of Grease	0.033	kg/m
Conductor Greasing to ER-L38	CAT 3	
Data input into ENA TS 43-40 Spreadsheet		
Greased Conductor Weight	1.022	kg/m
Cross Sectional Area of Conductor	342.54	mm²
Conductor Overall Diameter	24.71	mm
Coefficient of Linear Expansion	0.000023	/°C
Modulus of Elasticity	5700	kg/mm²
Rated Breaking Strength of Conductor (RBS)	10300.7	kgf (BS EN 50182 value)
Basic / Recommended Span	80	m
Wind Pressure on Conductor	380	N/m²
Radial Ice Thickness	9.5	mm
Ice Density	913	kg/m³
Absolute Maximum Working Tension (MWT) Limit	2045	kgf (MWT set to match sag of non OPPC)
Temperature at MWT Limit	-5.6	°C
Maximum "Everyday" Tension (EDT) Limit	2060.14	20% of RBS
Temperature at EDT Limit	5	°C
Equipment Weight	600	kg
Wind Span	115	m
Results from ENA TS 43-40 Spreadsheet		
Actual Everyday Stress	11.2	% (Design ruled by MWT)
Maximum Conductor Tension @ -5.6°C (MCT)	2045.0	kgf
Maximum Conductor Weight (MCW)	1.954	kg/m
Maximum Conductor Pressure (MCP)	1.694	kg/m
Freezing Point Tension (FPT) at 0°C	1288.5	kgf
Minimum ENA TS 43-40 Conductor Factor of Safety	2.5	
Actual Conductor Factor of Safety Used	5.04	
Working FoS @ -5.6°C with Ice and Wind	5.04	
Working FoS @ -5.6°C without Ice and Wind	7.03	
Additional Design Parameters		
Erection Over-Tension @ 15°C (short term creep)	10	%
Ground Clearance Profile Ordinate Tension Reduction @ 15°C (long term creep)	-10	%
Weather Coordinates for Clashing Model	4 D	Severe Weather Area
Design Temperature		
Maximum Conductor Temperature for Assessing Ground Clearances	65°C	
Factors of Safety		
Unstayed Poles	3.5	
Pole Foundations	3.5	
Stayed Poles	3.5	
Stays	3.5	
Steelwork	3.5	
Pin Insulators	3.5	

21.2 Table 2: Support Types and Duties Table, 300mm² UPAS OPPC

Structure Type		Max Span Length (m)	Max Wind / Weight Span (m)	Max Gradient	Angle of Line Deviation	SP Energy Networks' Reference
Intermediate	Single Pole (*Double crossarm*)	100	110	1:10	0º	Fig 9 – SP4147832
	"H" Pole *(With pin insulators)*	100	115	1:5	0º	Fig 13 – SP4147836
	"H" Pole Delta *(With pin insulators)*	130	115	1:5	0º	Fig 15 – SP4147838
Pin Angle	Single Pole (*Double crossarm*)	100	100	1:10	3º	Fig 9 – SP4147832
Straight Section	Single Pole	N/A	N/A	N/A	N/A	N/A
	"H" Pole	100	115	1:5	0º	Fig 13 – SP4147836
	"H" Pole (*Long Span*)	130	130	1:10	0º	Fig 14 – SP4147837
	"H" Pole Delta	130	130	1:5	0º	Fig 15 – SP4147838
Angle Section	Single Pole	N/A	N/A	N/A	N/A	N/A
	"H" Pole	100	115	1:5	60º	Fig 13 – SP4147836
	"H" Pole Delta	130	130	1:5	60º	Fig 15 – SP4147838
Tee-Off	Stub Leg	100	60	1:10	0º	Fig 23 – SP4147861
Terminal	"H" Pole	100	60	1:10	0º	Fig 19 – SP4147852

NOTE: * See Section 12.2.2 for guidance on hillside applications.

21.3 Table 3: Conductor Design Table, 300mm² UPAS OPPC

Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		70	80	90	95	100	105	110	120	130
-5.6	1465.6	0.43	0.56	0.71	0.79	0.87	0.96	1.05	1.26	1.47
0	1288.5	0.49	0.63	0.80	0.89	0.99	1.09	1.20	1.43	1.68
5	1148.6	0.54	0.71	0.90	1.00	1.11	1.23	1.35	1.60	1.88
10	1027.2	0.61	0.80	1.01	1.12	1.24	1.37	1.50	1.79	2.10
15	924.1	0.68	0.88	1.12	1.25	1.38	1.52	1.67	1.99	2.34
20	837.7	0.75	0.98	1.24	1.38	1.52	1.68	1.85	2.20	2.58
25	765.7	0.82	1.07	1.35	1.51	1.67	1.84	2.02	2.40	2.82
30	705.7	0.89	1.16	1.47	1.63	1.81	2.00	2.19	2.61	3.06
35	655.4	0.96	1.25	1.58	1.76	1.95	2.15	2.36	2.81	3.29
40	612.8	1.02	1.33	1.69	1.88	2.08	2.30	2.52	3.00	3.52
45	576.5	1.09	1.42	1.79	2.00	2.22	2.44	2.68	3.19	3.75
50	545.2	1.15	1.50	1.90	2.11	2.34	2.58	2.84	3.37	3.96
55	518.0	1.21	1.58	2.00	2.23	2.47	2.72	2.98	3.55	4.17
60	494.1	1.27	1.65	2.09	2.33	2.59	2.85	3.13	3.72	4.37
65	473.0	1.32	1.73	2.19	2.44	2.70	2.98	3.27	3.89	4.56
70	454.1	1.38	1.80	2.28	2.54	2.81	3.10	3.40	4.05	4.75
75	437.3	1.43	1.87	2.37	2.64	2.92	3.22	3.54	4.21	4.94
These are the calculated sags after 2 years of short term conductor creep.										

21.4 Table 4: Conductor Pre-Tension Table, 300mm² UPAS OPPC

18.9% of Conductor RBS for 60 minutes									
Pre-tension at all temperatures (kgf)	Sag (m) for Span (m)								
	60	65	70	75	80	85	90	95	100
1950	0.24	0.28	0.32	0.37	0.42	0.47	0.53	0.59	0.66

21.5 Table 5: Conductor Erection Table, 300mm² UPAS OPPC

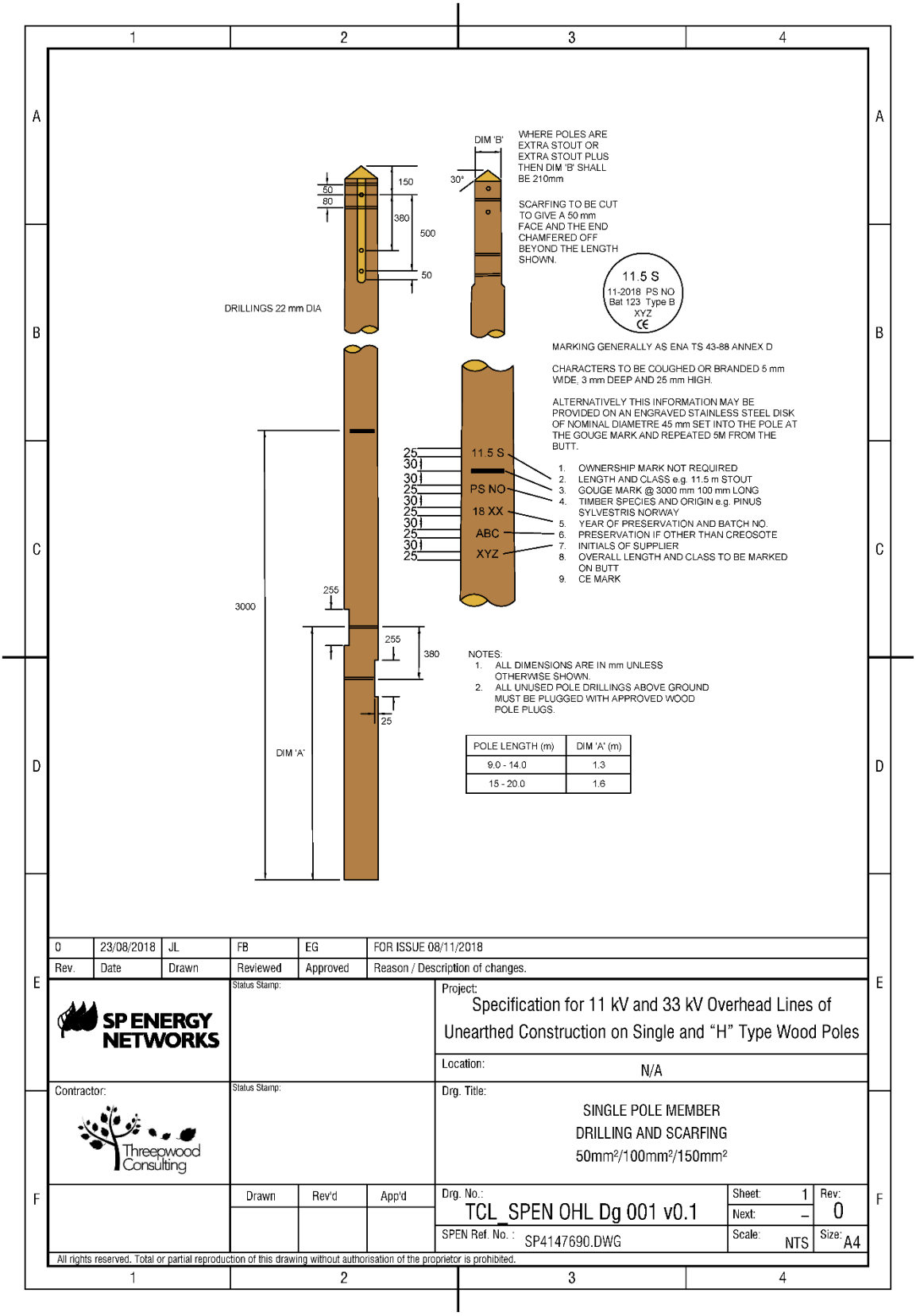
10% increase in tension @ 15°C										
Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		60	65	70	75	80	85	90	95	100
0	1429.9	0.32	0.38	0.44	0.50	0.57	0.65	0.72	0.81	0.89
1	1397.4	0.33	0.39	0.45	0.51	0.59	0.66	0.74	0.83	0.91
2	924.1	0.50	0.58	0.68	0.78	0.88	1.00	1.12	1.25	1.38
3	924.1	0.50	0.58	0.68	0.78	0.88	1.00	1.12	1.25	1.38
4	1304.0	0.35	0.41	0.48	0.55	0.63	0.71	0.79	0.88	0.98
5	1274.2	0.36	0.42	0.49	0.56	0.64	0.72	0.81	0.90	1.00
6	1245.2	0.37	0.43	0.50	0.58	0.66	0.74	0.83	0.93	1.03
7	1216.8	0.38	0.44	0.51	0.59	0.67	0.76	0.85	0.95	1.05
8	1189.2	0.39	0.45	0.53	0.60	0.69	0.78	0.87	0.97	1.07
9	1162.3	0.40	0.46	0.54	0.62	0.70	0.79	0.89	0.99	1.10
10	1136.1	0.40	0.48	0.55	0.63	0.72	0.81	0.91	1.01	1.12
11	1110.7	0.41	0.49	0.56	0.65	0.74	0.83	0.93	1.04	1.15
12	1086.0	0.42	0.50	0.58	0.66	0.75	0.85	0.95	1.06	1.18
13	1062.1	0.43	0.51	0.59	0.68	0.77	0.87	0.97	1.09	1.20
14	1039.0	0.44	0.52	0.60	0.69	0.79	0.89	1.00	1.11	1.23
15	1016.5	0.45	0.53	0.62	0.71	0.80	0.91	1.02	1.13	1.26
16	994.8	0.46	0.54	0.63	0.72	0.82	0.93	1.04	1.16	1.28
17	973.9	0.47	0.55	0.64	0.74	0.84	0.95	1.06	1.18	1.31
18	953.6	0.48	0.57	0.66	0.75	0.86	0.97	1.09	1.21	1.34
19	934.0	0.49	0.58	0.67	0.77	0.88	0.99	1.11	1.23	1.37
20	915.1	0.50	0.59	0.68	0.79	0.89	1.01	1.13	1.26	1.40
21	896.9	0.51	0.60	0.70	0.80	0.91	1.03	1.15	1.29	1.42
22	879.3	0.52	0.61	0.71	0.82	0.93	1.05	1.18	1.31	1.45
23	862.3	0.53	0.63	0.73	0.83	0.95	1.07	1.20	1.34	1.48
24	846.0	0.54	0.64	0.74	0.85	0.97	1.09	1.22	1.36	1.51
25	830.2	0.55	0.65	0.75	0.87	0.98	1.11	1.25	1.39	1.54
26	815.0	0.56	0.66	0.77	0.88	1.00	1.13	1.27	1.41	1.57
27	800.3	0.57	0.67	0.78	0.90	1.02	1.15	1.29	1.44	1.60
28	786.2	0.58	0.69	0.80	0.91	1.04	1.17	1.32	1.47	1.62
29	772.6	0.60	0.70	0.81	0.93	1.06	1.19	1.34	1.49	1.65
30	759.5	0.61	0.71	0.82	0.95	1.08	1.22	1.36	1.52	1.68

21.6 Table 6: Profile Table, 300mm² UPAS OPPC

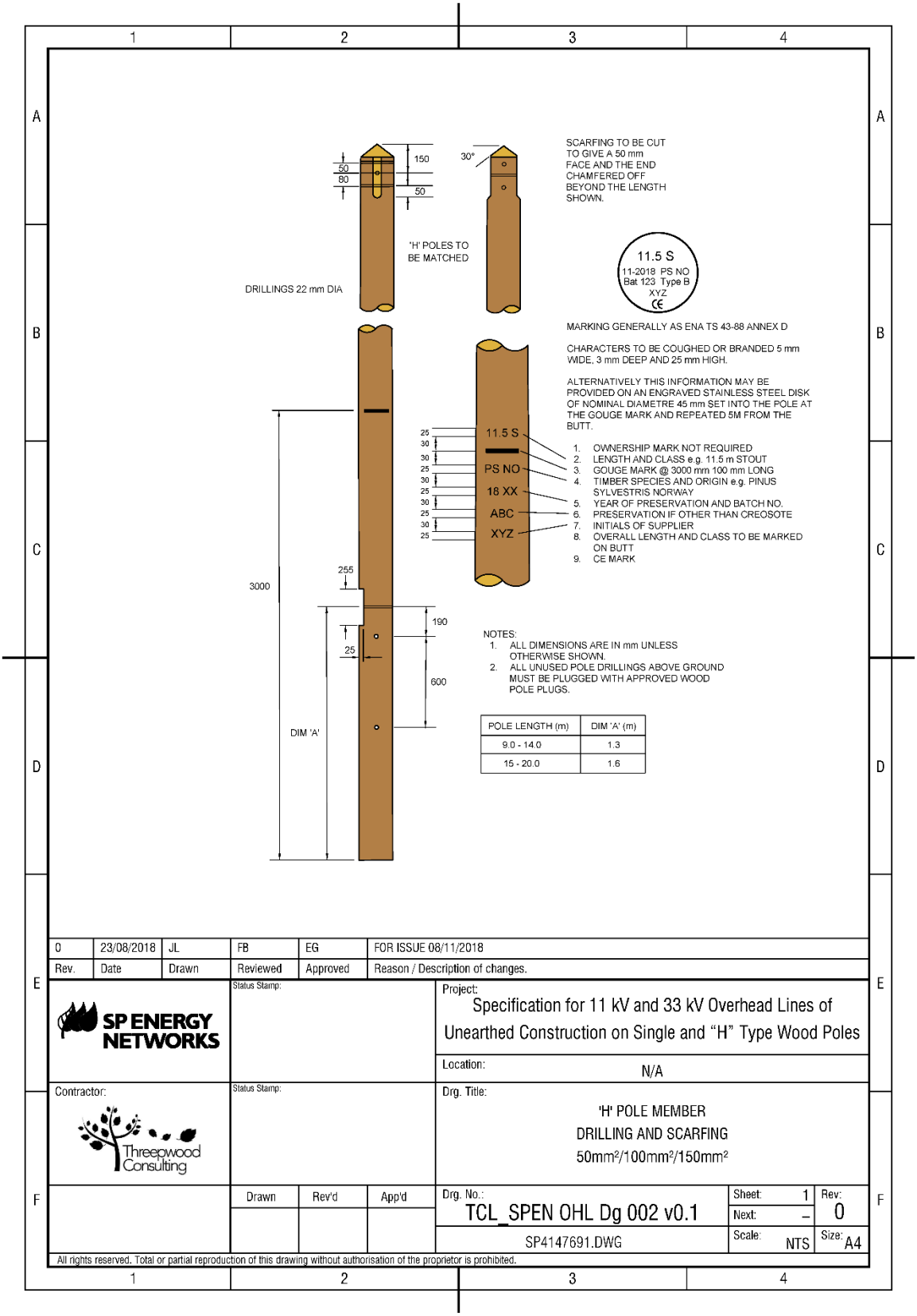
Ordinates for plotting Ground Clearance 10% @ 15°C										
Temp. (Deg. C)	Tension (kgf)	Sag (m) for Span (m)								
		70	80	90	95	100	105	110	120	130
0	1138.6	0.55	0.72	0.91	1.01	1.12	1.24	1.36	1.62	1.90
5	1018.7	0.61	0.80	1.02	1.13	1.25	1.38	1.52	1.81	2.12
10	916.9	0.68	0.89	1.13	1.26	1.39	1.54	1.69	2.01	2.35
15	831.7	0.75	0.98	1.24	1.39	1.54	1.69	1.86	2.21	2.60
20	760.7	0.82	1.07	1.36	1.52	1.68	1.85	2.03	2.42	2.84
25	701.5	0.89	1.17	1.48	1.64	1.82	2.01	2.20	2.62	3.08
30	651.8	0.96	1.25	1.59	1.77	1.96	2.16	2.37	2.82	3.31
35	609.8	1.03	1.34	1.70	1.89	2.09	2.31	2.53	3.02	3.54
40	573.9	1.09	1.42	1.80	2.01	2.23	2.45	2.69	3.21	3.76
45	543.0	1.15	1.51	1.91	2.12	2.35	2.59	2.85	3.39	3.98
50	516.0	1.21	1.58	2.01	2.23	2.48	2.73	3.00	3.56	4.18
55	492.4	1.27	1.66	2.10	2.34	2.59	2.86	3.14	3.74	4.38
60	471.5	1.33	1.73	2.19	2.45	2.71	2.99	3.28	3.90	4.58
65	452.8	1.38	1.81	2.29	2.55	2.82	3.11	3.41	4.06	4.77
70	436.0	1.44	1.88	2.37	2.64	2.93	3.23	3.55	4.22	4.95
75	420.9	1.49	1.94	2.46	2.74	3.04	3.35	3.67	4.37	5.13
These are the calculated sags after 25 years of long term conductor creep.										

22. DRAWINGS AND SCHEDULES OF MATERIALS

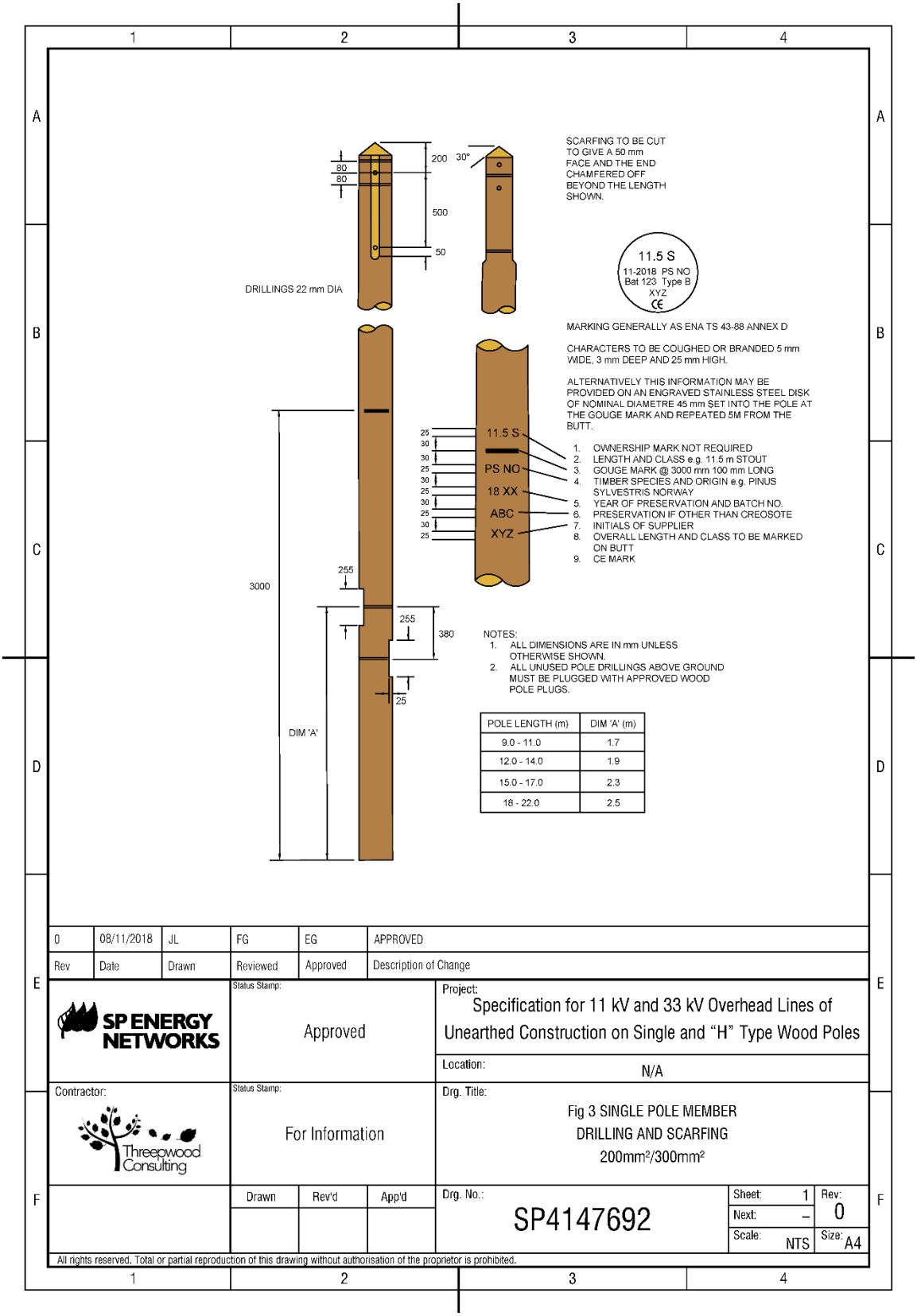
22.1 Figure 1 Single Pole Member Drilling and Scarfing 50mm², 100mm², 150mm² (Drawing No. SP4147690)



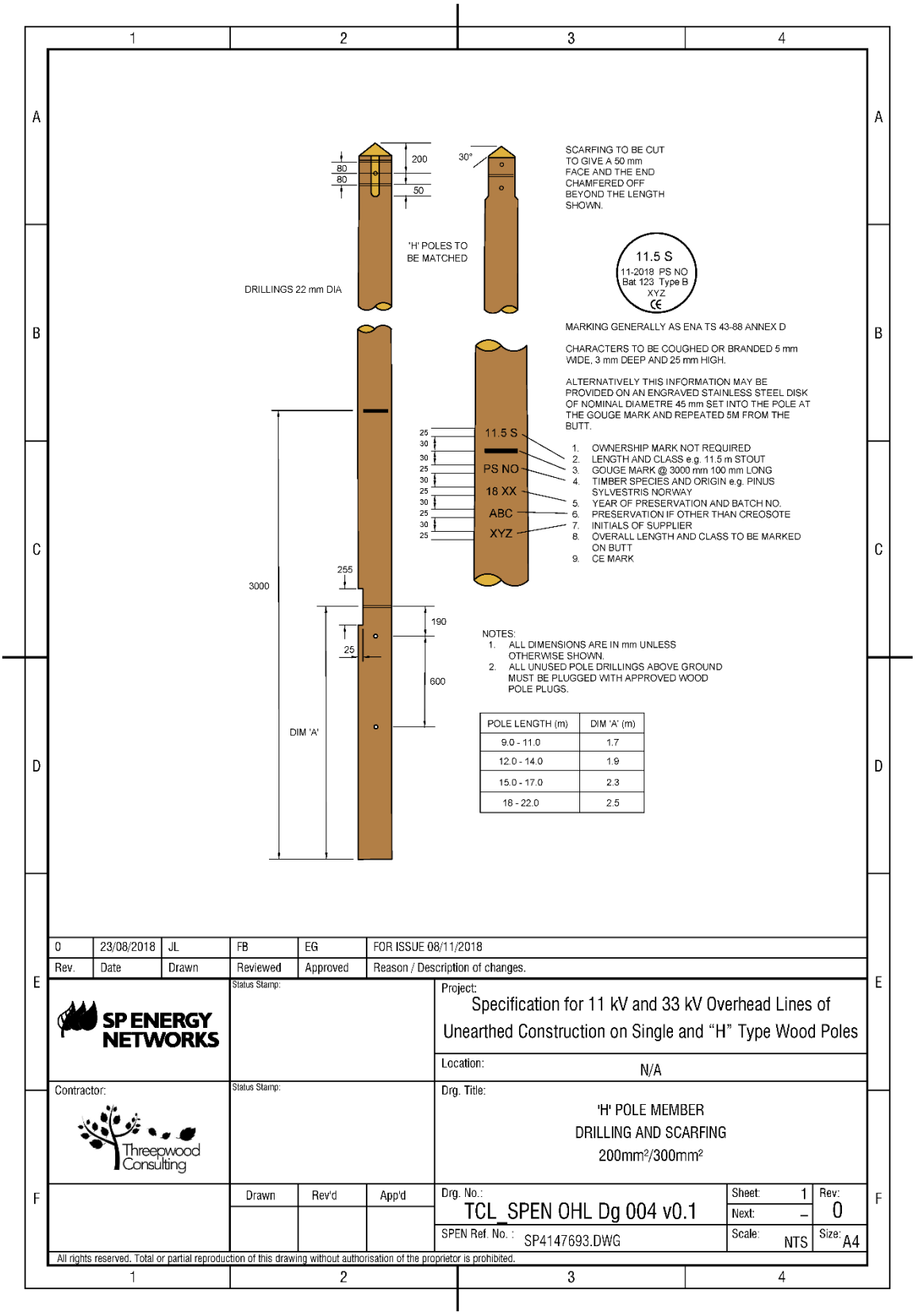
22.2 Figure 2 "H" Pole Member Drilling and Scarfing 50mm², 100mm², 150mm² (Drawing No. SP4147691)



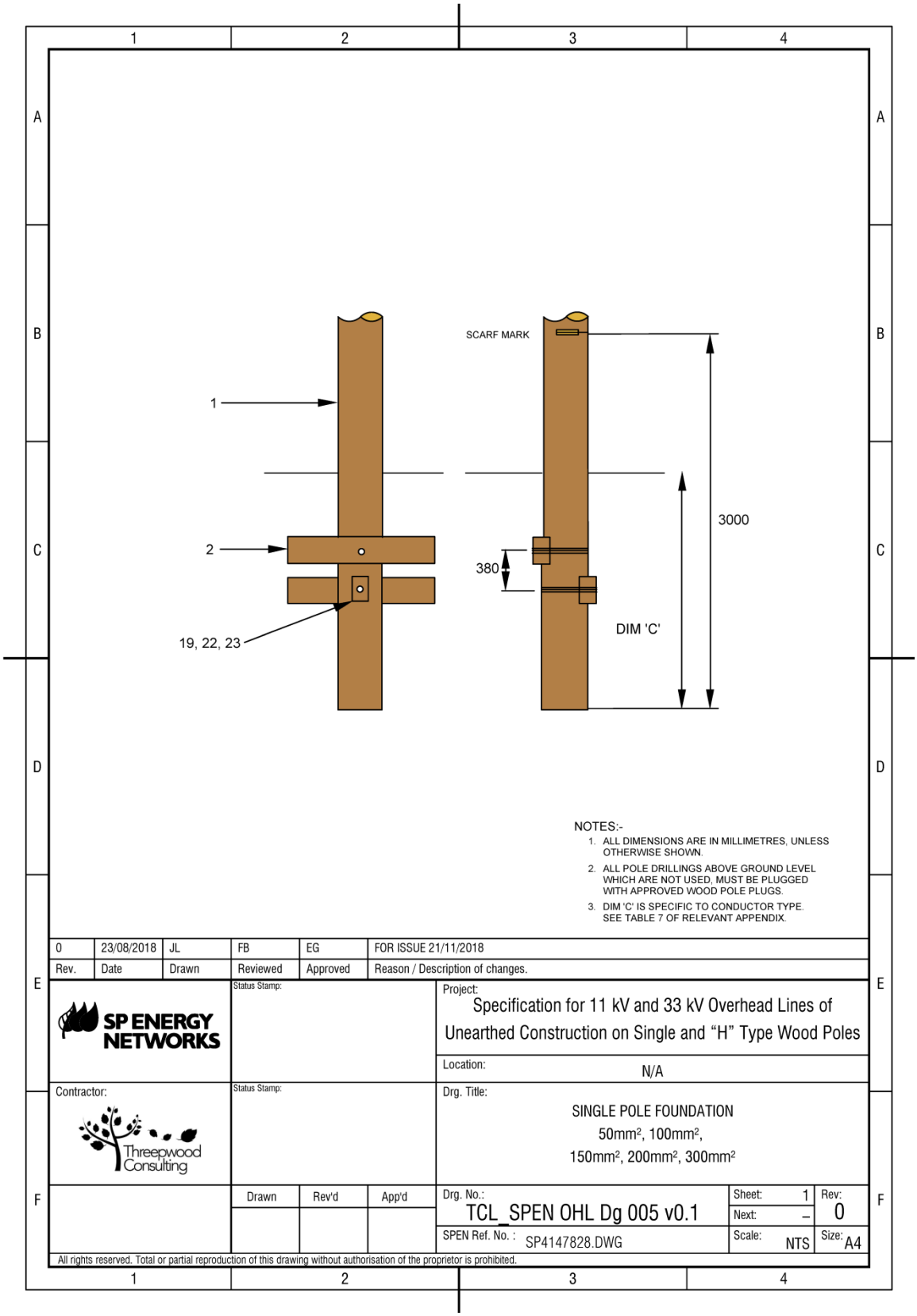
22.3 Figure 3 Single Pole Member Drilling and Scarfing 200mm², 300mm² (Drawing No. SP4147692)



22.4 Figure 4 "H" Pole Member Drilling and Scarfing 200mm², 300mm² (Drawing No. SP4147693)



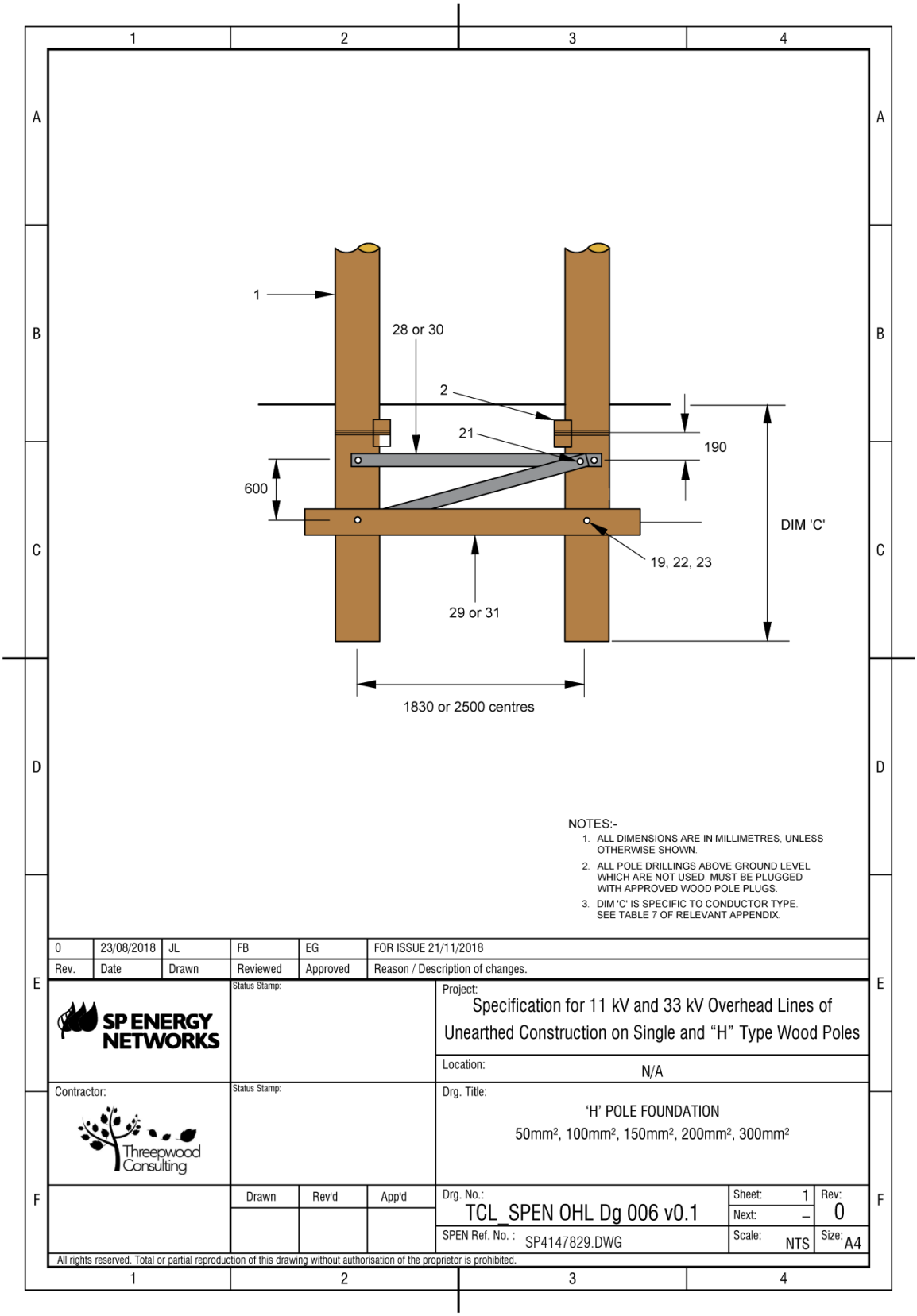
22.5 Figure 5 General Arrangement Single Pole Foundation (Drawing No. SP4147828)



22.5.1 Schedule of Materials – Single Pole Foundation (Drawing No. SP4147828)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	1	Wood Pole	ENA Drawing No. 434001	SP4147690 or SP4147692
02	1 or 2	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
19	1 or 2	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
22	1 or 2	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	1 or 2	M20 Square Flat Washer	ENA Drawing No. 439604	-
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

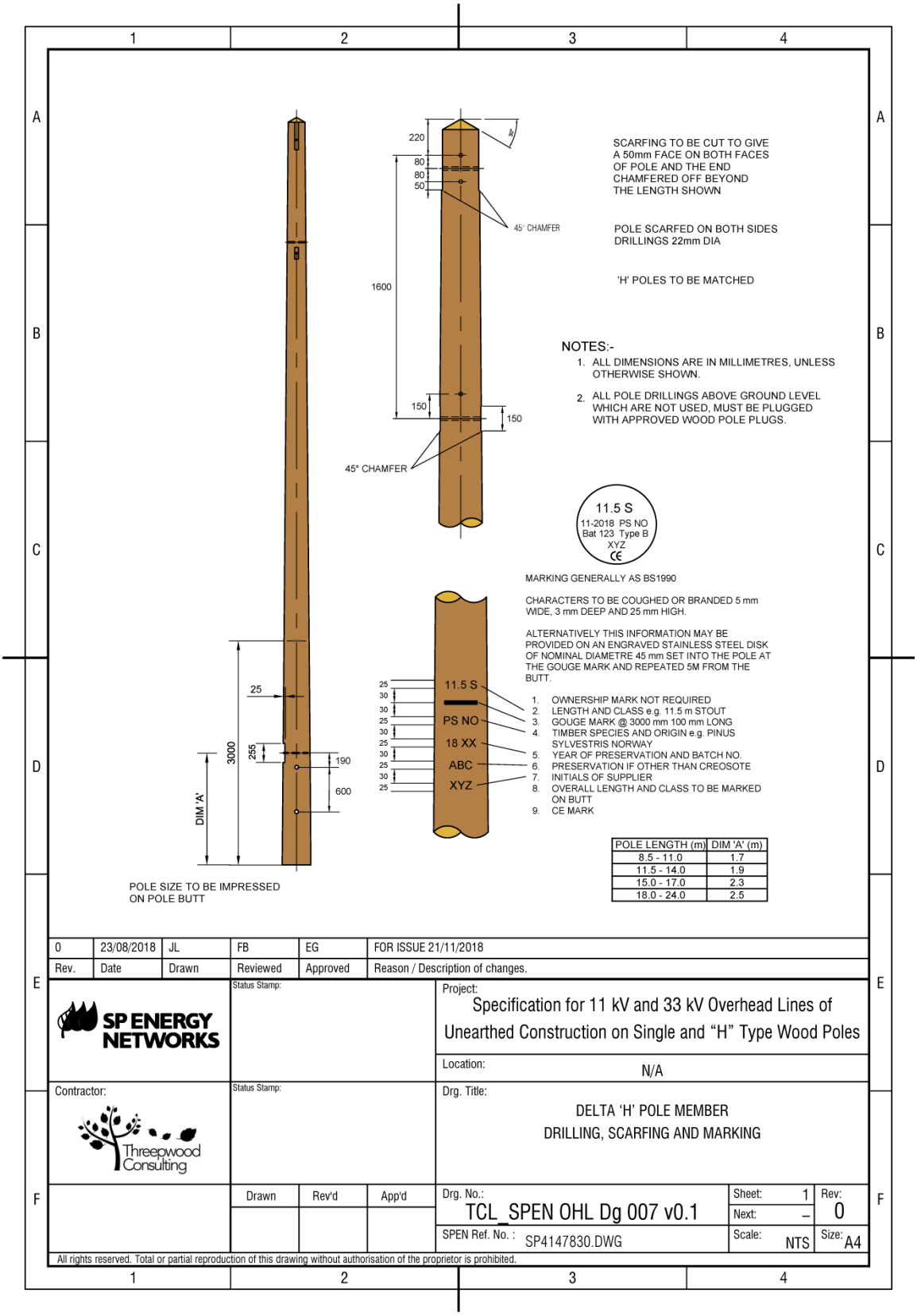
22.6 Figure 6 General Arrangement "H" Pole Foundation (Drawing No. SP4147829)



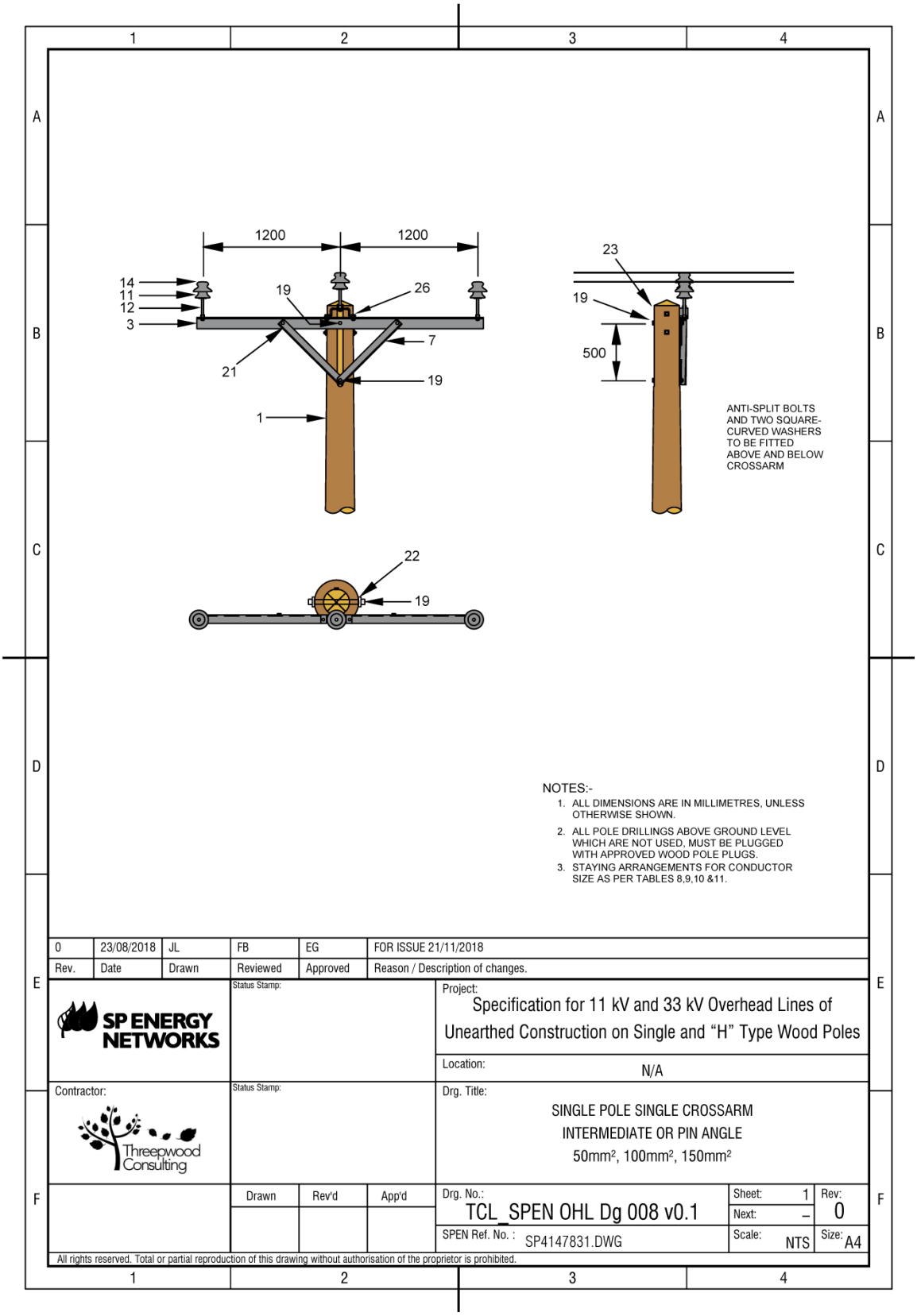
22.6.1 Schedule of Materials – "H" Pole Foundation (Drawing No. SP4147829)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	2	Wood Pole	ENA Drawing No. 434001	SP4147691 or SP4147693
02	2	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
19	6	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
21	1	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	6 or 8	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	6 or 8	M20 Square Flat Washer	ENA Drawing No. 439604	-
28	2	Foundation Brace Steelwork 1830mm centres	ENA Drawing No. 439558	SP4017651
29	1	Foundation Brace Block	ENA Drawing No. 439112 Type 1	SP4019036
30	2	Foundation Brace Steelwork 2500mm centres	ENA Drawing No. 439559	SP4017652
31	1	Foundation Brace Block	ENA Drawing No. 439112 Type 2	SP4019037
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

22.7 Figure 7 Delta "H" Pole Member Drilling, Scarfing and Marking (Drawing No. SP4147830)



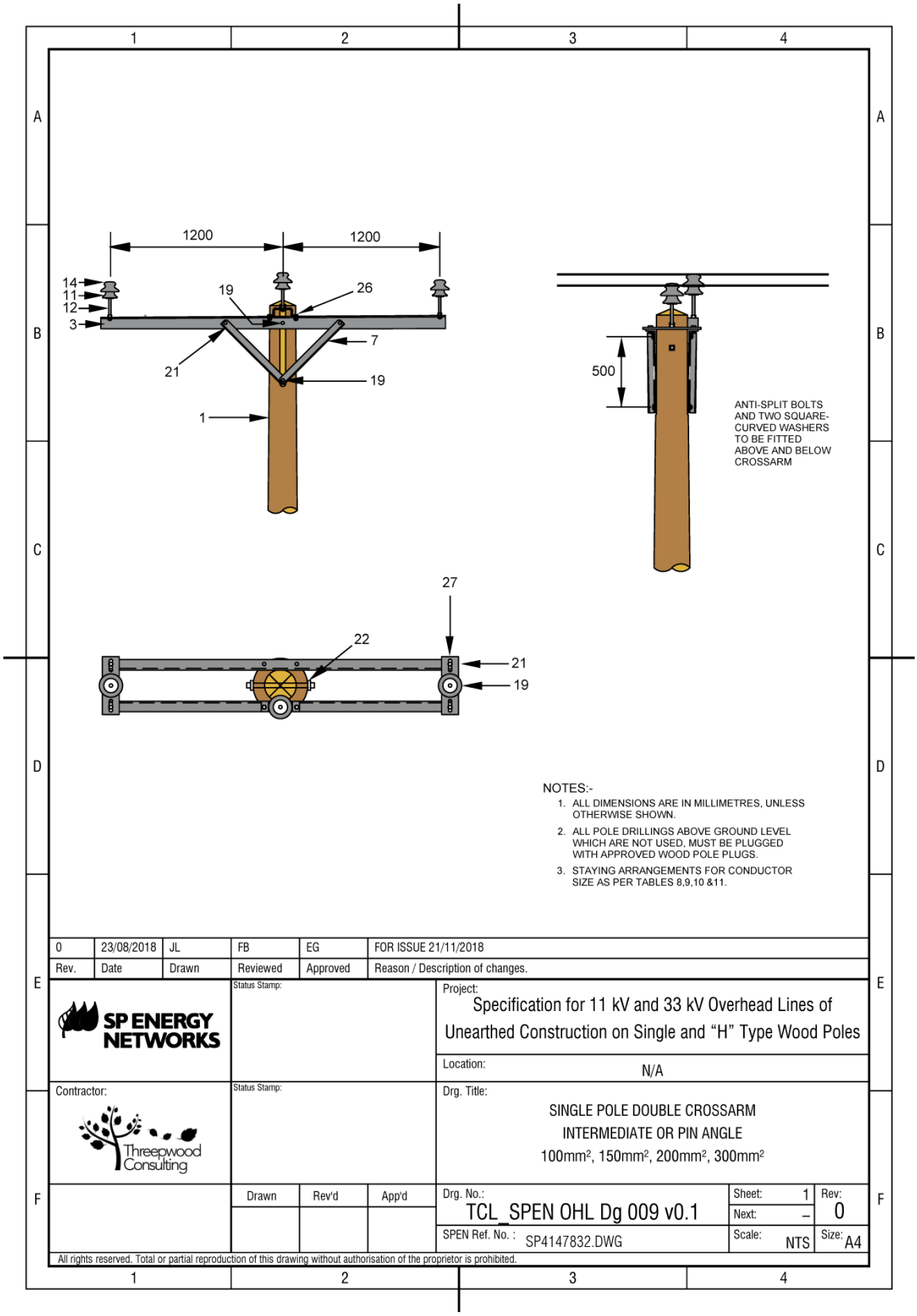
22.8 Figure 8 General Arrangement Single Pole Single Crossarm Intermediate or Pin Angle 50mm², 100mm², 150mm² (Drawing No. SP4147831)



22.8.1 Schedule of Materials – Single Pole Single Crossarm Intermediate or Pin Angle 50mm², 100mm², 150mm² (Drawing No. SP4147831)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	1	Wood Pole	ENA Drawing No. 434001	SP4147690
02	1 or 2	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
03	1	Intermediate Crossarm Member	ENA Drawing No. 439519	SP4018402
07	2	Crossarm Strut	ENA Drawing No. 439526	SP4017649
11	3	Insulator	ENA TS 43-93	-
12	3	Insulator Pin	BS 3288 Fig 4, Ref 29	-
14	3	Helical Ties	ENA TS 43-15	-
19	3 or 4	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
21	4	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	5 or 6	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	2	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	1 or 2	Safety Sign - English - Bilingual	- -	-
25	As Required	Pole Numbers	-	-
26	1	Insulator Bracket	ENA Drawing No. 439518	SP4018449
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

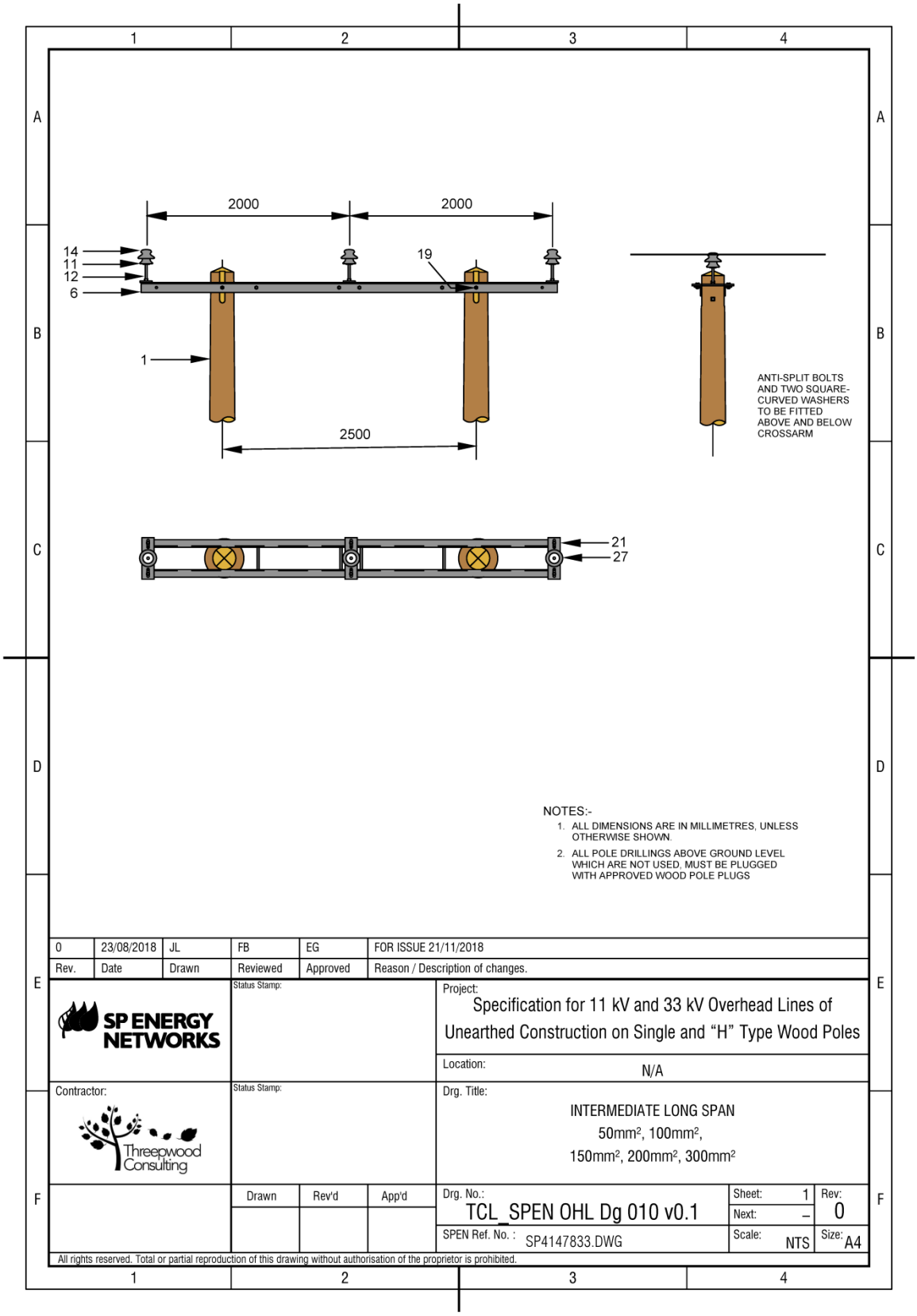
22.9 Figure 9 General Arrangement Single Pole Double Crossarm Intermediate or Pin Angle 100mm², 150mm², 200mm², 300mm² (Drawing No. SP4147832)



22.9.1 Schedule of Materials – Single Pole Double Crossarm Intermediate or Pin Angle 100mm², 150mm², 200mm², 300mm² (Drawing No. SP4147832)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	1	Wood Pole	ENA Drawing No. 434001	SP4147690 or SP4147692
02	1 or 2	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
03	2	Intermediate Crossarm Member	ENA Drawing No. 439519	SP4018402
07	4	Crossarm Strut	ENA Drawing No. 439526	SP4017649
11	3	Insulator	ENA TS 43-93	-
12	3	Insulator Pin	BS 3288 Fig 4, Ref 29	-
14	3	Helical Ties	ENA TS 43-15	-
19	4	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
21	10	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	4	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	1 or 2	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	1 or 2	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
26	1	Insulator Bracket	ENA Drawing No. 439518	SP4018449
27	2	Insulator Plate	-	SP4017637
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

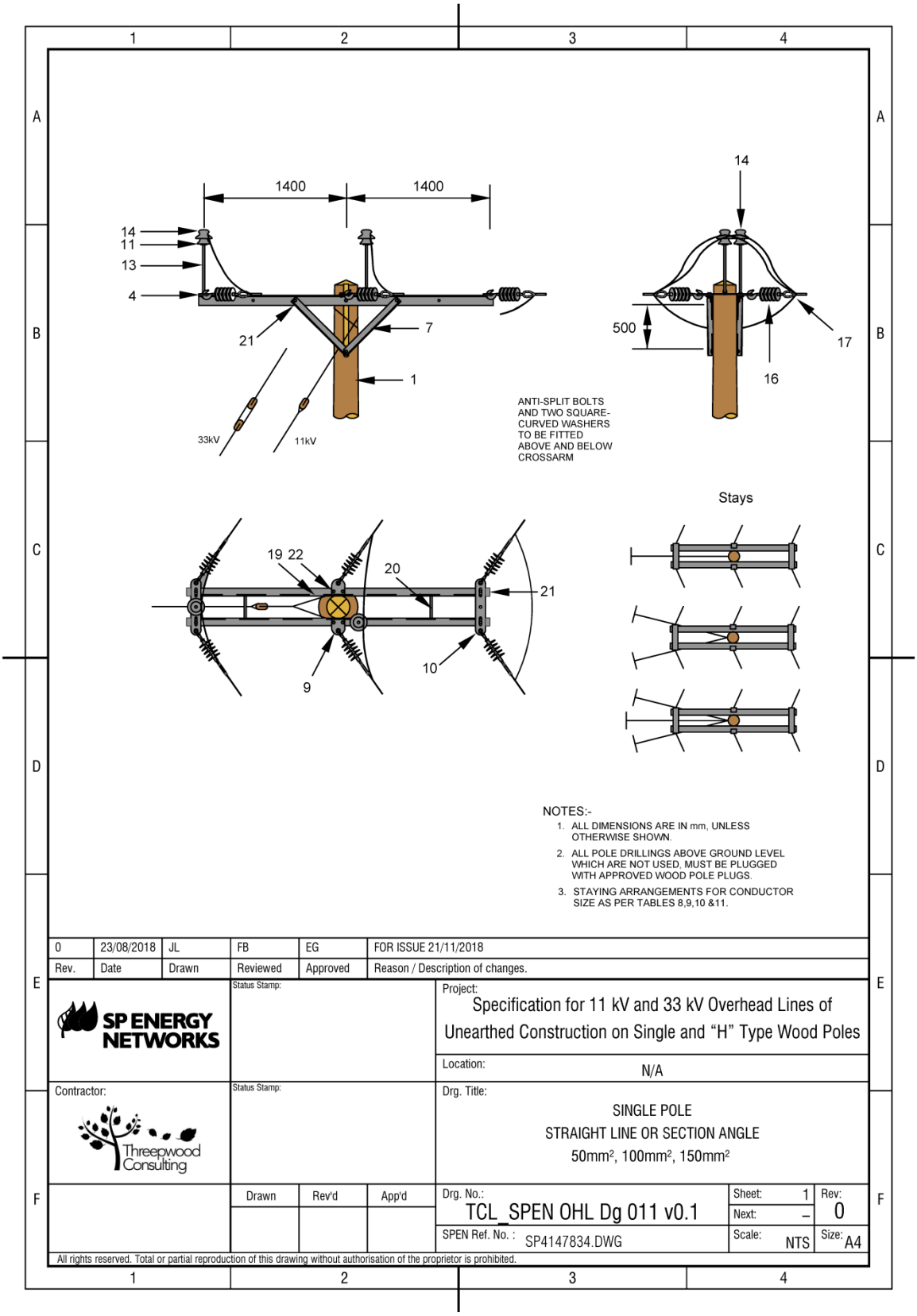
22.10 Figure 10 General Arrangement "H" Pole Intermediate Long Span (Drawing No. SP4147833)



22.10.1 Schedule of Materials – "H" Pole Intermediate Long Span (Drawing No. SP4147833)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	2	Wood Pole	ENA Drawing No. 434001	SP4147691 or SP4147693
02	2	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
06	2	Long Span Crossarm Member	ENA Drawing No. 439521	SP4017663
11	3	Insulator	ENA TS 43-93	-
12	3	Insulator Pin	BS 3288 Fig 4, Ref 29	-
14	3	Helical Ties	ENA TS 43-15	-
19	6	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	4	M20 Tie Rods	ENA Drawing No. 439608 Type 2 or 3	-
21	7	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	8	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	4 or 6	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	2 or 4	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
27	3	Insulator Plate	-	SP4017637
28	2	Foundation Brace Steelwork 2500mm centres	ENA Drawing No. 439559	SP4017652
29	1	Foundation Brace Block	ENA Drawing No. 439112 Type 2	SP4019037
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

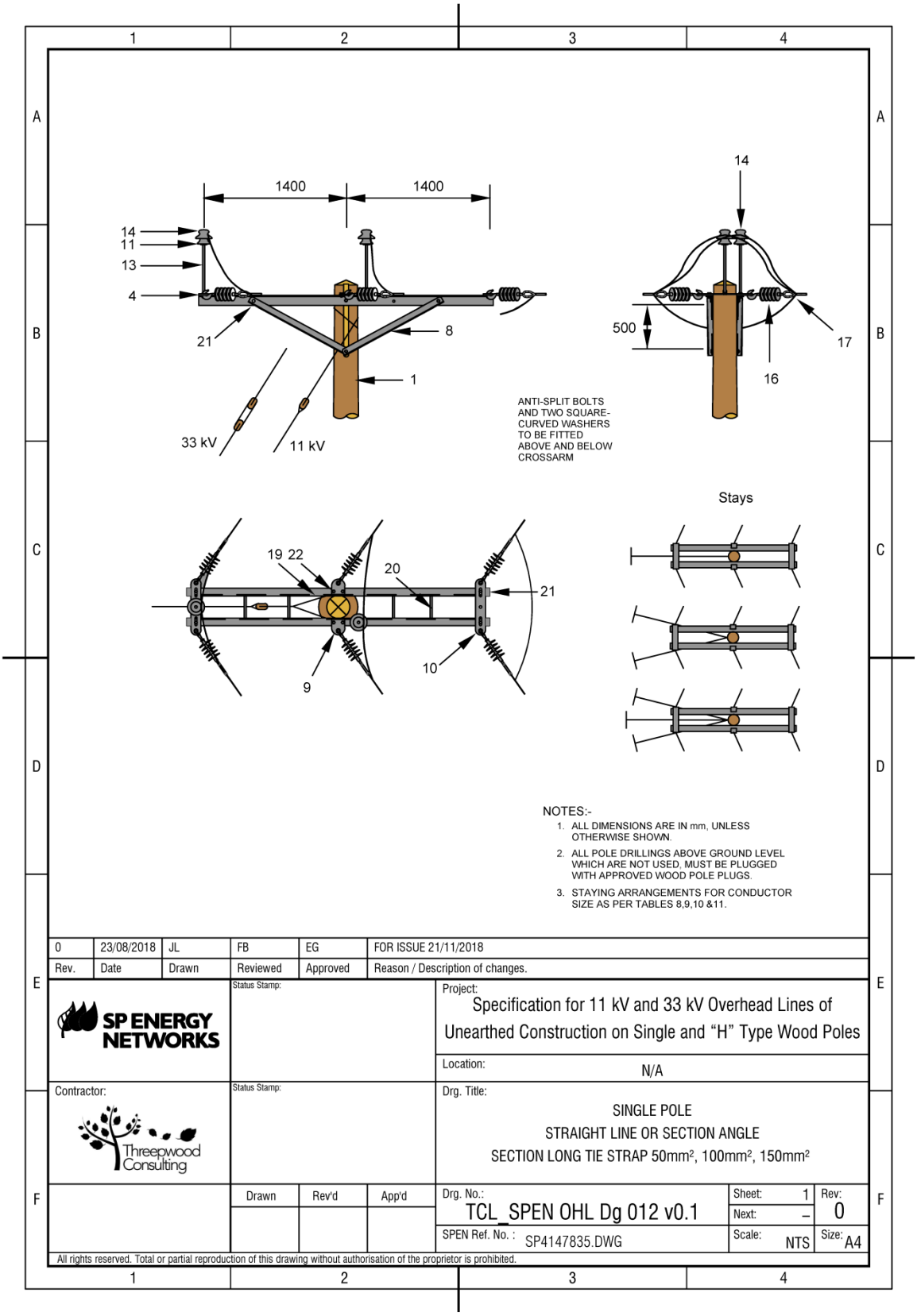
22.11 Figure 11 General Arrangement Single Pole Straight Line or Angle Section 50mm², 100mm², 150mm² (Drawing No. SP4147834)



22.11.1 Schedule of Materials – Single Pole Straight Line or Angle Section 50mm², 100mm², 150mm² (Drawing No. SP4147834)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	1	Wood Pole	ENA Drawing No. 434001	SP4147690
02	1 or 2	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
04	2	Section Crossarm Member	ENA Drawing No. 439520	SP4018433
07	4	Crossarm Strut	ENA Drawing No. 439526	SP4017649
09	2	Terminal Strap	ENA Drawing No. 439528	SP4017664
10	2	Section Strap	ENA Drawing No. 439525	SP4017666
11	2	Pin Insulator	ENA TS 43-93	-
13	2	Pilot Pin 50mm Shank	BS 3288 Fig 5, Ref 50	-
14	2	Helical Ties	ENA TS 43-15	-
15	6	Ball End Hook 70kN (up to 200mm²) Shackle 125kN (300mm²) Ball End Eye Link 125kN (300mm²)	BS 3288 Fig 12 Ref 15/32 BS 3288 Fig 12 Ref 28/29 BS 3288 Fig 12 Ref 28/30	-
16	6	Tension Insulator	ENA TS 43-93	-
17	6	Helical Dead End Assembly	ENA TS 43-92	-
18	3	Non-tension Joint	-	-
19	6	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	2	M20 Tie Rods	ENA Drawing No. 439608 Type 2 or 3	-
21	12	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	4	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	4	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	1 or 2	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

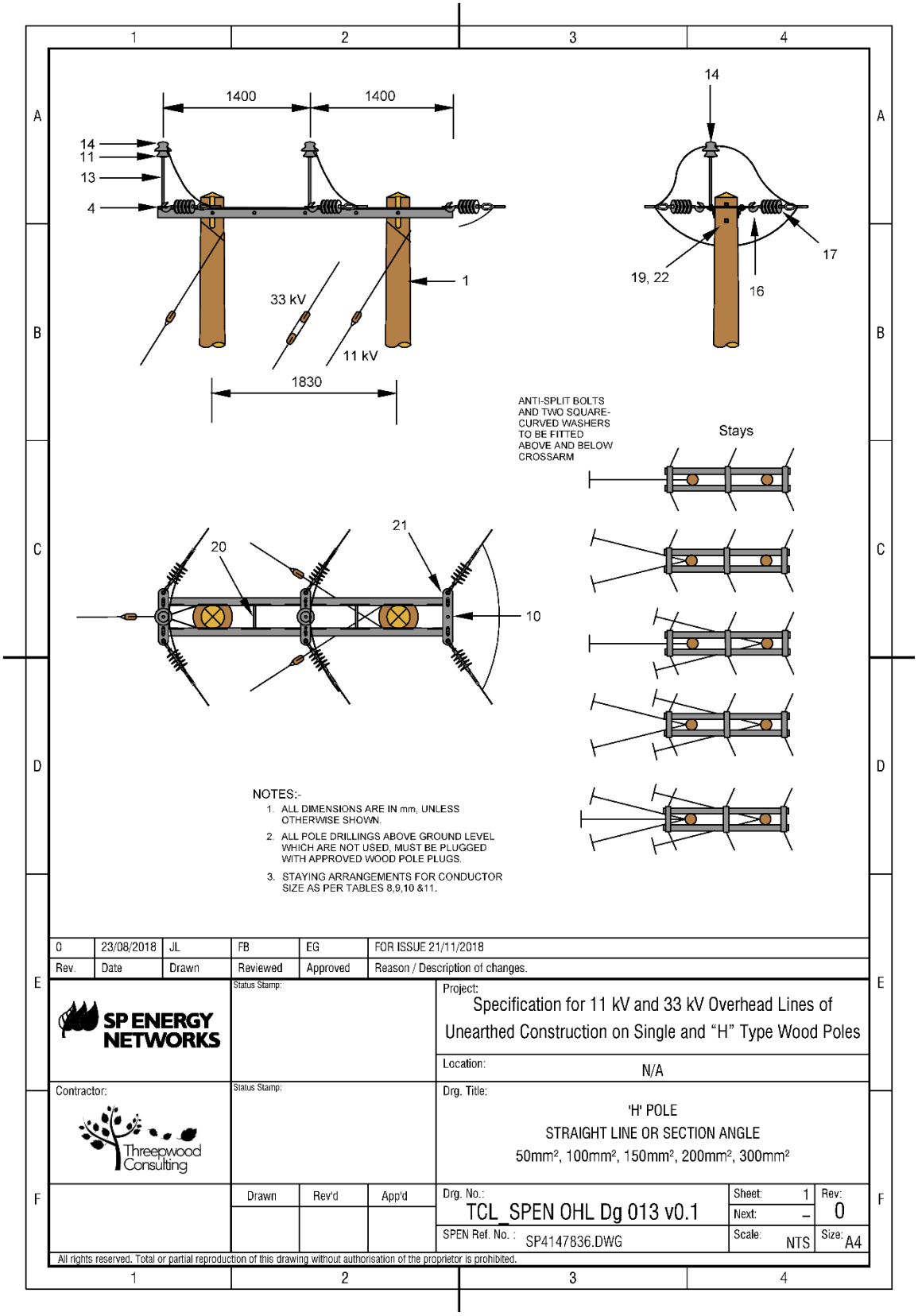
22.12 Figure 12 General Arrangement Single Pole Straight Line or Angle Section Long Tie Strap 50mm², 100mm², 150mm² (Drawing No. SP4147835)



22.12.1 Schedule of Materials – Single Pole Straight Line or Angle Section Long Tie Strap 50mm², 100mm², 150mm² (Drawing No. SP4147835)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	1	Wood Pole	ENA Drawing No. 434001	SP4147690
02	1 or 2	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
04	2	Section Crossarm Member	ENA Drawing No. 439520	SP4018433
08	4	Long Crossarm Strut	-	SP4017635
09	2	Terminal Strap	ENA Drawing No. 439528	SP4017664
10	2	Section Strap	ENA Drawing No. 439525	SP4017666
11	2	Pin Insulator	ENA TS 43-93	-
13	2	Pilot Pin 50mm Shank	BS 3288 Fig 5, Ref 50	-
14	2	Helical Ties	ENA TS 43-15	-
15	6	Ball End Hook 70kN (up to 200mm²) Shackle 125kN (300mm²) Ball End Eye Link 125kN (300mm²)	BS 3288 Fig 12 Ref 15/32 BS 3288 Fig 12 Ref 28/29 BS 3288 Fig 12 Ref 28/30	-
16	6	Tension Insulator	ENA TS 43-93	-
17	6	Helical Dead End Assembly	ENA TS 43-92	-
18	3	Non-tension Joint	-	-
19	4	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	4	M20 Tie Rods	ENA Drawing No. 439608 Type 2 or 3	-
21	12	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	4	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	4	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	1 or 2	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

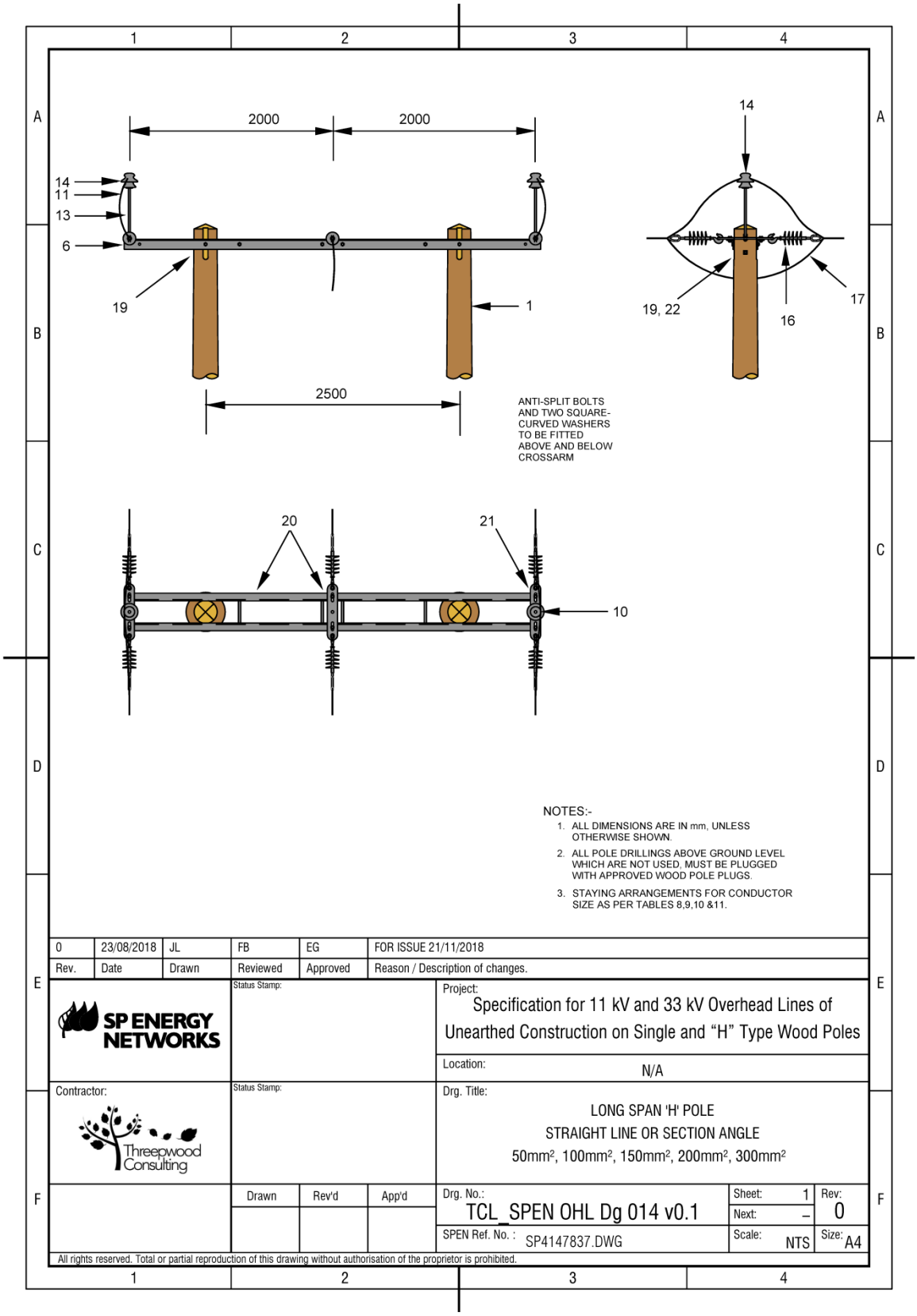
22.13 Figure 13 General Arrangement "H" Pole Straight Line or Angle Section (Drawing No. SP4147836)



22.13.1 Schedule of Materials – "H" Pole Straight Line or Angle Section (Drawing No. SP4147836)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	2	Wood Pole	ENA Drawing No. 434001	SP4147691 or SP4147693
02	2 or 4	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
04	2	Section Crossarm Member	ENA Drawing No. 439520	SP4018433
10	3	Section Strap	ENA Drawing No. 439525	SP4017666
11	2	Pin Insulator	ENA TS 43-93	-
13	2	Pilot Pin 50mm Shank	BS 3288 Fig 5, Ref 50	-
14	2	Helical Ties	ENA TS 43-15	-
15	6	Ball End Hook 70kN (up to 200mm²) Shackle 125kN (300mm²) Ball End Eye Link 125kN (300mm²)	BS 3288 Fig 12 Ref 15/32 BS 3288 Fig 12 Ref 28/29 BS 3288 Fig 12 Ref 28/30	-
16	6	Tension Insulator	ENA TS 43-93	-
17	6	Helical Dead End Assembly	ENA TS 43-92	-
18	3	Non-tension Joint	-	-
19	6	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	2	M20 Tie Rods	ENA Drawing No. 439608 Type 2 or 3	-
21	7	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	6 or 8	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	4 or 6	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	2 or 4	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
28	2	Foundation Brace Steelwork 1830mm centres	ENA Drawing No. 439558	SP4017651
29	1	Foundation Brace Block	ENA Drawing No. 439112 Type 1	SP4019036
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

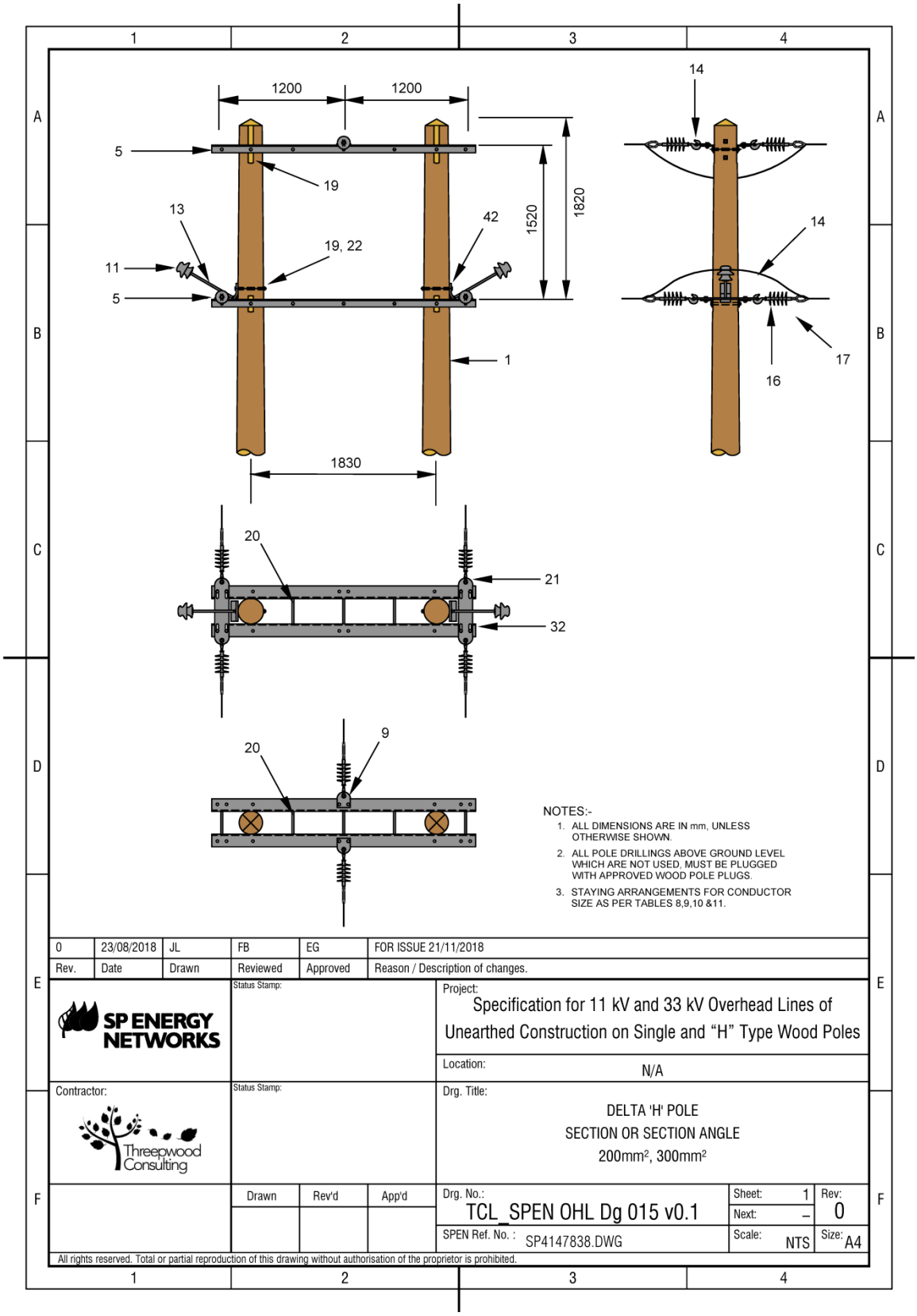
22.14 Figure 14 General Arrangement Long Span "H" Pole Straight Line or Angle Section (Drawing No. SP4147837)



22.14.1 Schedule of Materials – Long Span "H" Pole Straight Line or Angle Section (Drawing No. SP4147837)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	2	Wood Pole	ENA Drawing No. 434001	SP4147691 or SP4147693
02	2 or 4	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
06	2	Long Span Crossarm Member	ENA Drawing No. 439521	SP4017663
10	3	Section Strap	ENA Drawing No. 439525	SP4017666
11	2	Pin Insulator	ENA TS 43-93	-
13	2	Pilot Pin 50mm Shank	BS 3288 Fig 5, Ref 50	-
14	2	Helical Ties	ENA TS 43-15	-
15	6	Ball End Hook 70kN (up to 200mm²) Shackle 125kN (300mm²) Ball End Eye Link 125kN (300mm²)	BS 3288 Fig 12 Ref 15/32 BS 3288 Fig 12 Ref 28/29 BS 3288 Fig 12 Ref 28/30	-
16	6	Tension Insulator	ENA TS 43-93	-
17	6	Helical Dead End Assembly	ENA TS 43-92	-
18	3	Non-tension Joint	-	-
19	6	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	6	M20 Tie Rods	ENA Drawing No. 439608 Type 2 or 3	-
21	7	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	8	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	8	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	2 or 4	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
28	2	Foundation Brace Steelwork 2500mm centres	ENA Drawing No. 439558	SP4017651
29	1	Foundation Brace Block	ENA Drawing No. 439112 Type 2	SP4019037
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

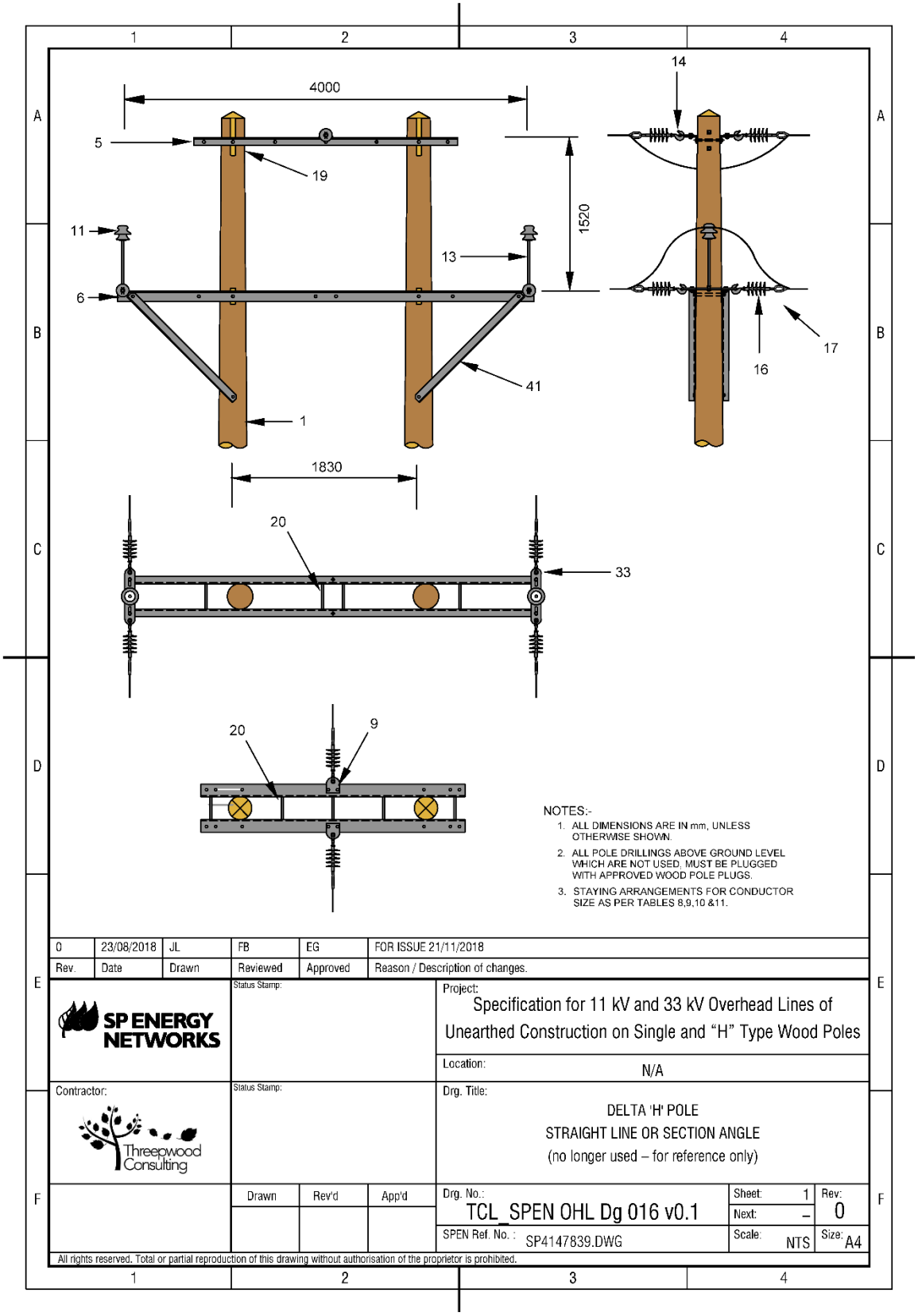
22.15 Figure 15 General Arrangement Delta "H" Pole Section or Section Angle 200mm², 300mm² (Drawing No. SP4147838)



22.15.1 Schedule of Materials – Delta "H" Pole Section or Section Angle 200mm², 300mm² (Drawing No. SP4147838)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	2	Wood Pole	ENA Drawing No. 434001	SP4147830
02	2 or 4	Pole Block	ENA Drawing No. 439103 Type 2	SP4019020
05	4	Terminal Crossarm Member	ENA Drawing No. 439522	SP4018401
09	2	Terminal Strap	ENA Drawing No. 439528	SP4017664
11	2	Pin Insulator	ENA TS 43-93	-
13	2	Pilot Pin 50mm Shank	BS 3288 Fig 5, Ref 50	-
14	3	Helical Ties	ENA TS 43-15	-
15	6	Ball End Hook 70kN (up to 200mm²) Shackle 125kN (300mm²) Ball End Eye Link 125kN (300mm²)	BS 3288 Fig 12 Ref 15/32 BS 3288 Fig 12 Ref 28/29 BS 3288 Fig 12 Ref 28/30	-
16	6	Tension Insulator	ENA TS 43-93	-
17	6	Helical Dead End Assembly	ENA TS 43-92	-
18	3	Non-tension Joint	-	-
19	6	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	8	M20 Tie Rods	ENA Drawing No. 439608 Type 2 or 3	-
21	13	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	6 or 8	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	4 or 6	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	2 or 4	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
28	2	Foundation Brace Steelwork 1830mm centres	ENA Drawing No. 439558	SP4017651
29	1	Foundation Brace Block	ENA Drawing No. 439112 Type 1	SP4019036
32	2	Delta H Section Strap	-	SP2146143
42	2	30 Degree Angle Bracket	-	SP4018951
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

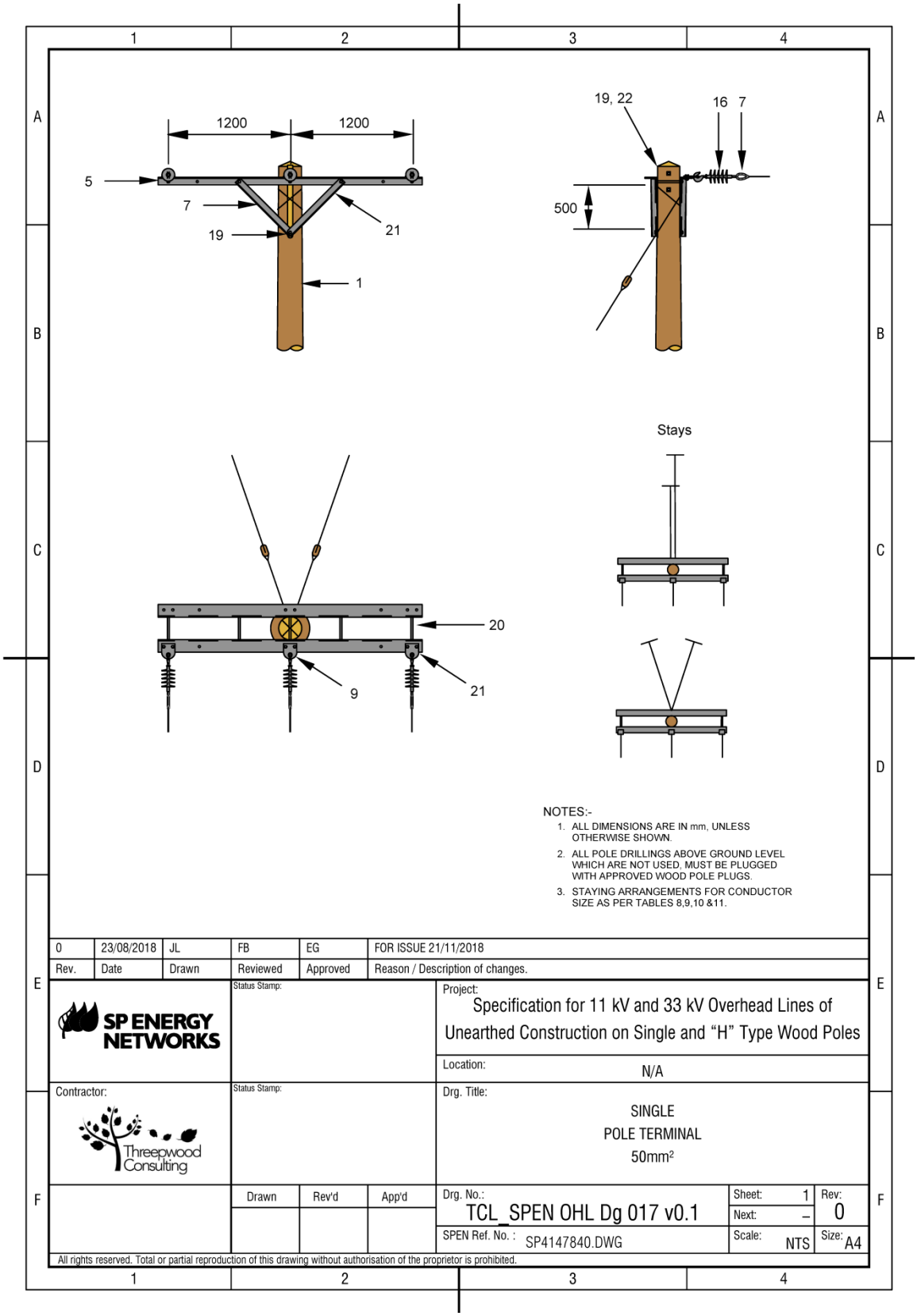
22.16 Figure 16 General Arrangement Delta Long Span "H" Pole Section or Section Angle (Drawing No. SP4147839)



22.16.1 Schedule of Materials – Delta Long Span "H" Pole Section or Section Angle (Drawing No. SP4147839)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	2	Wood Pole	ENA Drawing No. 434001	SP4147830
02	2 or 4	Pole Block	ENA Drawing No. 439103 Type 2	SP4019020
05	2	Terminal Crossarm Member	ENA Drawing No. 439522	SP4018401
06	2	Long Span Crossarm Member	ENA Drawing No. 439521	SP4017663
09	2	Terminal Strap	ENA Drawing No. 439528	SP4017664
11	2	Pin Insulator	ENA TS 43-93	-
13	2	Pilot Pin 50mm Shank	BS 3288 Fig 5, Ref 50	-
14	2	Helical Ties	ENA TS 43-15	-
15	6	Ball End Hook 70kN (up to 200mm²) Shackle 125kN (300mm²) Ball End Eye Link 125kN (300mm²)	BS 3288 Fig 12 Ref 15/32 BS 3288 Fig 12 Ref 28/29 BS 3288 Fig 12 Ref 28/30	-
16	6	Tension Insulator	ENA TS 43-93	-
17	6	Helical Dead End Assembly	ENA TS 43-92	-
18	3	Non-tension Joint	-	-
19	8	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	9	M20 Tie Rods	ENA Drawing No. 439608 Type 2 or 3	-
21	8	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	6 or 8	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	4 or 6	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	2 or 4	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
28	2	Foundation Brace Steelwork 1830mm centres	ENA Drawing No. 439558	SP4017651
29	1	Foundation Brace Block	ENA Drawing No. 439112 Type 1	SP4019036
33	2	Long Section Strap for Long Span Delta "H" Pole	-	SP4019183
41	4	Long Span Delta Crossarm Strut	-	SP2143987
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

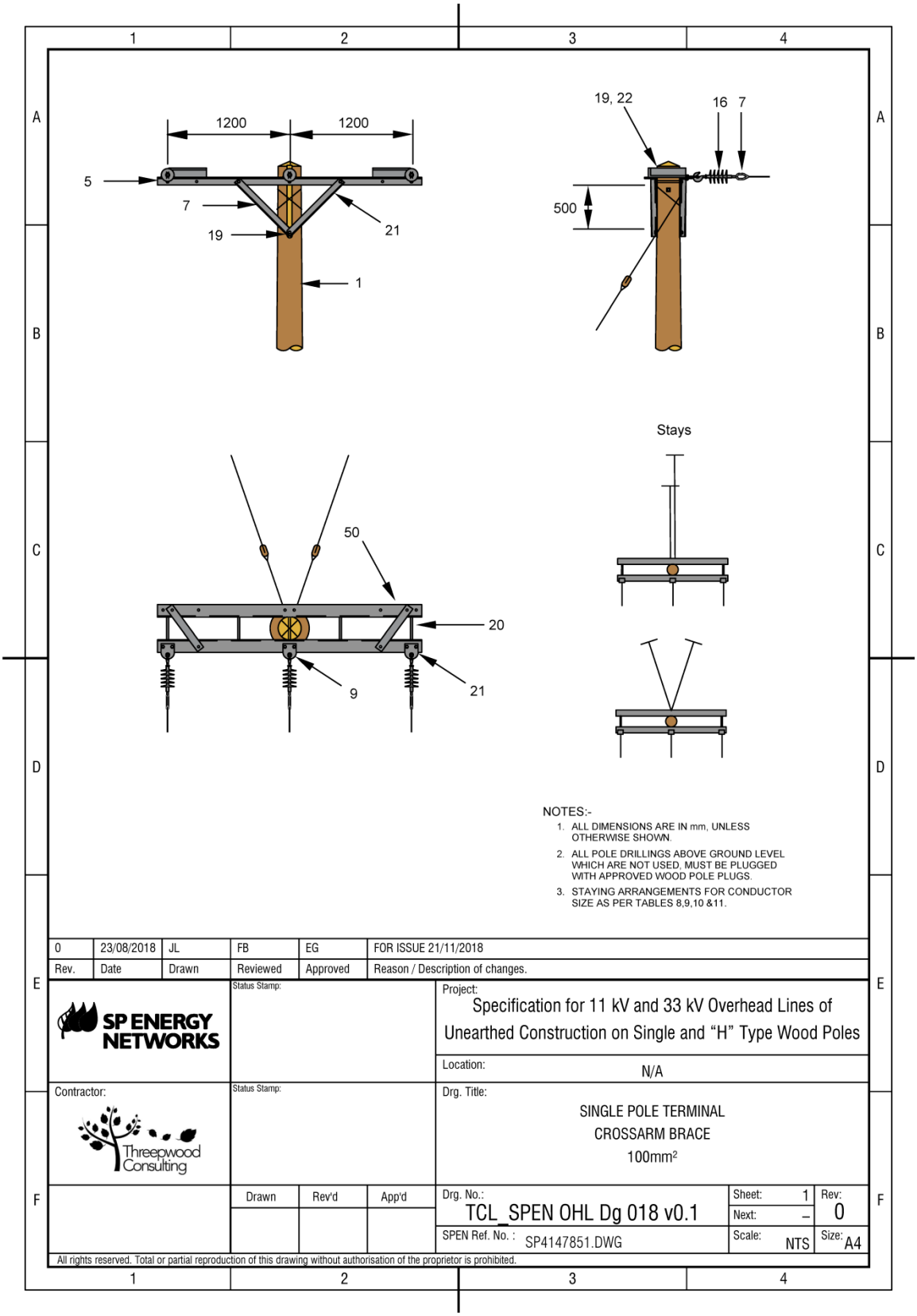
22.17 Figure 17 General Arrangement Single Pole Terminal 50mm² (Drawing No. SP4147840)



22.17.1 Schedule of Materials – Single Pole Terminal 50mm² (Drawing No. SP4147840)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	1	Wood Pole	ENA Drawing No. 434001	SP4147690
02	1 or 2	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
05	2	Terminal Crossarm Member	ENA Drawing No. 439522	SP4018401
07	4	Crossarm Strut	ENA Drawing No. 439526	SP4017649
09	3	Terminal Strap	ENA Drawing No. 439528	SP4017664
15	3	Ball End Hook 70kN	BS 3288 Fig 12 Ref 15/32	-
16	3	Tension Insulator	ENA TS 43-93	-
17	3	Helical Dead End Assembly	ENA TS 43-92	-
19	4	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	4	M20 Tie Rods	ENA Drawing No. 439608 Type 2 or 3	-
21	10	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	4	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	4	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	1 or 2	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

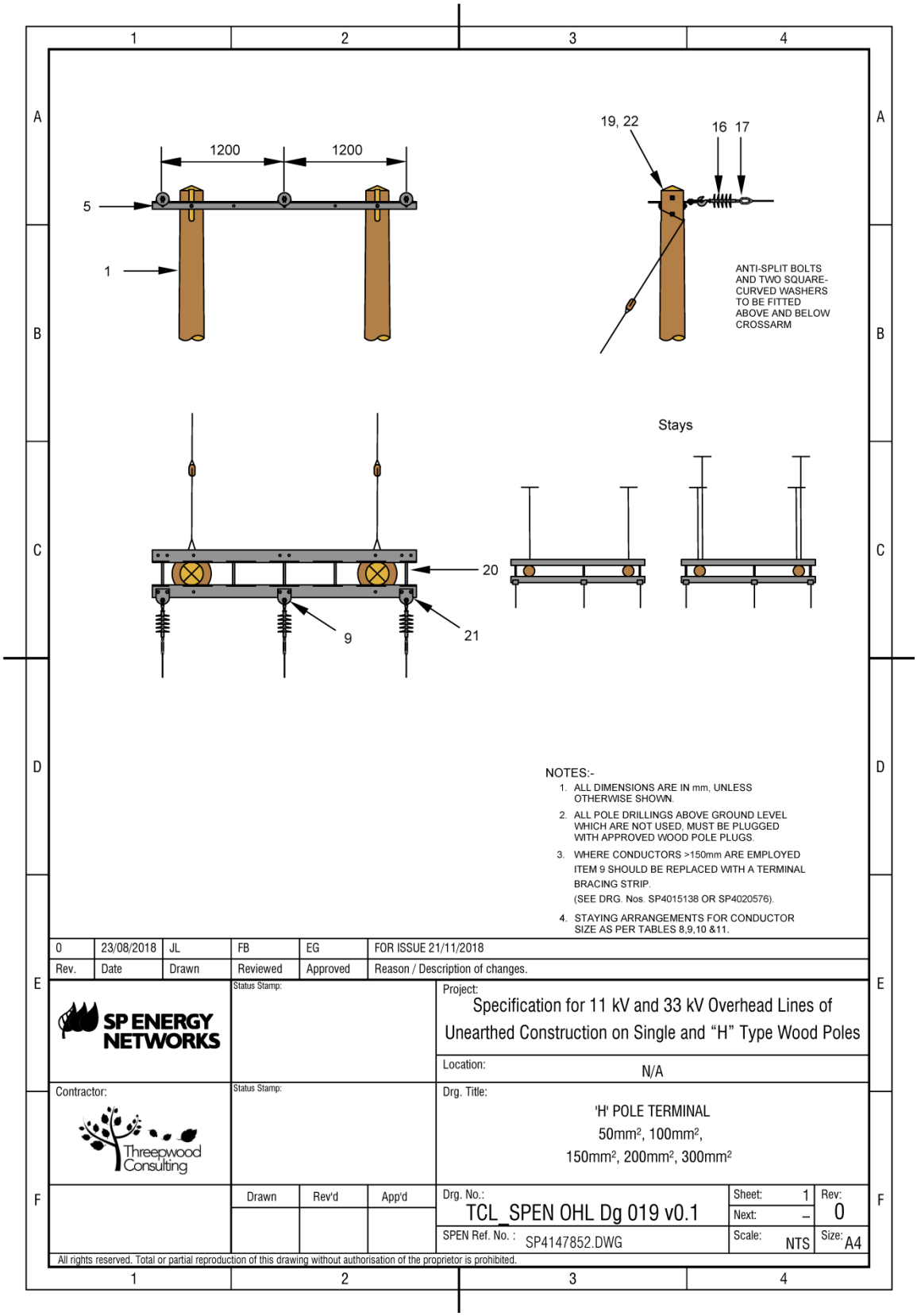
22.18 Figure 18 General Arrangement Single Pole Terminal Crossarm Brace 100mm² (Drawing No. SP4147851)



22.18.1 Schedule of Materials – Single Pole Terminal Crossarm Brace 100mm² (Drawing No. SP4147851)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	1	Wood Pole	ENA Drawing No. 434001	SP4147690
02	1 or 2	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
05	2	Terminal Crossarm Member	ENA Drawing No. 439522	SP4018401
07	4	Crossarm Strut	ENA Drawing No. 439526	SP4017649
09	3	Terminal Strap	ENA Drawing No. 439528	SP4017664
15	3	Ball End Hook 70kN	BS 3288 Fig 12 Ref 15/32	-
16	3	Tension Insulator	ENA TS 43-93	-
17	3	Helical Dead End Assembly	ENA TS 43-92	-
19	4	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	4	M20 Tie Rods	ENA Drawing No. 439608 Type 2 or 3	-
21	12	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	1 or 2	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	1 or 2	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	1 or 2	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
50	2	Crossarm Brace	ENA Drawing No. 439515	-
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

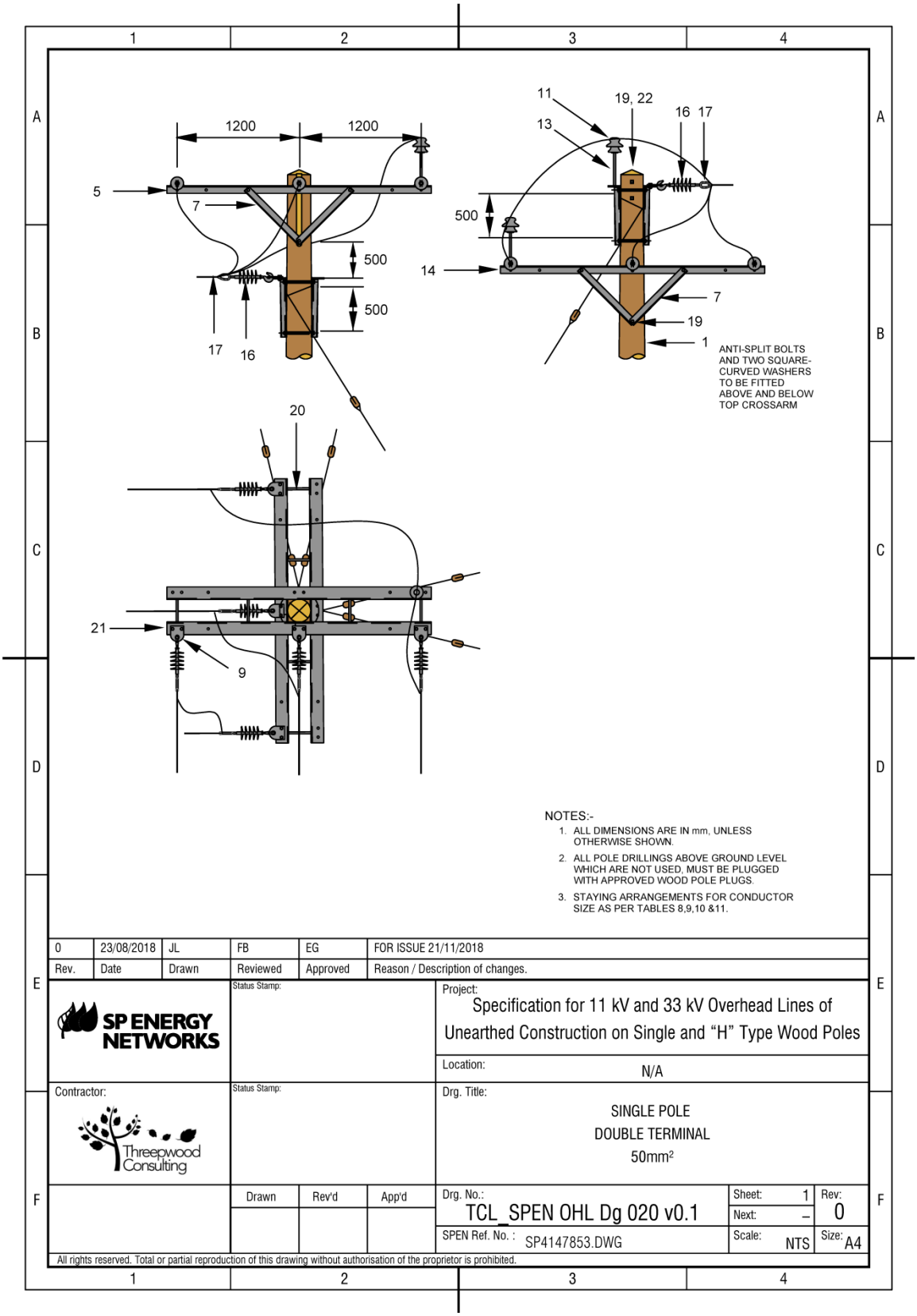
22.19 Figure 19 General Arrangement "H" Pole Terminal (Drawing No. SP4147852)



22.19.1 Schedule of Materials – "H" Pole Terminal (Drawing No. SP4147852)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	2	Wood Pole	ENA Drawing No. 434001	SP4147691 or SP4147693
02	2	Pole Block	ENA Drawing No. 439103 Type3	SP4019020
05	2	Terminal Crossarm Member	ENA Drawing No. 439522	SP4018401
09	3	Terminal Strap 50mm², 100mm², 150mm² Terminal Strap 200mm² Terminal Strap 300mm²	ENA Drawing No. 439528 N/A N/A	SP4017664 SP4020576 SP4015138
15	3	Ball End Hook 70kN (up to 200mm²) Shackle 125kN (300mm²) Ball End Eye Link 125kN (300mm²)	BS 3288 Fig 12 Ref 15/32 BS 3288 Fig 12 Ref 28/29 BS 3288 Fig 12 Ref 28/30	-
16	3	Tension Insulator	ENA TS 43-93	-
17	3	Helical Dead End Assembly	ENA TS 43-92	-
19	8 or 10	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	5	M20 Tie Rods	ENA Drawing No. 439608 Type 2 or 3	-
21	6	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	8	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	8	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	2 or 4	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
28	2	Foundation Brace Steelwork 1830mm centres	ENA Drawing No. 439558	SP4017651
29	1	Foundation Brace Block	ENA Drawing No. 439112 Type 1	SP4019036
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

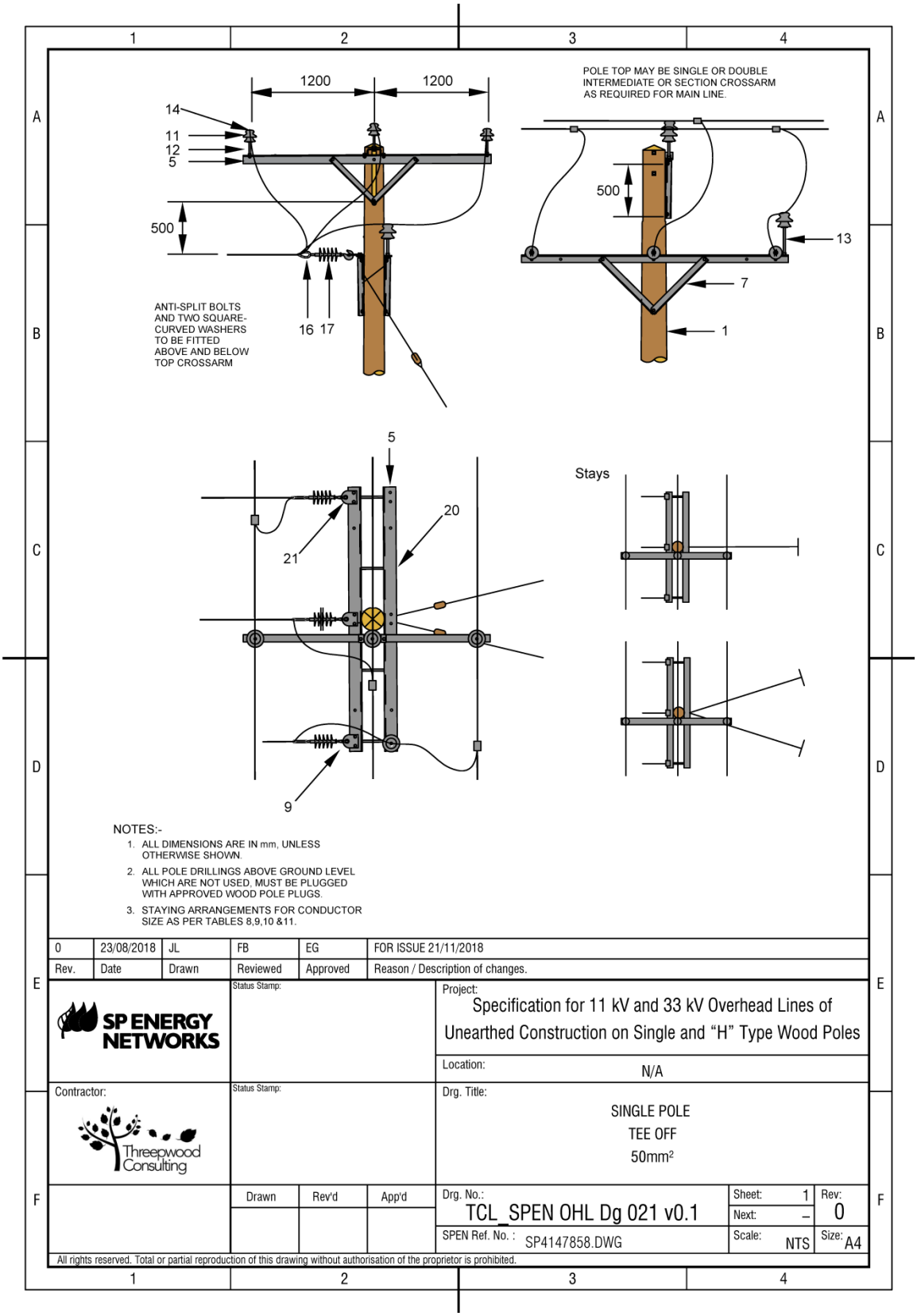
22.20 Figure 20 General Arrangement Single Pole Double Terminal 50mm² (Drawing No. SP4147853)



22.20.1 Schedule of Materials – Single Pole Double Terminal 50mm² (Drawing No. SP4147853)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	1	Wood Pole	ENA Drawing No. 434001	SP4147690
02	1 or 2	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
05	4	Terminal Crossarm Member	ENA Drawing No. 439522	SP4018401
07	8	Crossarm Strut	ENA Drawing No. 439526	SP4017649
09	6	Terminal Strap	ENA Drawing No. 439528	SP4017664
15	6	Ball End Hook	BS 3288 Fig 12 Ref 15/32	-
16	6	Tension Insulator	ENA TS 43-93	-
17	6	Helical Dead End Assembly	ENA TS 43-92	-
19	6	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	8	M20 Tie Rods	ENA Drawing No. 439608 Type 2 or 3	-
21	20	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	4	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	1 or 2	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	1 or 2	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

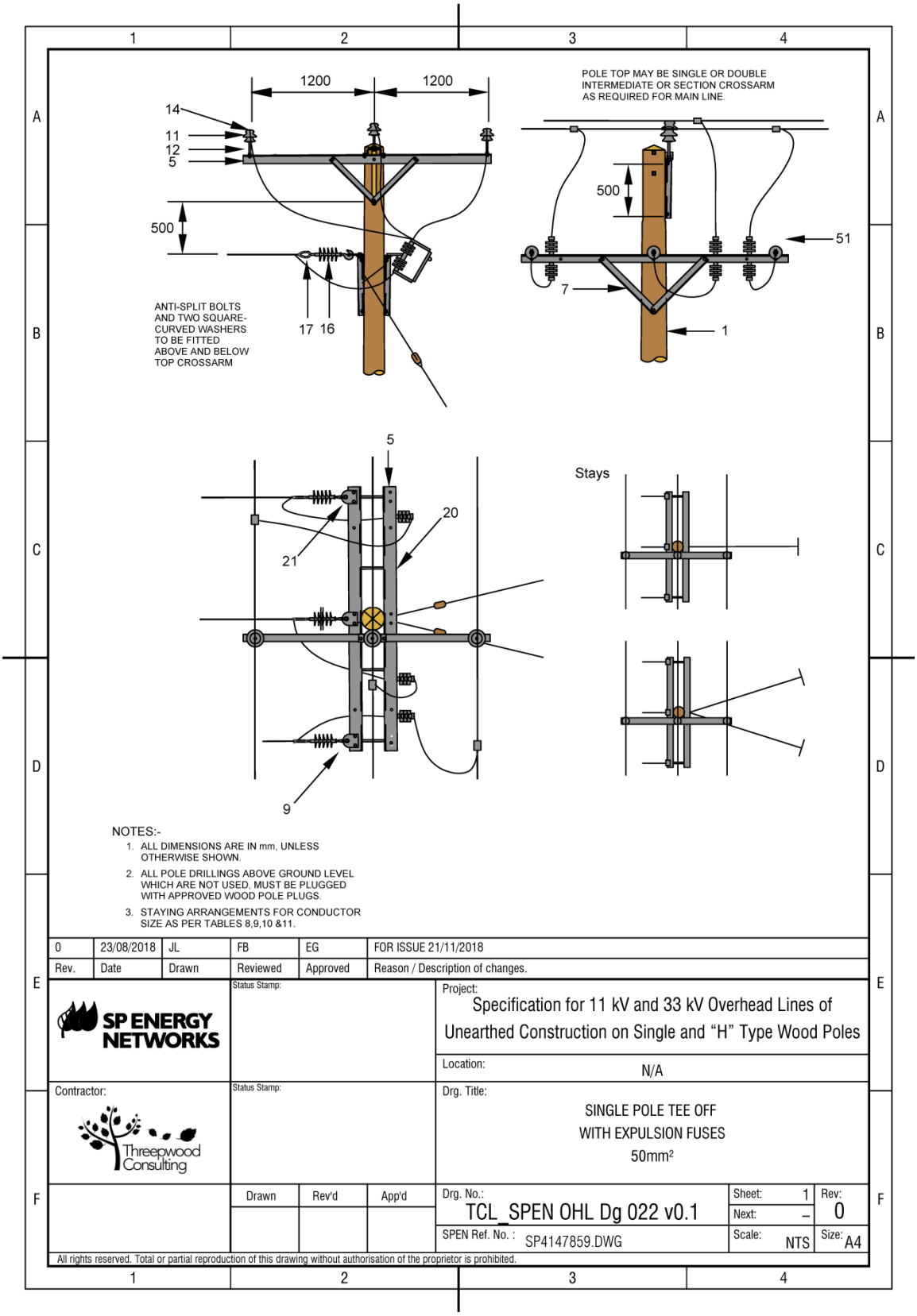
22.21 Figure 21 General Arrangement Single Pole Tee-off 50mm² (Drawing No. SP4147858)



22.21.1 Schedule of Materials – Single Pole Tee-off 50mm² (Drawing No. SP4147858)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	1	Wood Pole	ENA Drawing No. 434001	SP4147690
02	1 or 2	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
05	4	Terminal Crossarm Member	ENA Drawing No. 439522	SP4018401
07	8	Crossarm Strut	ENA Drawing No. 439526	SP4017649
09	6	Terminal Strap	ENA Drawing No. 439528	SP4017664
11	4	Insulator	ENA TS 43-93	-
12	3	Insulator Pin	BS 3288 Fig 4, Ref 29	-
13	1	Pilot Pin 50mm Shank	BS 3288 Fig 5, Ref 50	-
14	4	Helical Ties	ENA TS 43-15	-
16	6	Tension Insulator	ENA TS 43-93	-
17	6	Helical Dead End Assembly	ENA TS 43-92	-
19	5 or 6	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	8	M20 Tie Rods	ENA Drawing No. 439608 Type 2 or 3	-
21	20	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	1 or 2	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	1 or 2	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	1 or 2	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

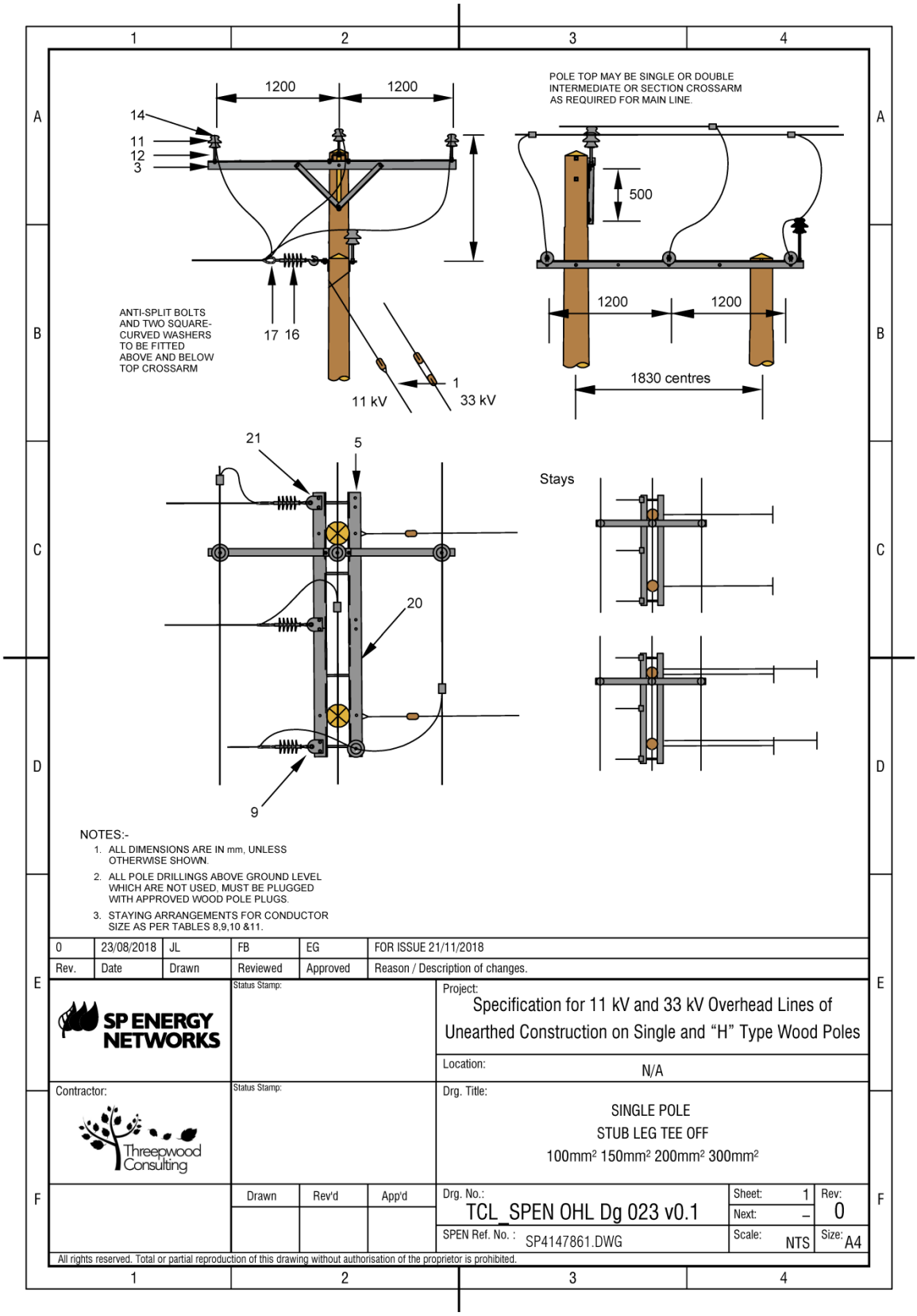
22.22 Figure 22 General Arrangement Single Pole Tee-off 50mm² with Expulsion Fuses (Drawing No. SP4147859)



22.22.1 Schedule of Materials – Single Pole Tee-off 50mm² with Expulsion Fuses (Drawing No. SP4147859)

ITEM	NUMBER	DESCRIPTION to be populated with correct items	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	1	Wood Pole	ENA Drawing No. 434001	SP4147690
02	1 or 2	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
05	4	Terminal Crossarm Member	ENA Drawing No. 439522	SP4018401
07	8	Crossarm Strut	ENA Drawing No. 439526	SP4017649
09	6	Terminal Strap	ENA Drawing No. 439528	SP4017664
11	3	Insulator	ENA TS 43-93	-
12	3	Insulator Pin	BS 3288 Fig 4, Ref 29	-
13	1	Pilot Pin 50mm Shank	BS 3288 Fig 5, Ref 50	-
14	3	Helical Ties	ENA TS 43-15	-
16	6	Tension Insulator	ENA TS 43-93	-
17	6	Helical Dead End Assembly	ENA TS 43-92	-
19	5 or 6	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	8	M20 Tie Rods	ENA Drawing No. 439608 Type 2 or 3	-
21	20	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	1 or 2	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	1 or 2	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	1 or 2	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
51	3	HV Fusemount	-	-
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

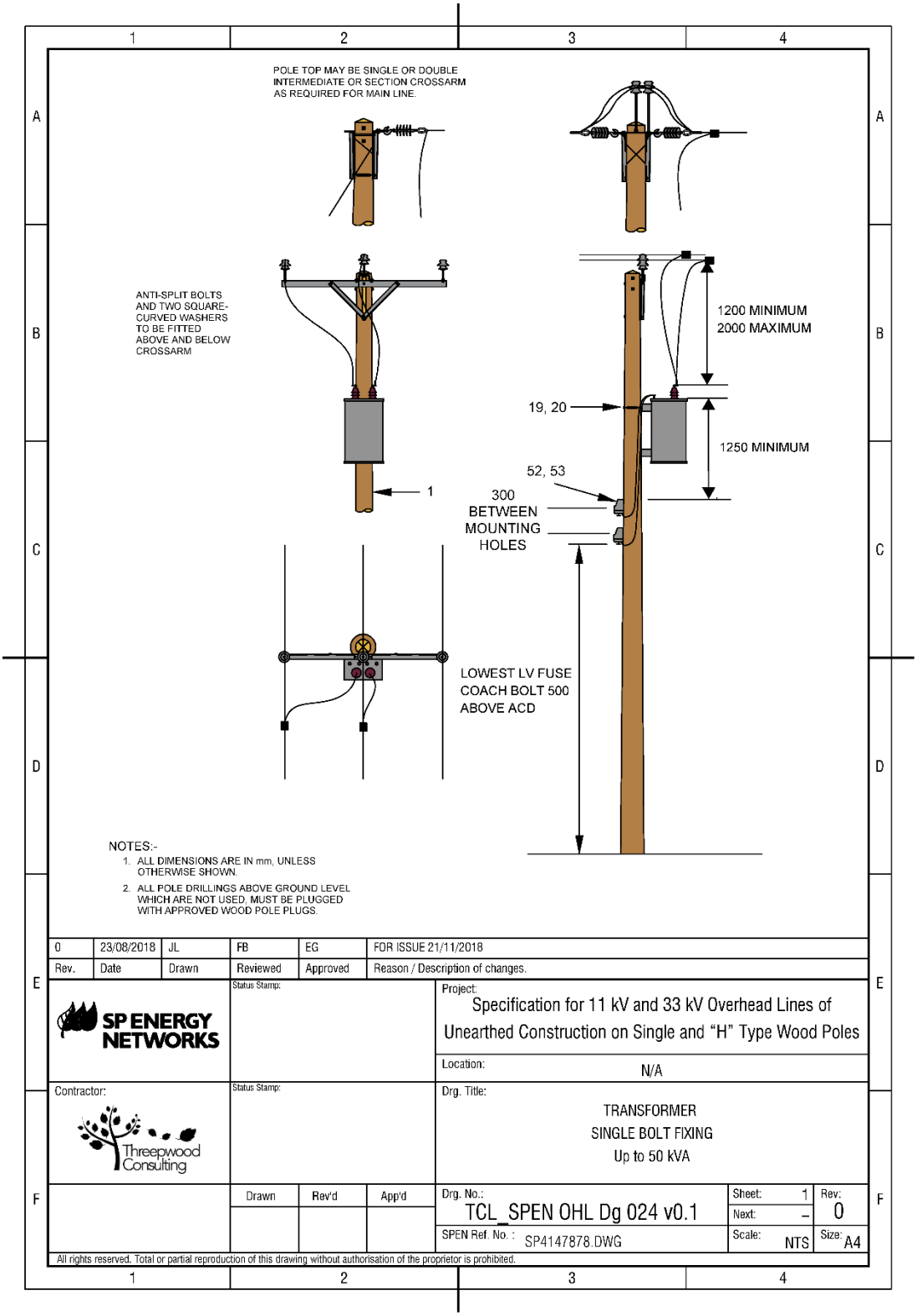
22.23 Figure 23 General Arrangement Single Pole Stub Leg Tee-off 100mm² to 300mm² (Drawing No. SP4147861)



22.23.1 Schedule of Materials – Single Pole Stub Leg Tee-off 100mm² to 300mm² (Drawing No. SP4147861)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
01	1	Wood Pole	ENA Drawing No. 434001	SP4147690 or SP4147692
02	1 or 2	Pole Block	ENA Drawing No. 439103 Type 3	SP4019020
03	1 or 2	Intermediate Crossarm Member	ENA Drawing No. 439519	SP4018402
05	2	Terminal Crossarm Member	ENA Drawing No. 439522	SP4018401
07	2 or 4	Crossarm Strut	ENA Drawing No. 439526	SP4017649
09	3	Terminal Strap 50mm², 100mm², 150mm² Terminal Strap 200mm² Terminal Strap 300mm²	ENA Drawing No. 439528 N/A N/A	SP4017664 SP4020576 SP4015138
15	3	Ball End Hook 70kN (up to 200mm²) Shackle 125kN (300mm²) Ball End Eye Link 125kN (300mm²)	BS 3288 Fig 12 Ref 15/32 BS 3288 Fig 12 Ref 28/29 BS 3288 Fig 12 Ref 28/30	-
16	3	Tension Insulator	ENA TS 43-93	-
17	3	Helical Dead End Assembly	ENA TS 43-92	-
19	6	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	4	M20 Tie Rods	ENA Drawing No. 439608 Type 2 or 3	-
21	10 or 14	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
22	4 or 6	M20 Square Curved Washer	ENA Drawing No. 439605	-
23	1 or 2	M20 Square Flat Washer	ENA Drawing No. 439604	-
24	1 or 2	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
27	2	Insulator Plate	-	SP4017637
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

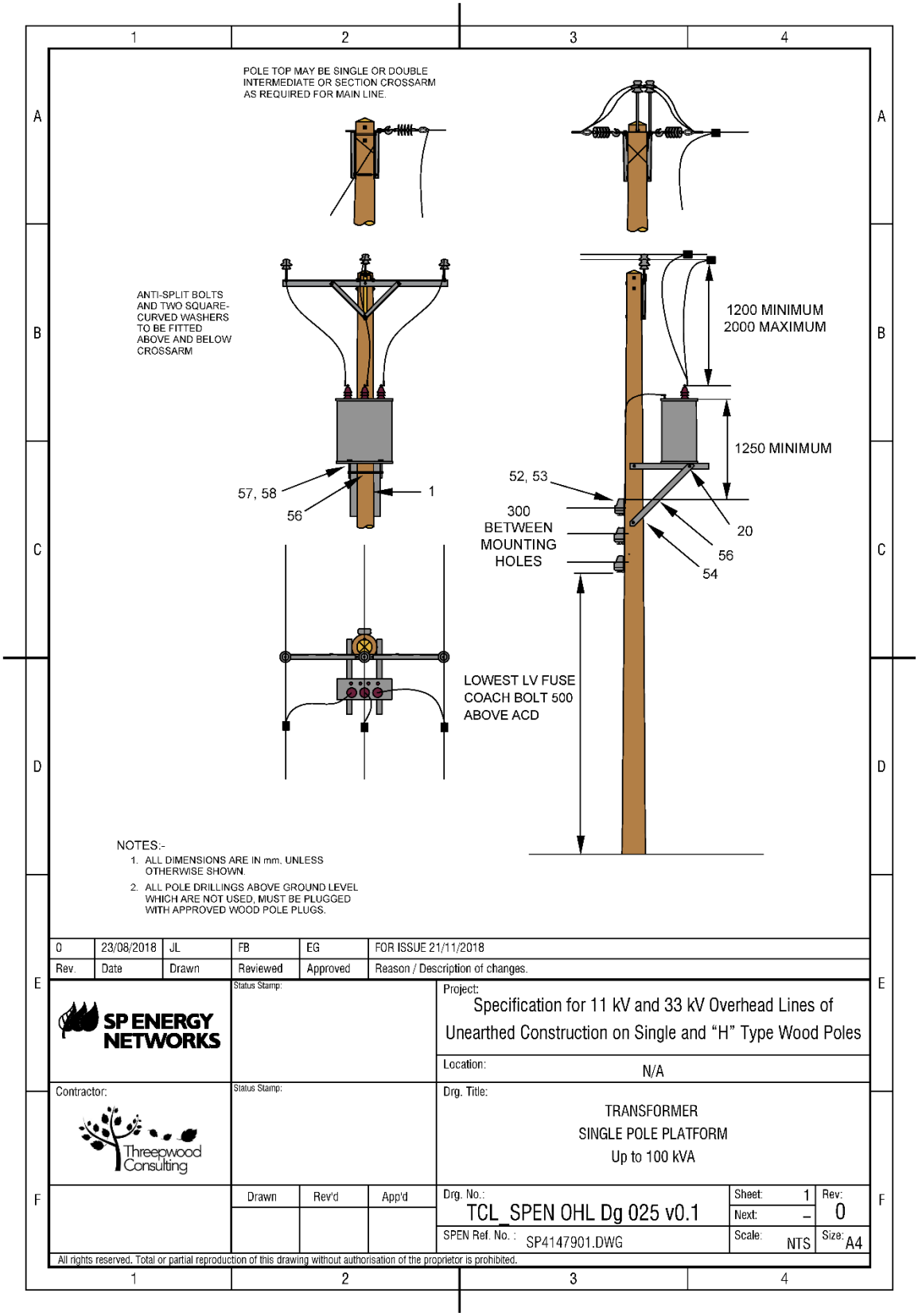
22.24 Figure 24 General Arrangement Transformer Single Bolt Fixing up to 400kg (Drawing No. SP4147878)



22.24.1 Schedule of Materials – Transformer Single Bolt Fixing up to 400kg (Drawing No. SP4147878)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
-	-	See General Arrangement for pole top materials relevant to conductor size and application	-	-
19	1	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
22	1	M20 Square Curved Washer	ENA Drawing No. 439605	-
24	1 or 2	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-
52	1 or 2	LV Fuses	-	-
53	3	Coach Screws	-	-
-	4	Coach Screws	-	-
-	2	Anti-climbing guard	ENA Drawing No. 439516	-
-	-	Barbed Wire	-	-

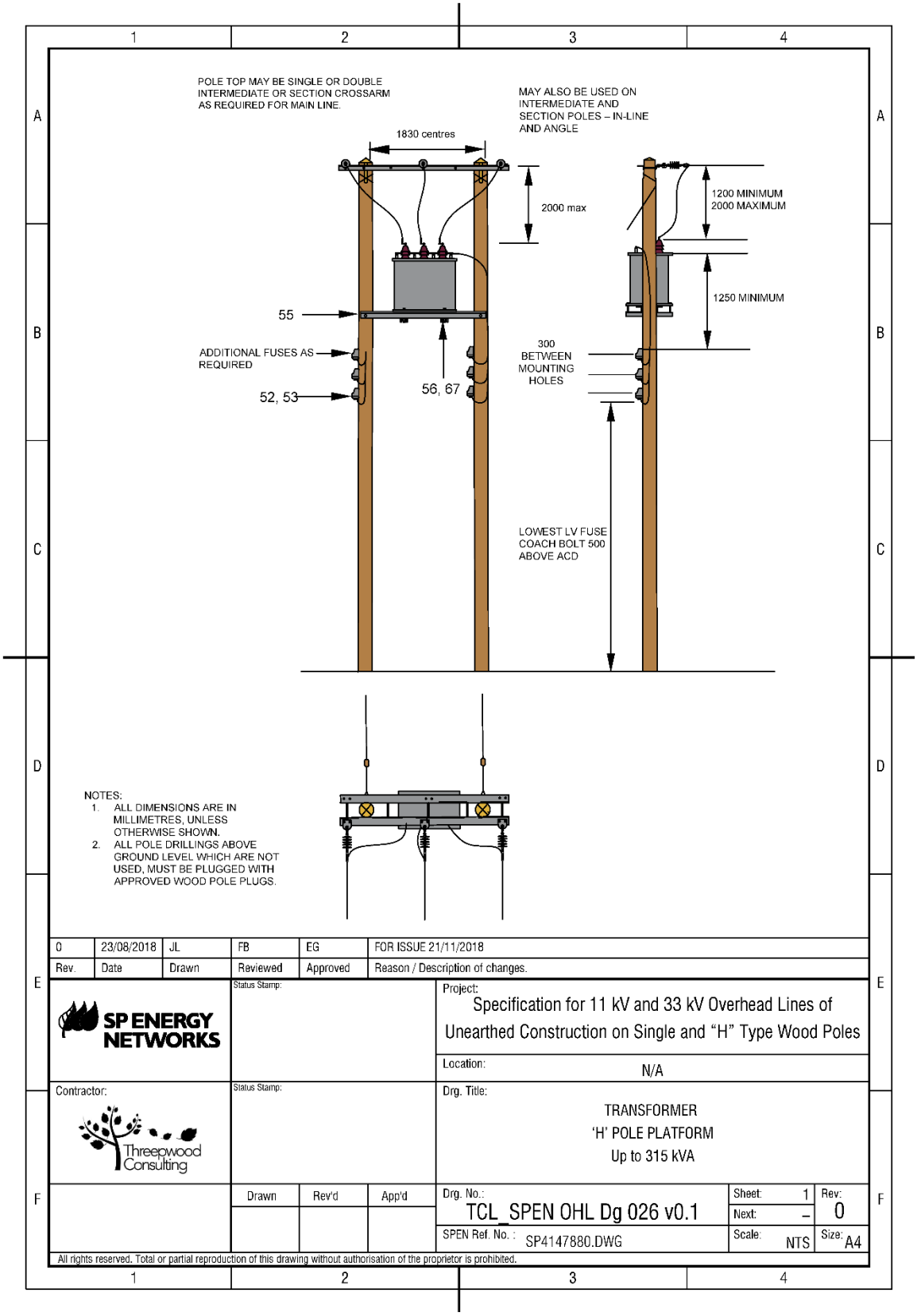
22.25 Figure 25 General Arrangement Transformer Single Pole Platform up to 1000kg (Drawing No. SP4147901)



22.25.1 Schedule of Materials – Transformer Single Pole Platform up to 1000kg (Drawing No. SP4147901)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
-	-	See General Arrangement for pole top materials relevant to conductor size and application	-	-
19	2	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
20	1	M20 Tie Rods	ENA Drawing No. 439608 Type 2	-
21	2	M20 x 60mm Assembly Bolt and Nut	ENA TS 43-96 Clause 4.2	-
24	1 or 2	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-
52	3	LV Fuses	-	-
53	3	Coach Screws	-	-
54	2	Platform & Strut – Transformer – Single Pole	ENA Drawing No. 439523	-
56	2	Transformer Clamping Plate	ENA Drawing No. 439529	-
57	4	Bolt & Nut M20 x 100	ENA TS 43-96 Clause 4.2	-
58	4	Washer Round M20	ENA TS 43-96 Clause 4.2	-
-	4	Coach Screws	-	-
-	2	Anti-climbing guard	ENA Drawing No. 439516	-
-	-	Barbed Wire	-	-

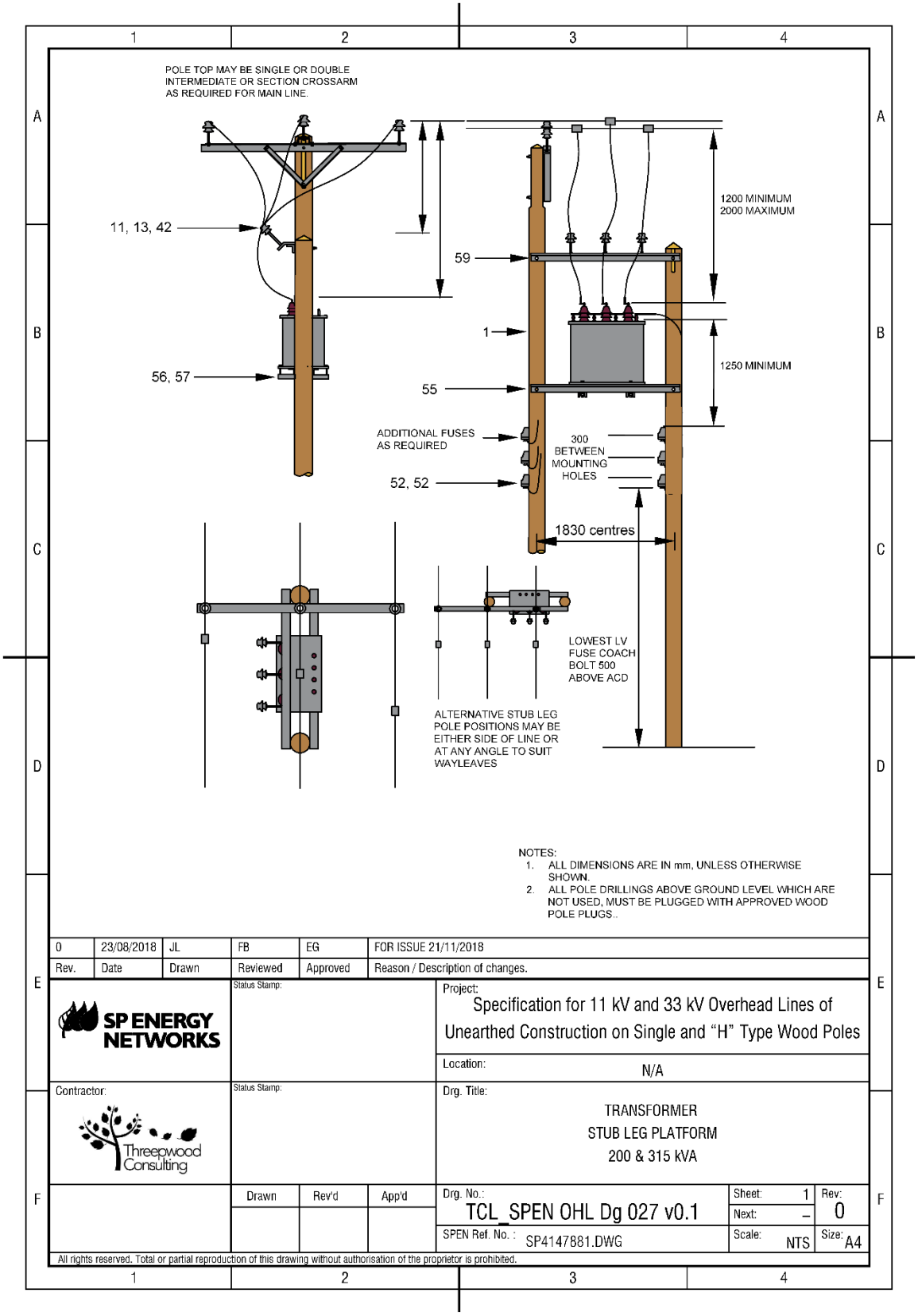
22.26 Figure 26 General Arrangement Transformer "H" Pole Platform (Drawing No. SP4147880)



22.26.1 Schedule of Materials – Transformer "H" Pole Platform (Drawing No. SP4147880)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
-	-	See General Arrangement for pole top materials relevant to conductor size and application	-	-
19	2	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
24	1 or 2	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-
52	3	LV Fuses	-	-
53	3	Coach Screws	-	-
55	2	Platform – Transformer – "H" Pole	ENA Drawing No. 439524	-
56	2	Transformer Clamping Plate	ENA Drawing No. 439529	-
57	4	Bolt & Nut M20 x 100	ENA TS 43-96 Clause 4.2	-
58	4	Washer Round M20	ENA TS 43-96 Clause 4.2	-
-	4	Coach Screws	-	-
-	2	Anti-climbing guard	ENA Drawing No. 439516	-
-	-	Barbed Wire	-	-

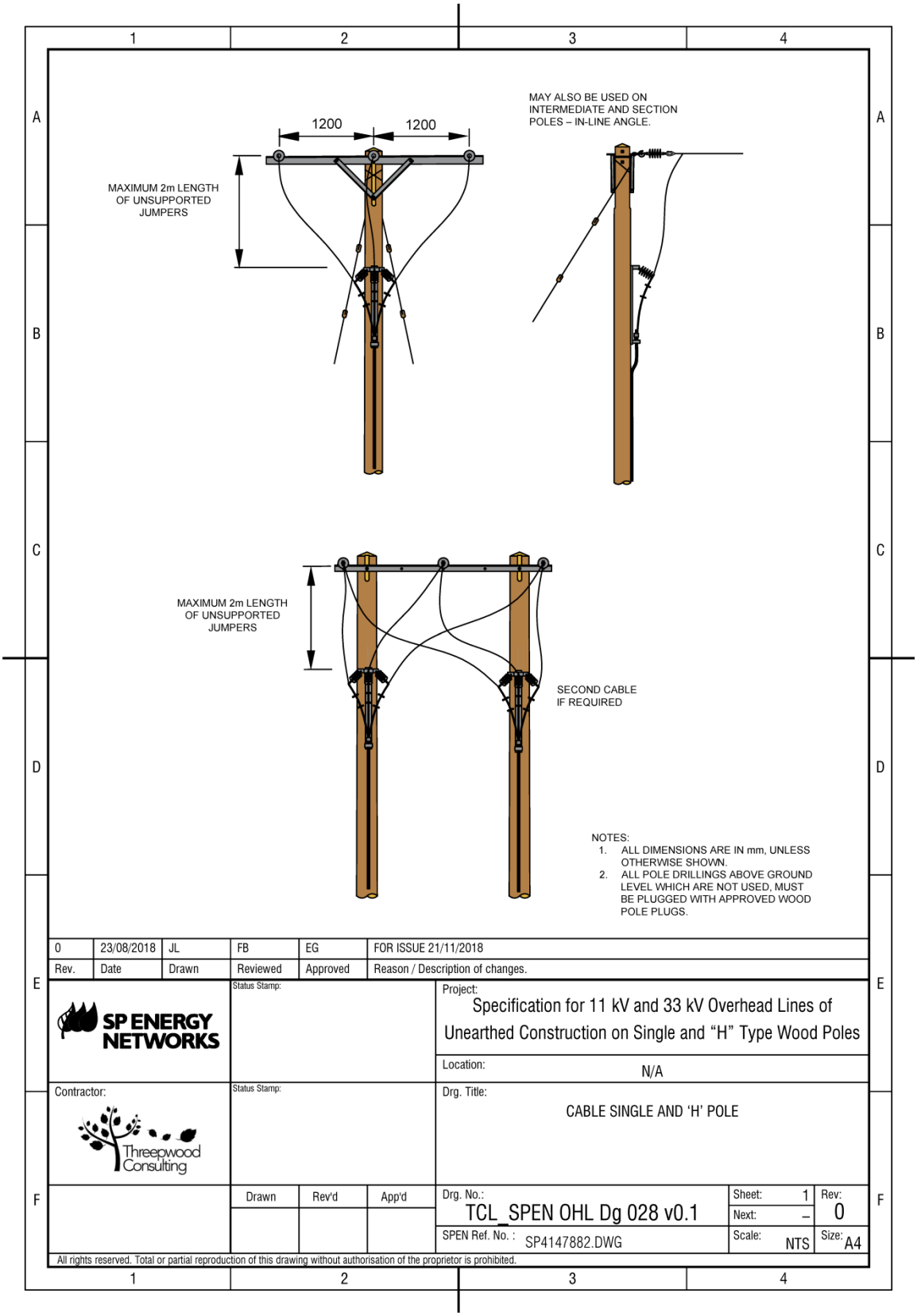
22.27 Figure 27 General Arrangement Transformer Stub Leg Platform (Drawing No. SP4147881)



22.27.1 Schedule of Materials – Transformer Stub Leg Platform (Drawing No. SP4147881)

ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
-	-	See General Arrangement for pole top materials relevant to conductor size and application	-	-
19	2	M20 Pole Bolt (HYS) and Nut. Length to suit Pole diameter	ENA TS 43-96 Clause 4.2 (Grade 8.8 HYS)	-
11	4	Insulator	ENA TS 43-93	-
13	1	Pilot Pin 50mm Shank	BS 3288 Fig 5, Ref 50	-
14	4	Helical Ties	ENA TS 43-15	-
24	1 or 2	Safety Sign - English - Bilingual	-	-
25	As Required	Pole Numbers	-	-
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-
42	2	30 Degree Angle Bracket	-	SP4018951
52	3	LV Fuses	-	-
53	3	Coach Screws	-	-
55	2	Platform – Transformer – “H” Pole	ENA Drawing No. 439524	-
56	2	Transformer Clamping Plate	ENA Drawing No. 439529	-
57	4	Bolt & Nut M20 x 100	ENA TS 43-96 Clause 4.2	-
58	4	Washer Round M20	ENA TS 43-96 Clause 4.2	-
59	1	Fuse crossarm	-	-
-	4	Coach Screws	-	-
-	2	Anti-climbing guard	ENA Drawing No. 439516	-
-	-	Barbed Wire	-	-

22.28 Figure 28 General Arrangement Cable Single and "H" Pole (Drawing No. SP4147882)

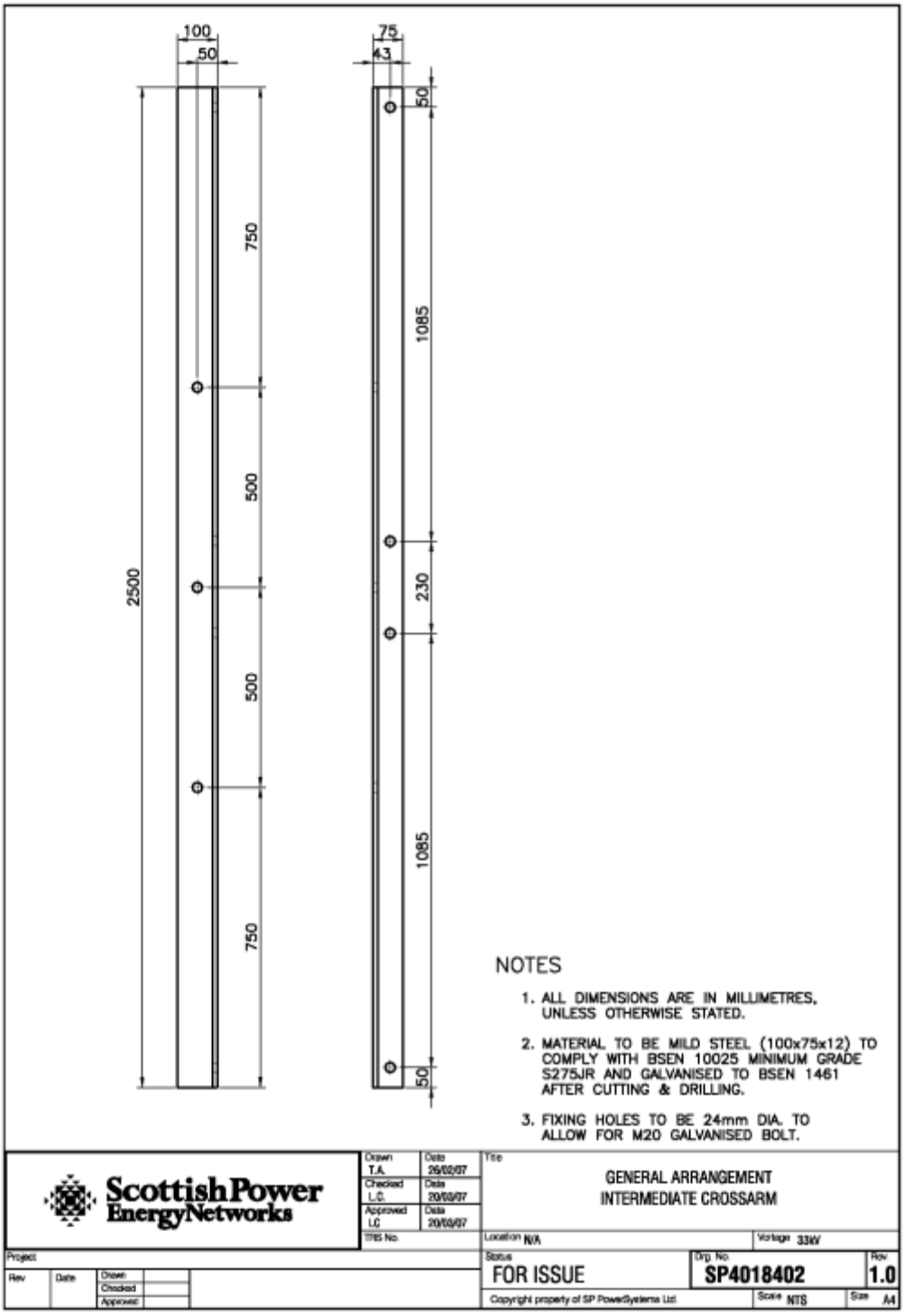


22.28.1 Schedule of Materials – Cable Single and “H” Pole (Drawing No. SP4147882)

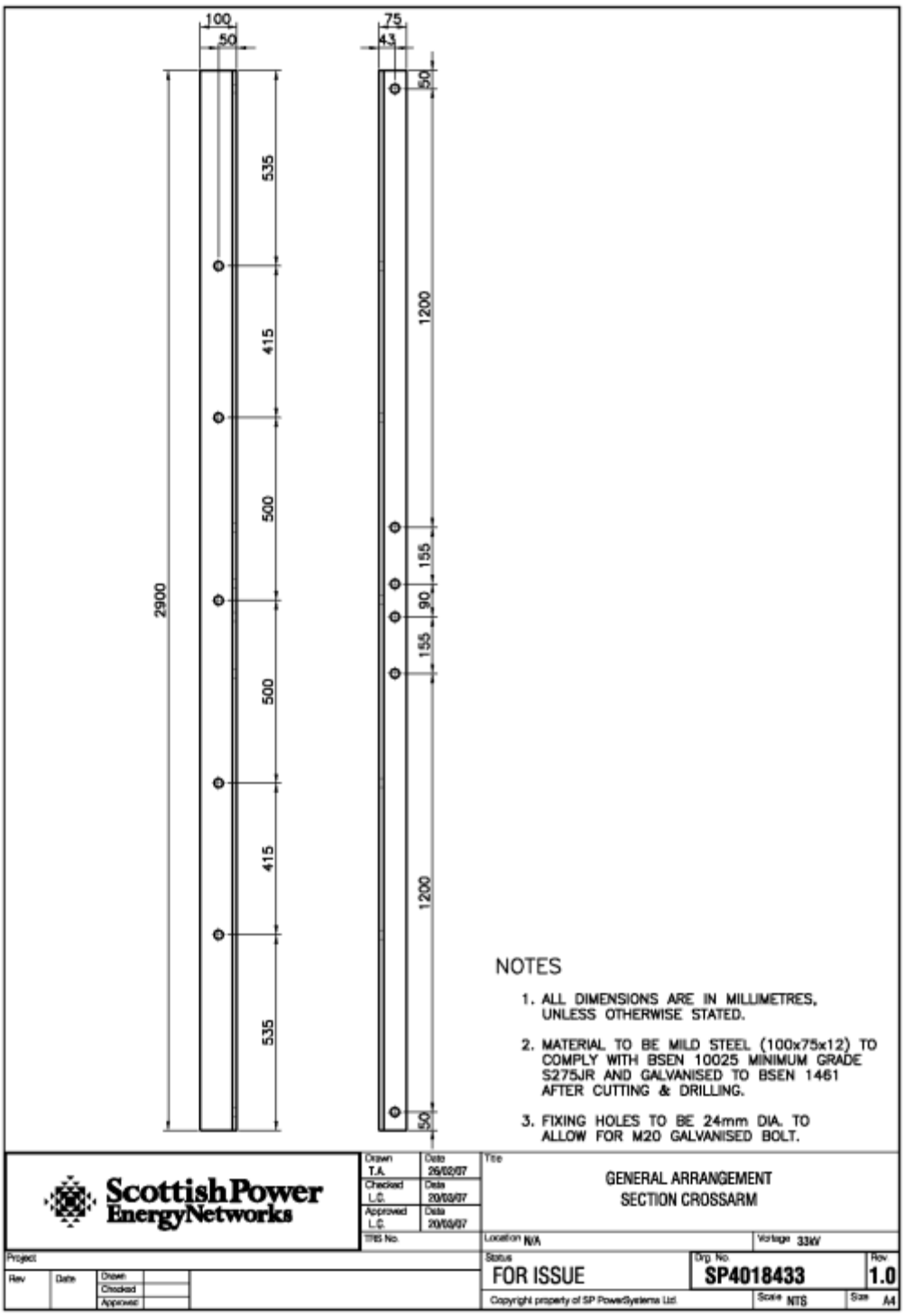
ITEM	NUMBER	DESCRIPTION	ENA TS, BS or OTHER REFERENCE	DRAWING NUMBER
-	-	See General Arrangement for pole top materials relevant to conductor size and application	-	-
-	-	Pole termination	See **OHL-18-017**	-
-	-	Cable Guard	-	-
-	4	Coach Screws	-	-
-	2	Anti-climbing guard	ENA Drawing No. 439516	-
-	-	Barbed Wire	-	-
25	As Required	Pole Numbers	-	-
-	As Required	Hardwood Plugs	ENA Drawing No. 439516	-

Note: For guidance on 33kV cable termination see OHL-18-019. The assembly in Fig is not suitable for 33kV cable terminations.

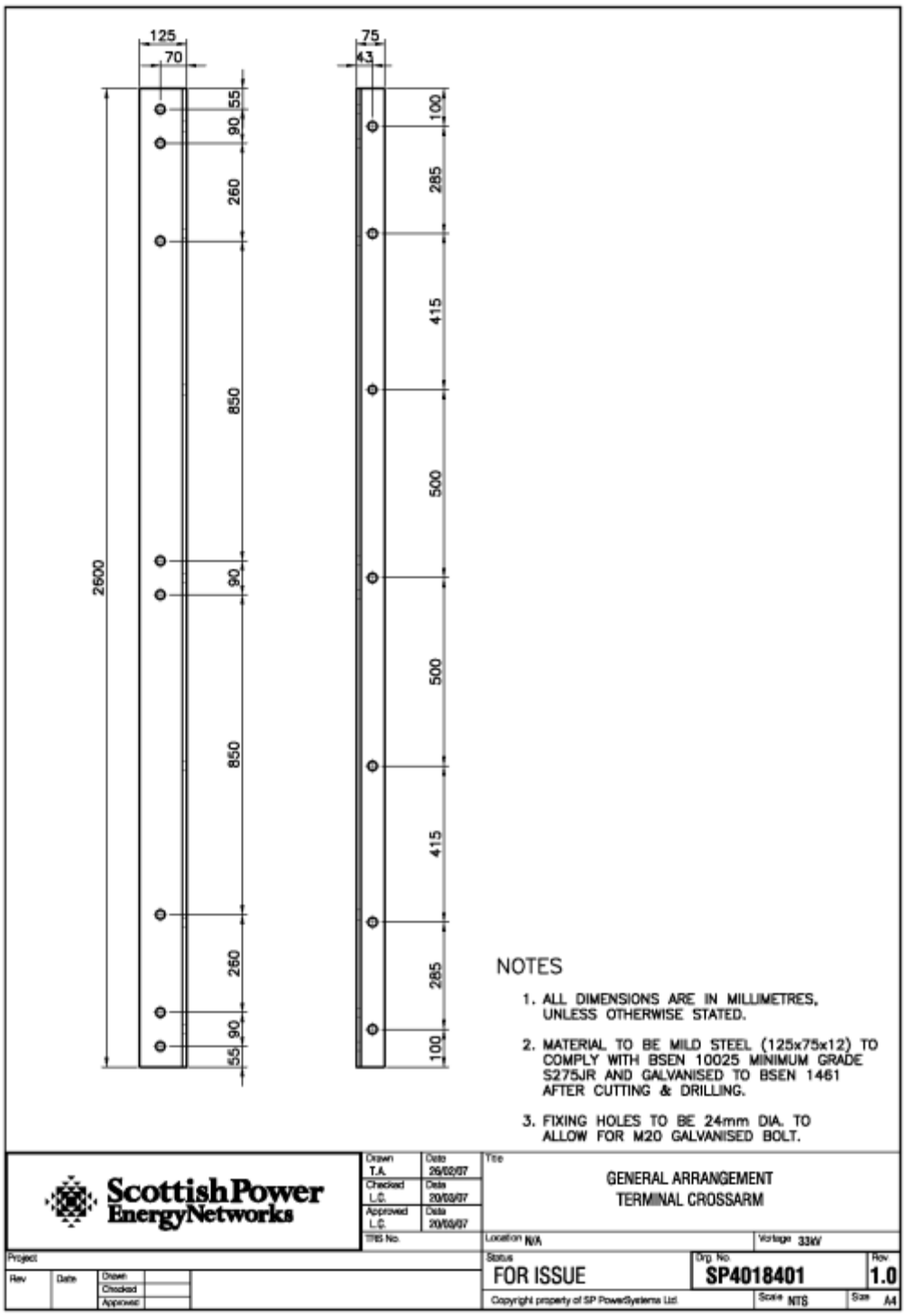
22.29 Figure 29 General Arrangement Intermediate Crossarm (Drawing No. SP4018402)



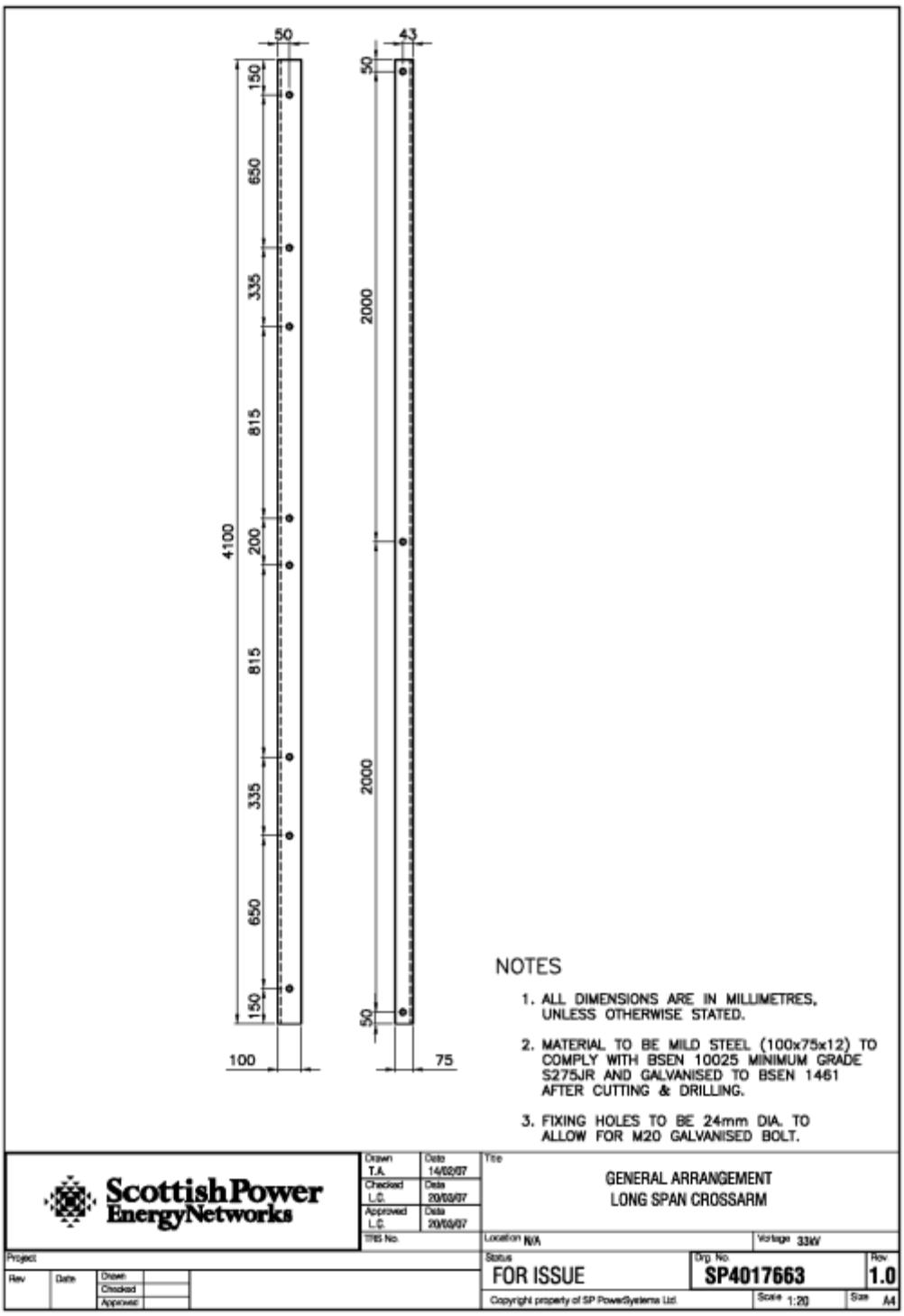
22.30 Figure 30 General Arrangement Section Crossarm (Drawing No. SP4018433)



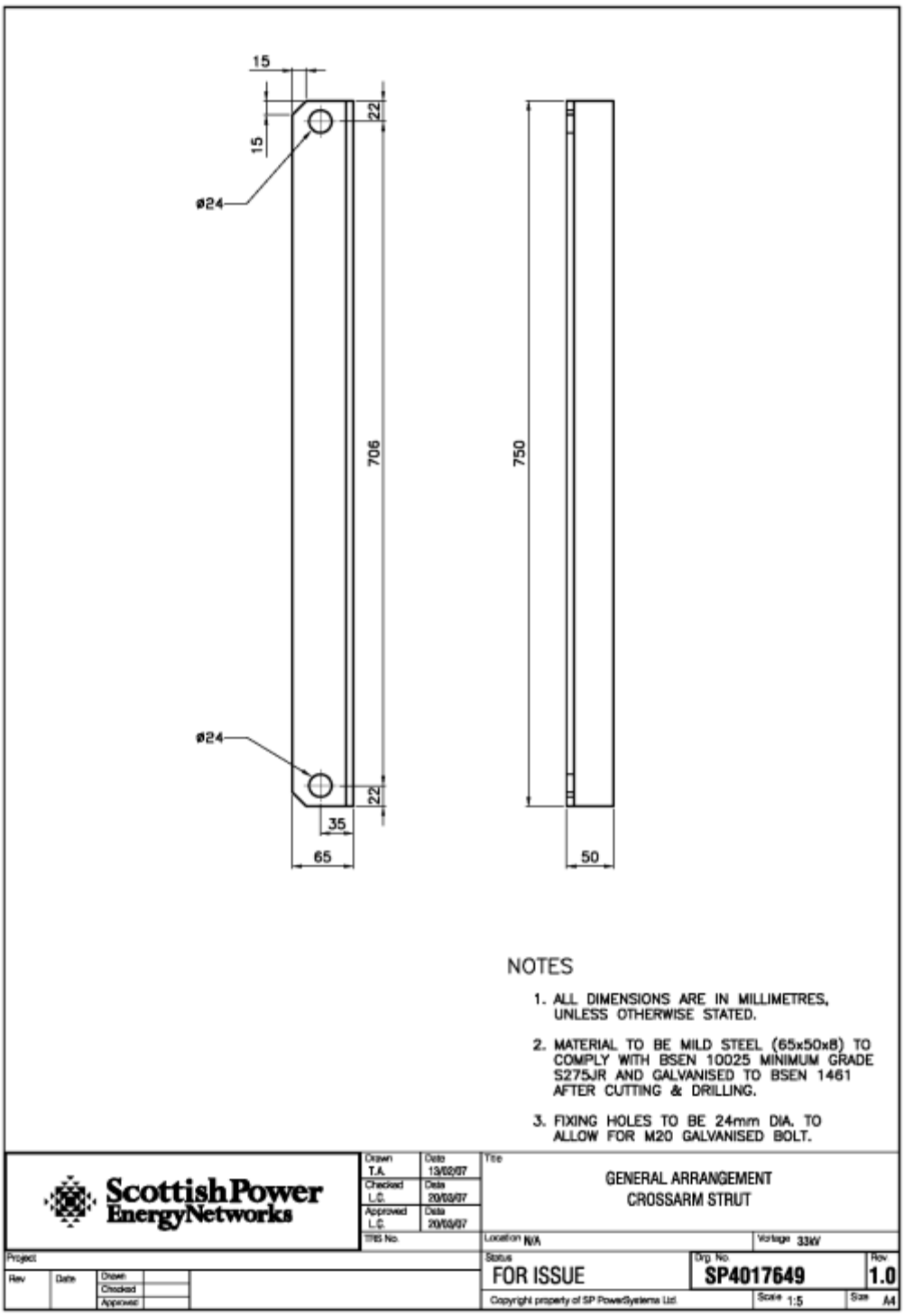
22.31 Figure 31 General Arrangement Terminal Crossarm (Drawing No. SP4018401)



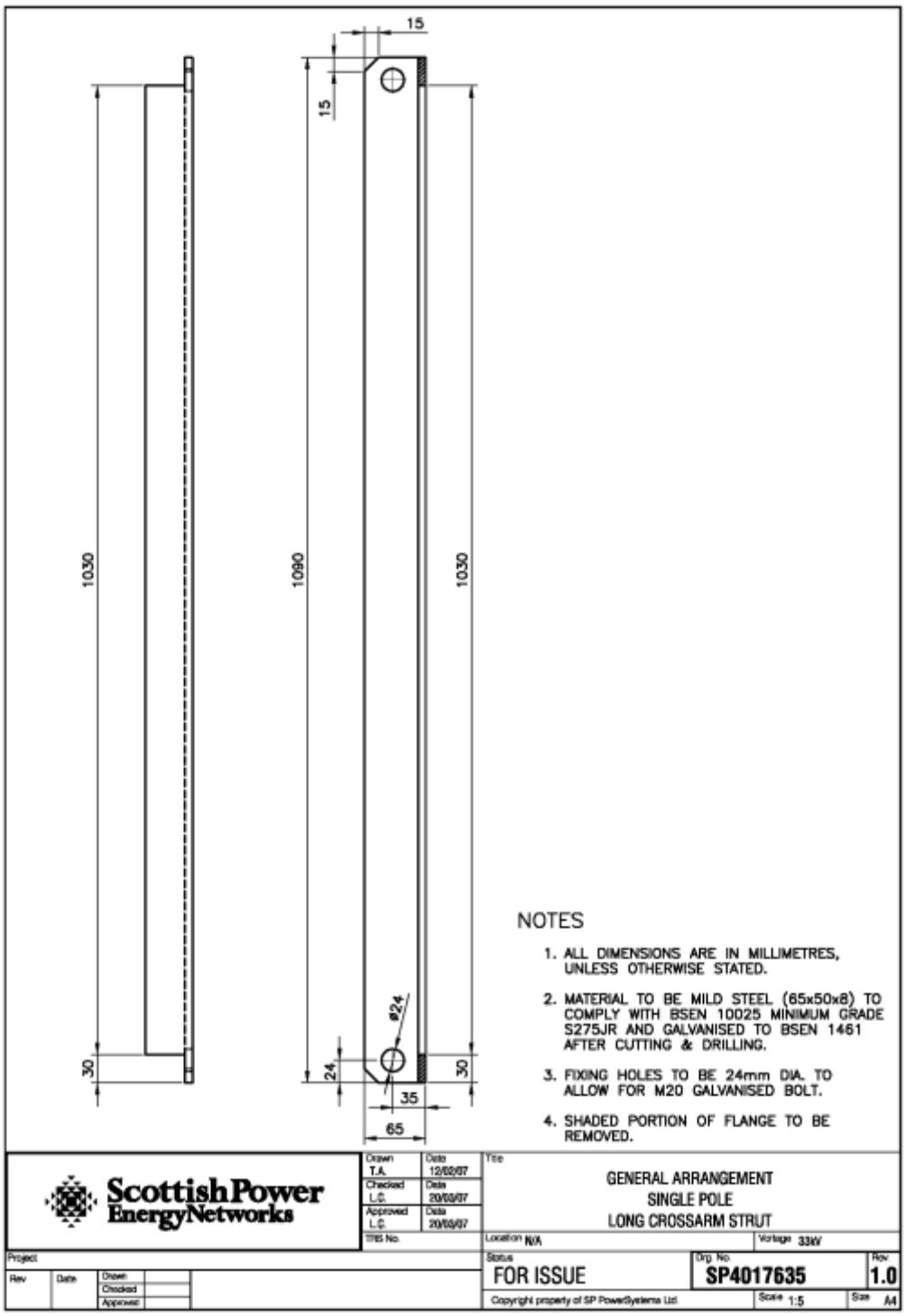
22.32 Figure 32 General Arrangement Long Span Crossarm (Drawing No. SP4017663)



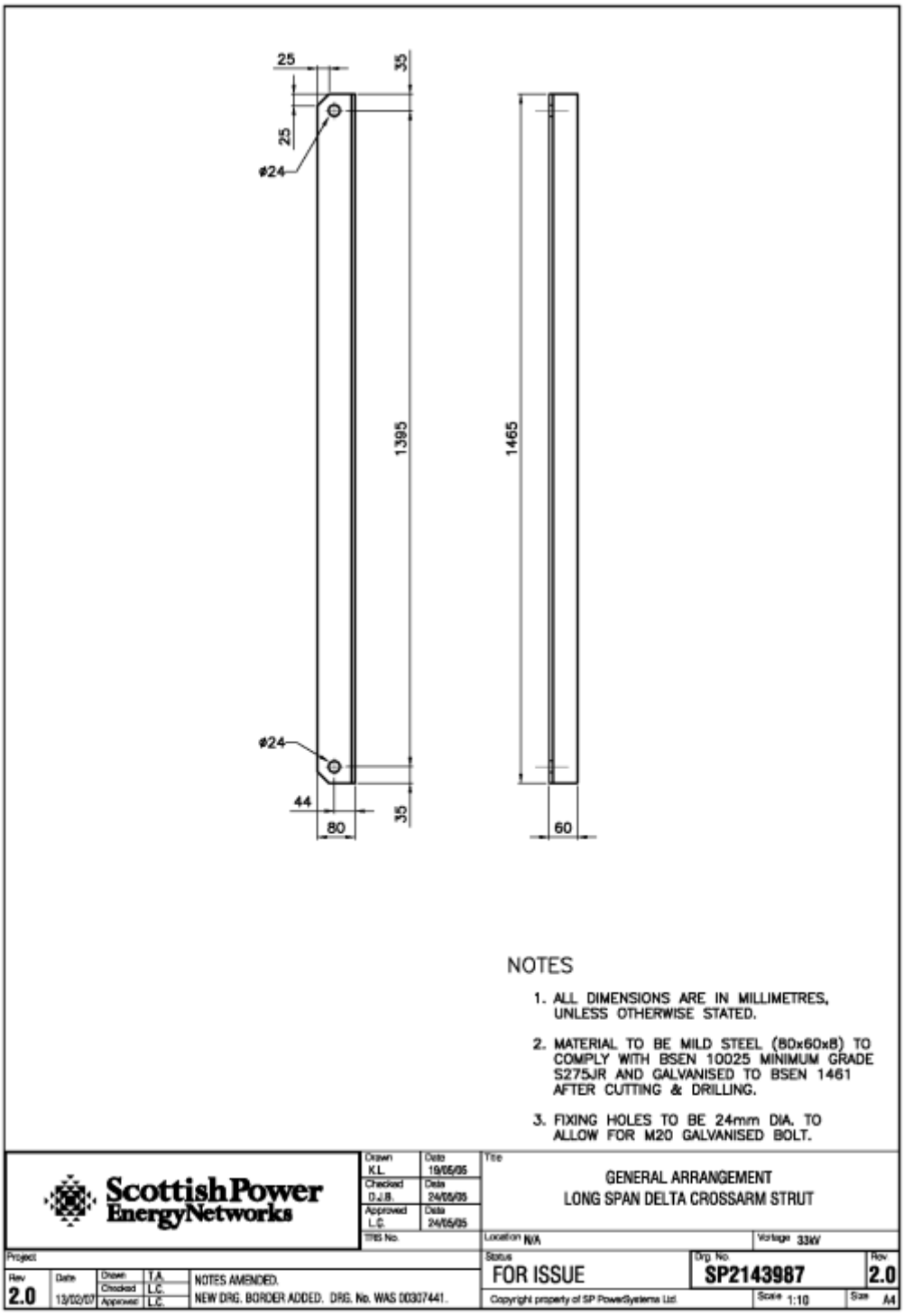
22.33 Figure 33 General Arrangement Crossarm Strut (Drawing No. SP4017649)



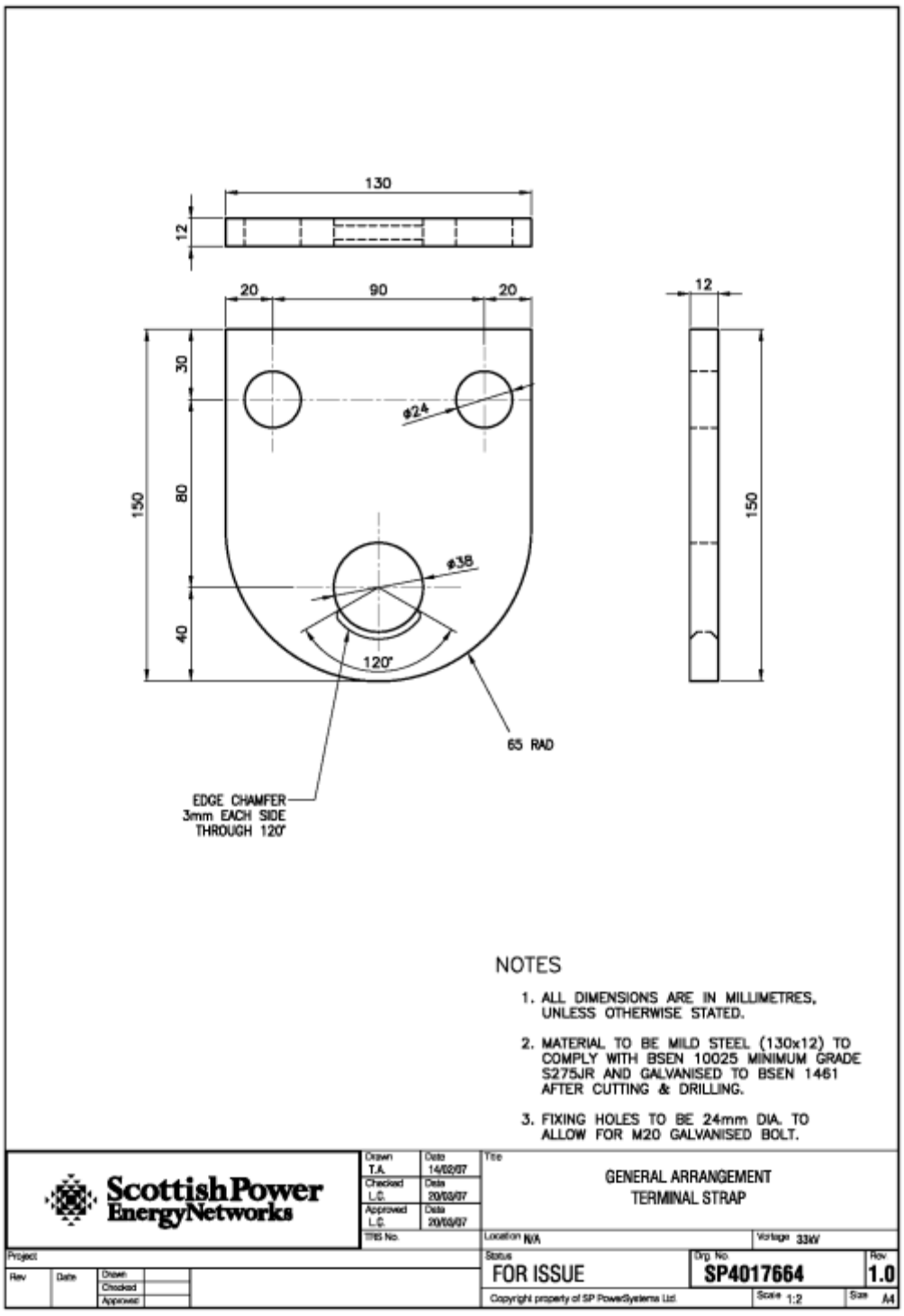
22.34 Figure 34 General Arrangement Long Crossarm Strut (Drawing No. SP4017635)



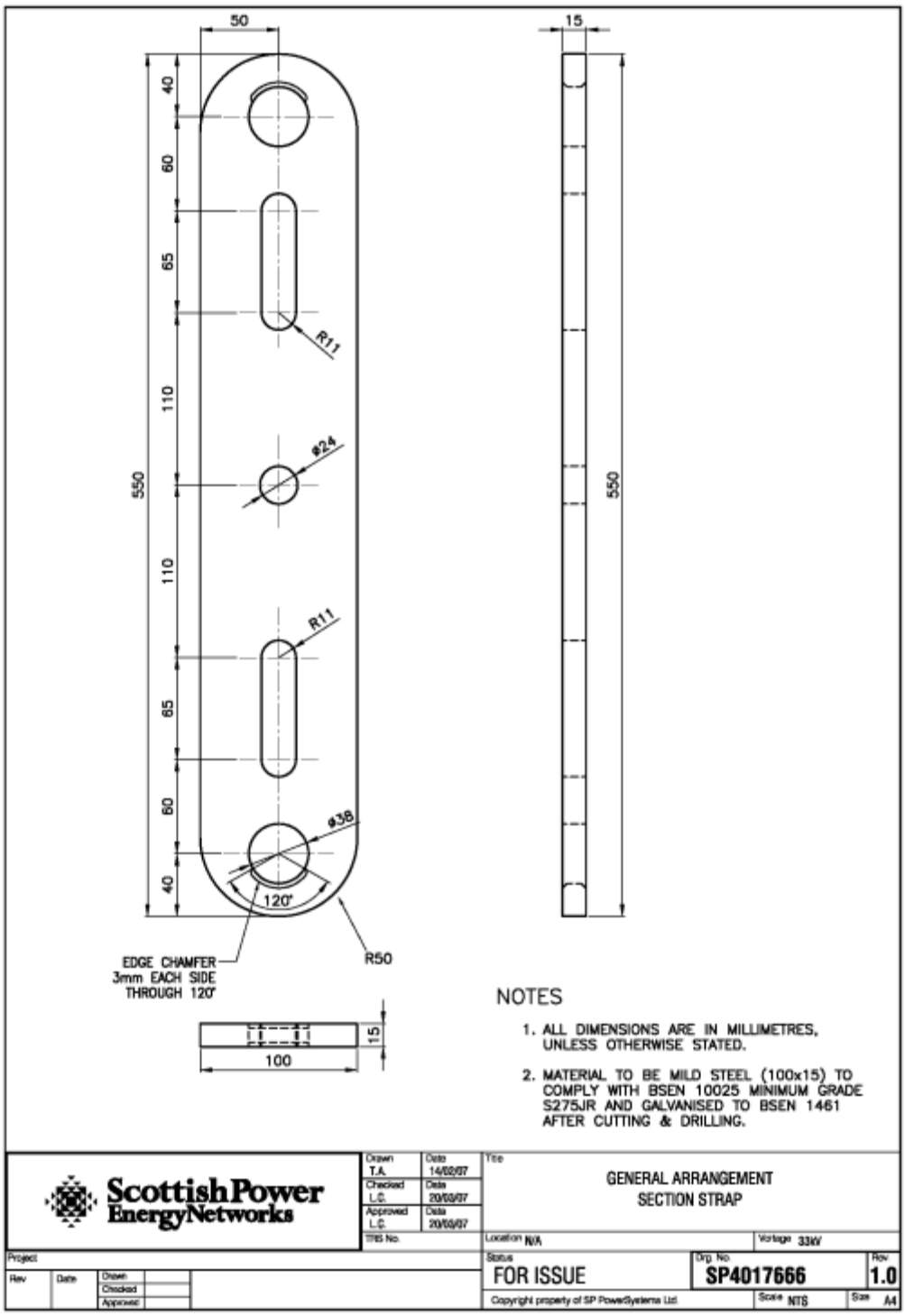
22.35 Figure 35 General Arrangement Long Span Delta Crossarm Strut (Drawing No. SP2143987)



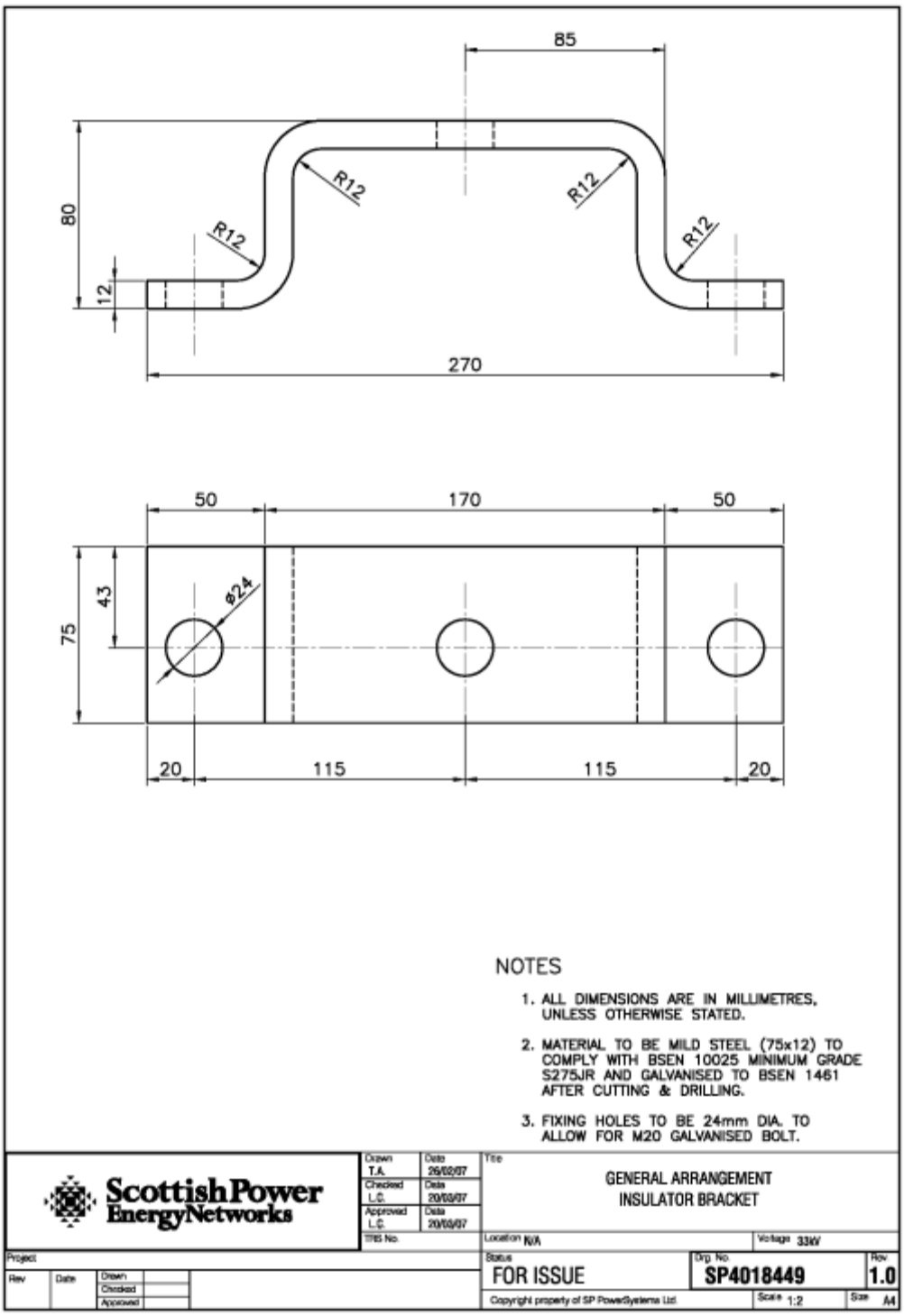
22.36 Figure 36 General Arrangement Terminal Strap (Drawing No. SP4017664)



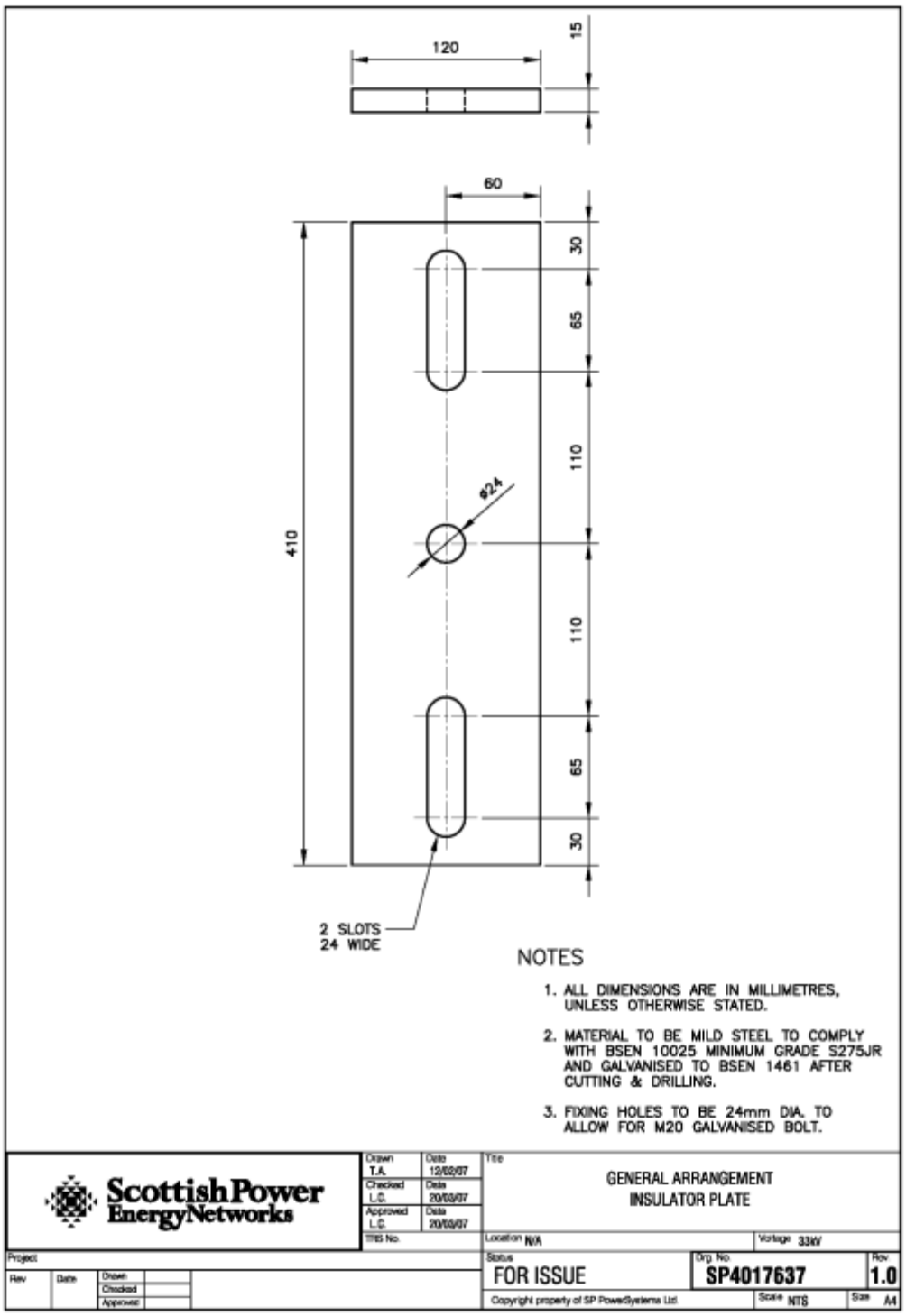
22.37 Figure 37 General Arrangement Section Strap (Drawing No. SP4017666)



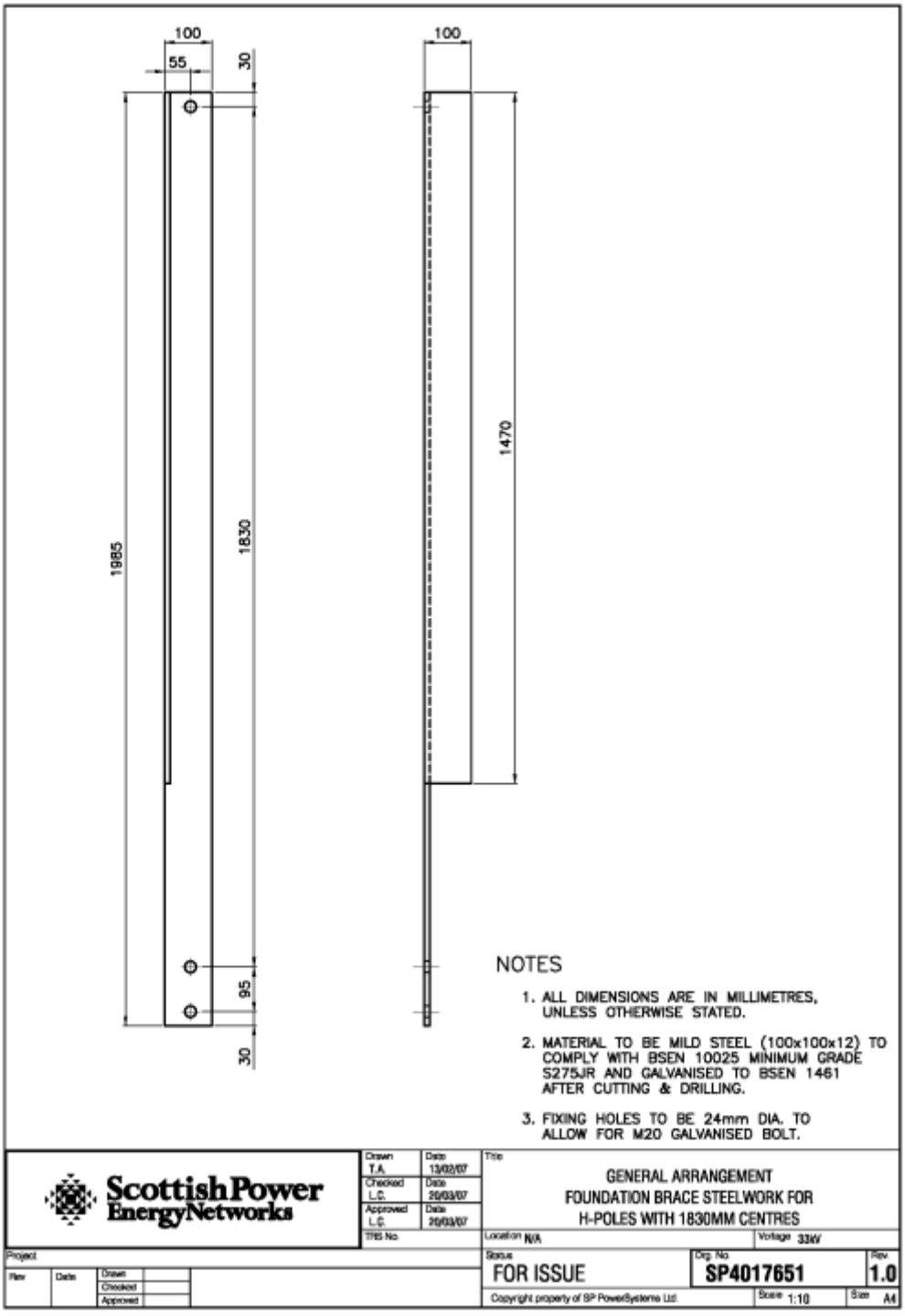
22.38 Figure 38 General Arrangement Insulator Bracket (Drawing No. SP4018449)



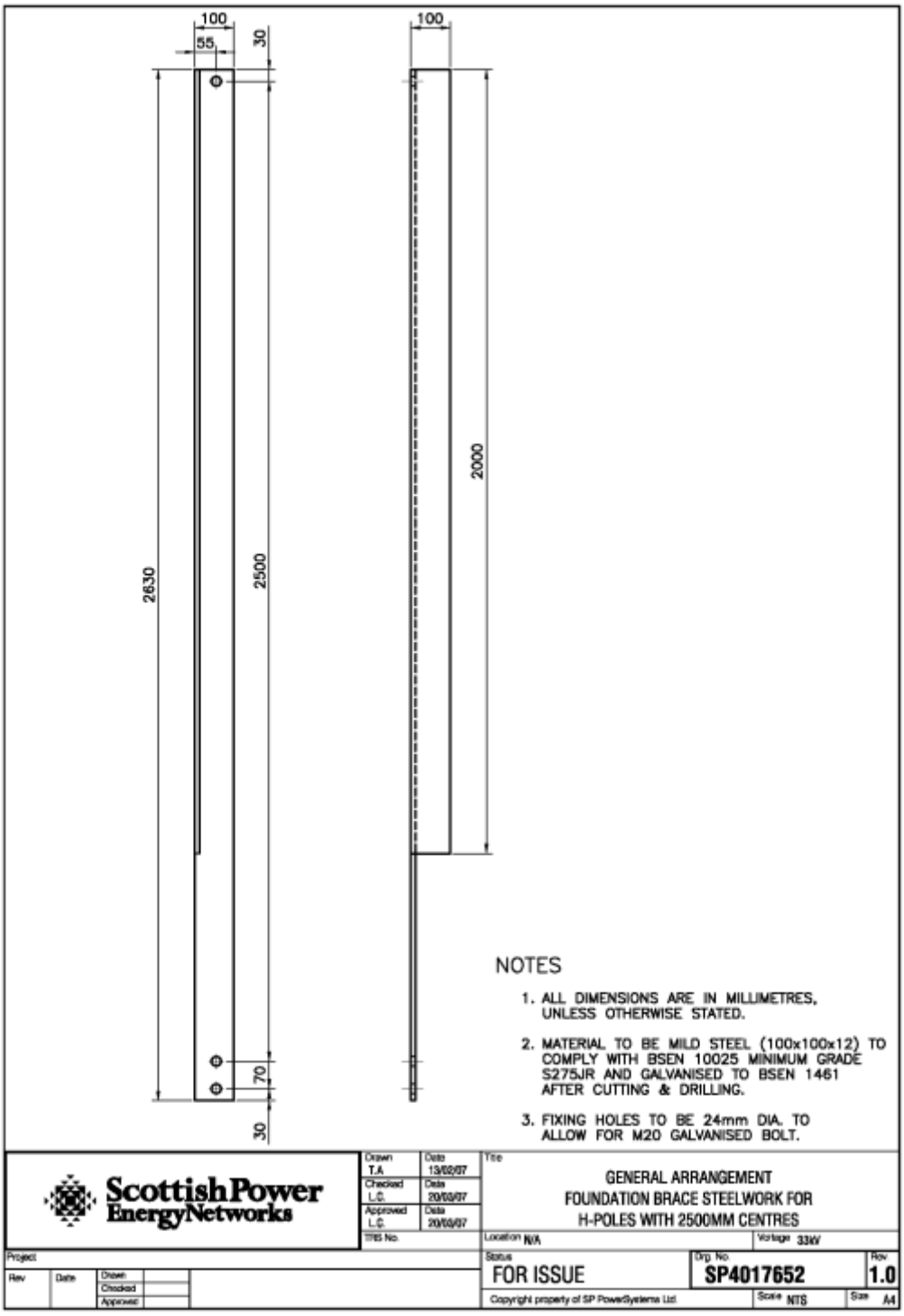
22.39 Figure 39 General Arrangement Insulator Plate (Drawing No. SP4017637)



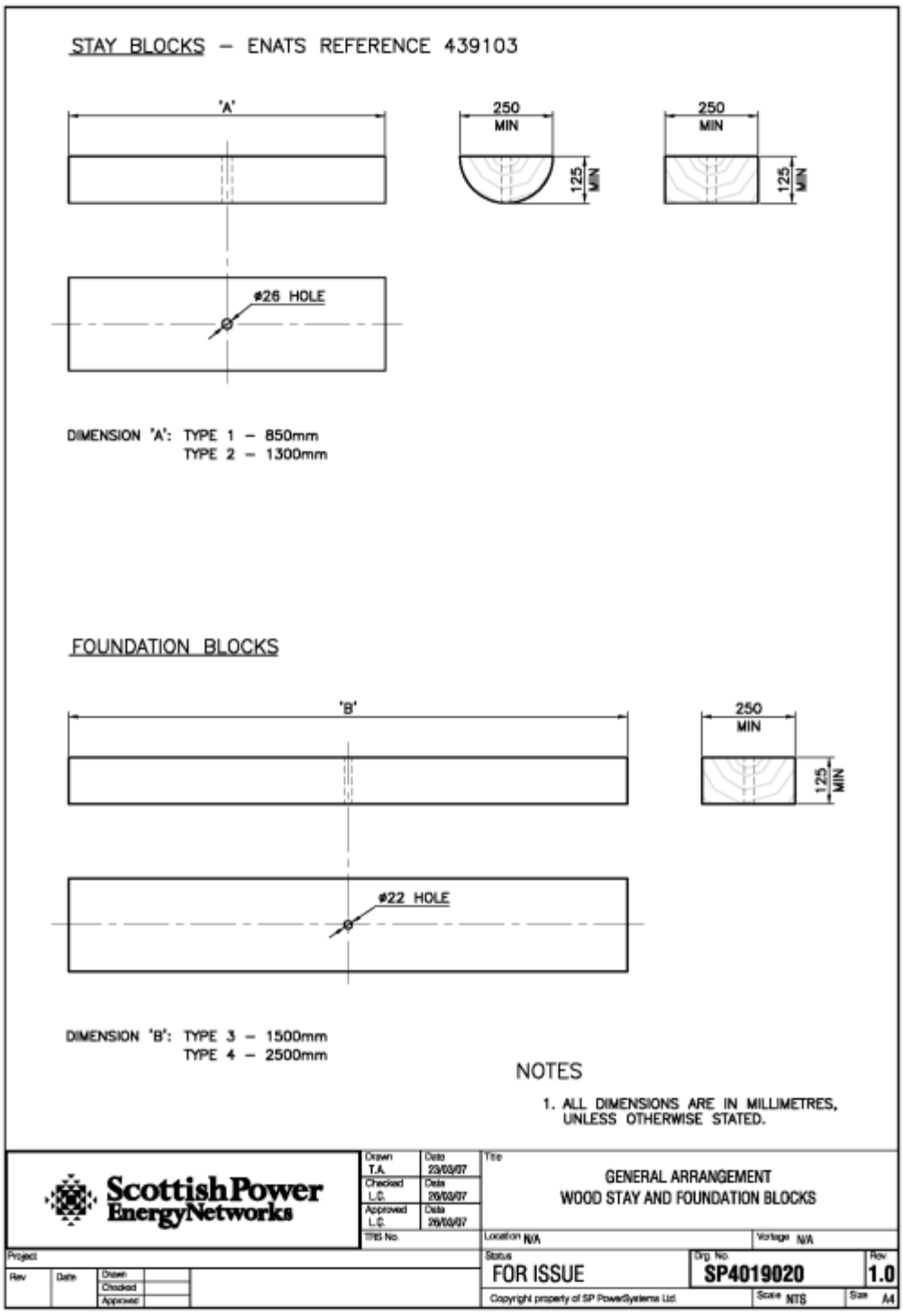
22.40 Figure 40 General Arrangement Foundation Brace Steelwork "H" Pole 1830mm Centres (Drawing No. SP4017651)



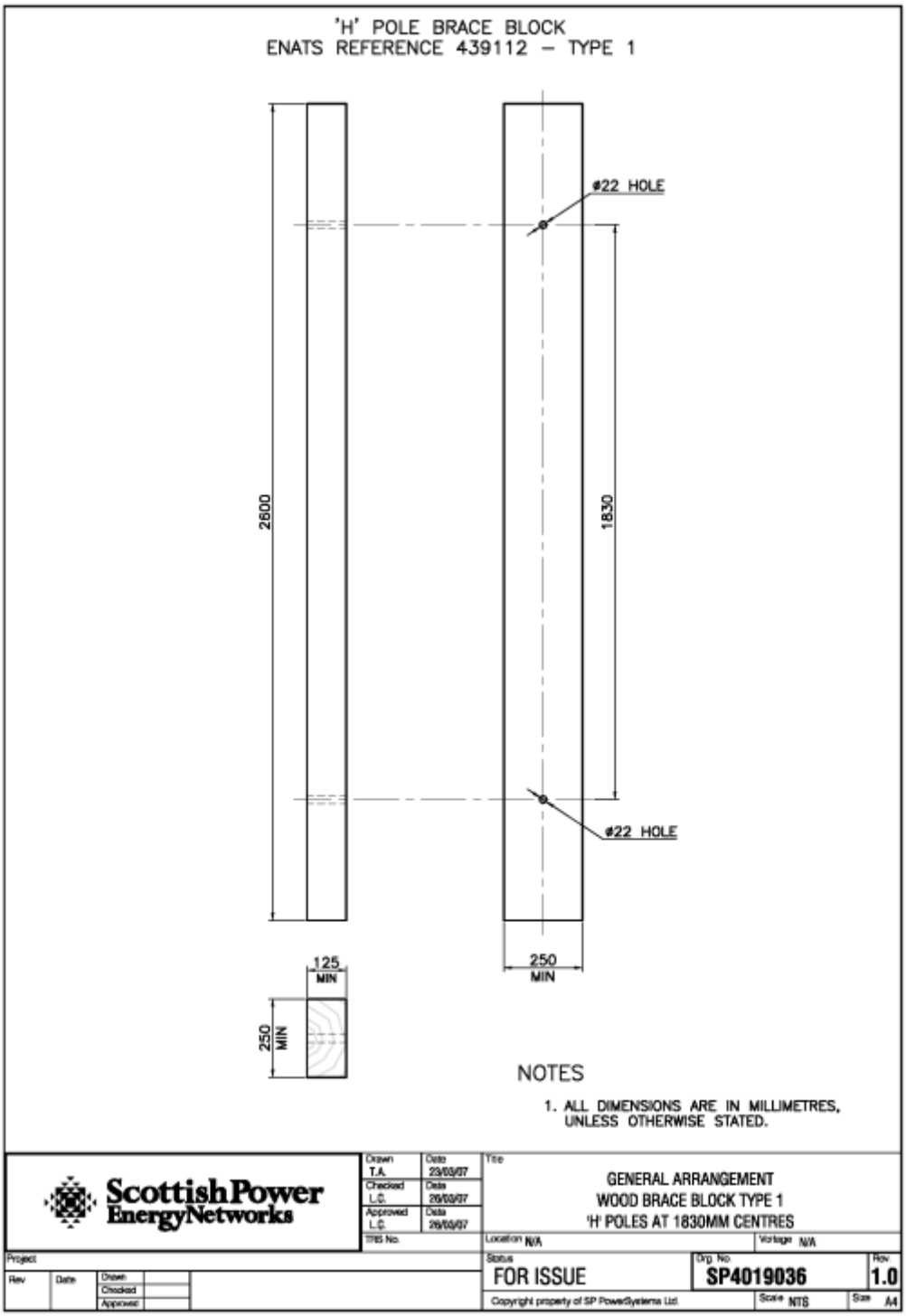
22.41 Figure 41 General Arrangement Foundation Brace Steelwork "H" Pole 2500mm Centres (Drawing No. SP4017652)



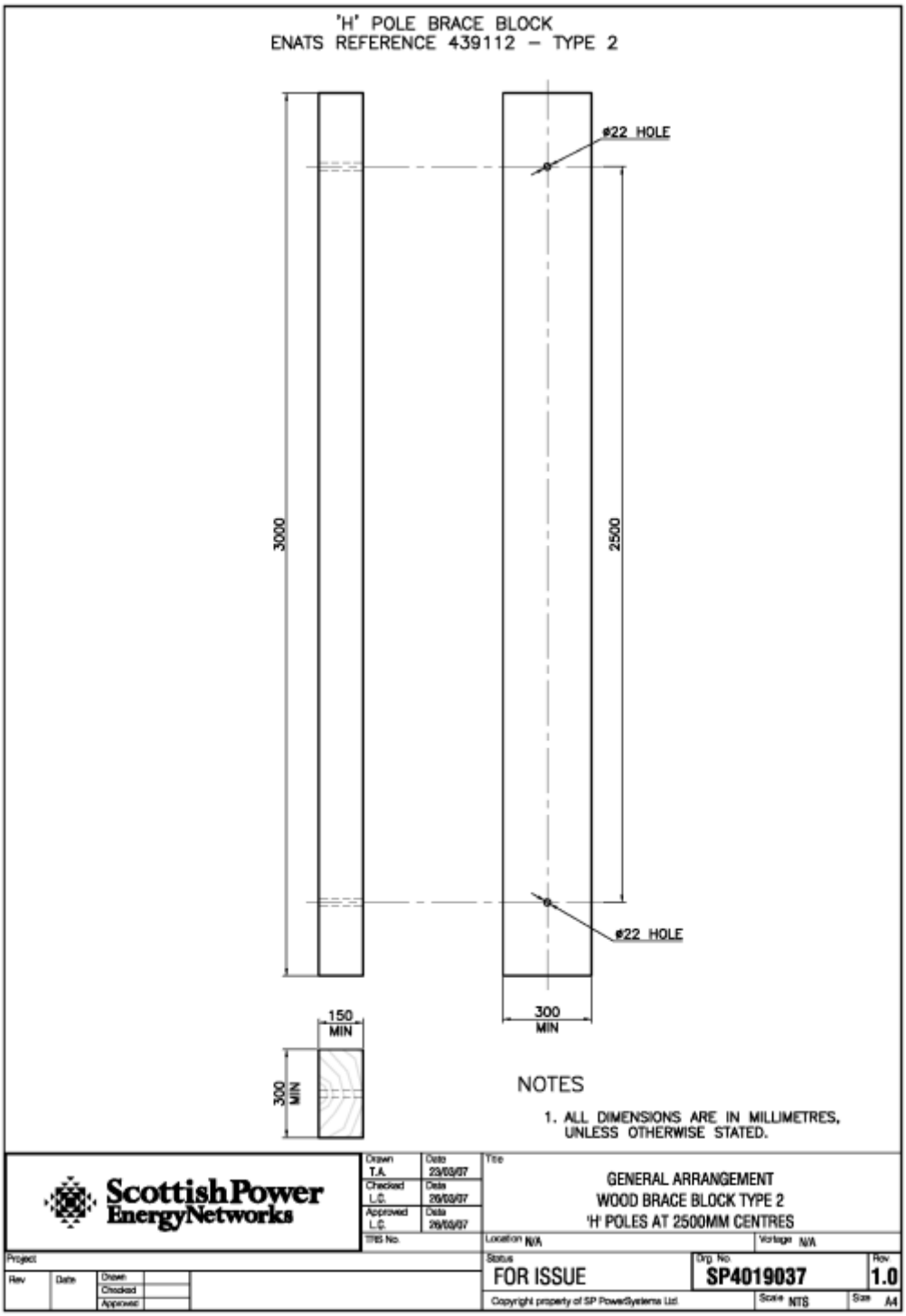
22.42 Figure 42 General Arrangement Stay and Foundation Blocks (Drawing No. SP4019020)



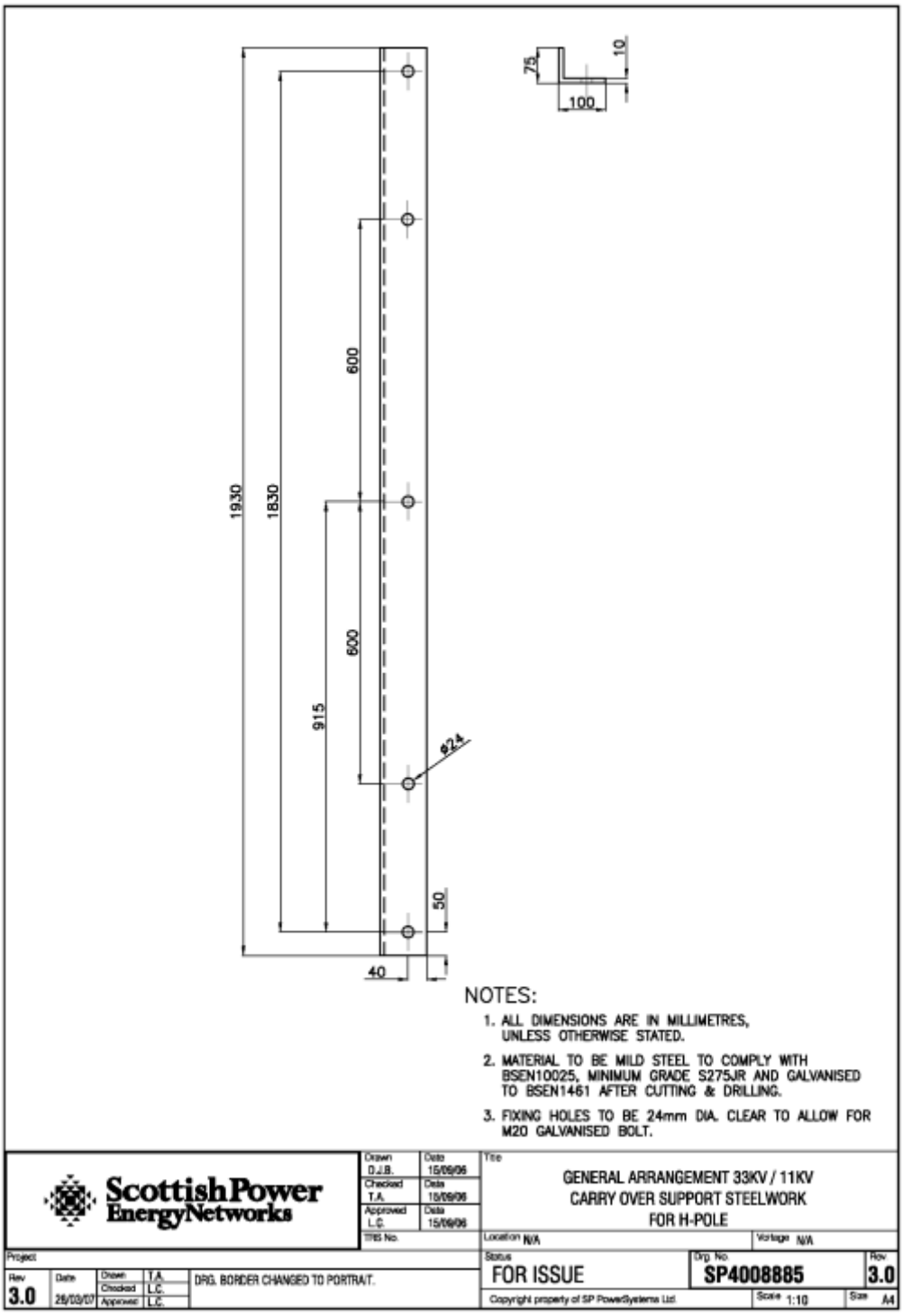
22.43 Figure 43 General Arrangement Wood Brace Block Type 1 "H" Pole 1830mm Centres (Drawing No. SP4019036)



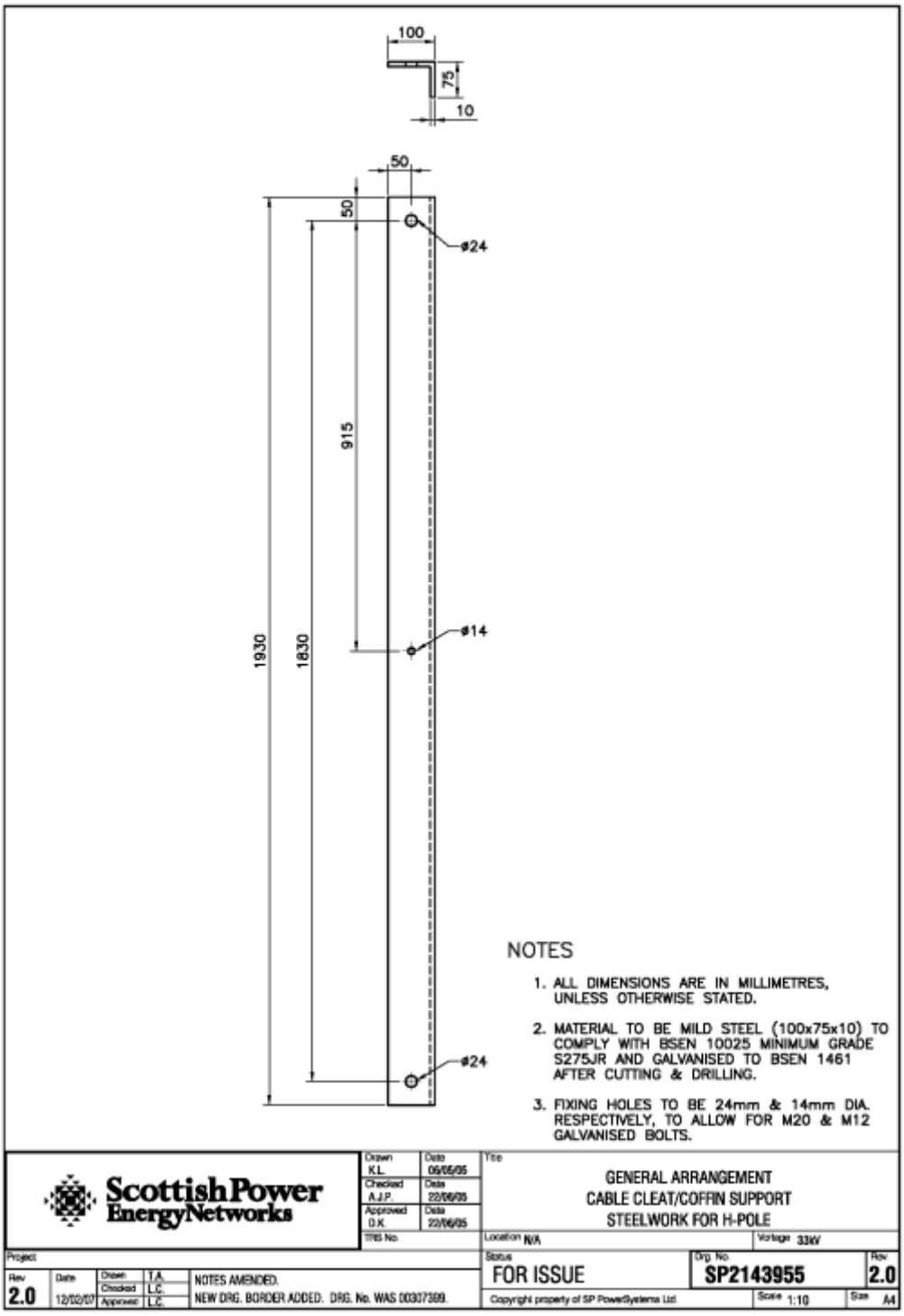
22.44 Figure 44 General Arrangement Wood Brace Block Type 2 "H" Pole 2500mm Centres (Drawing No. SP4019037)



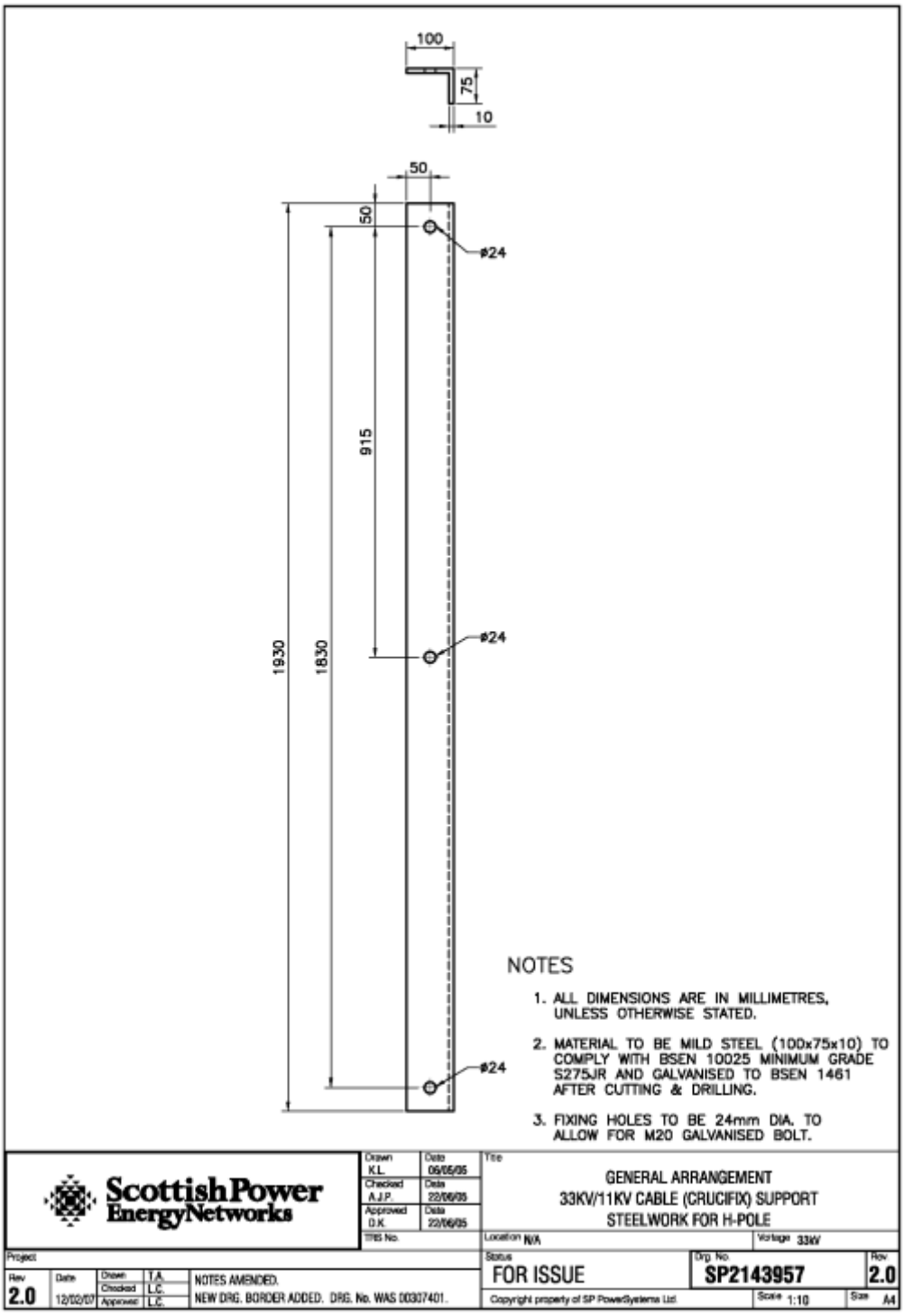
22.45 Figure 45 General Arrangement "H" Pole Carryover Support Steelwork (Drawing No. SP4008885)



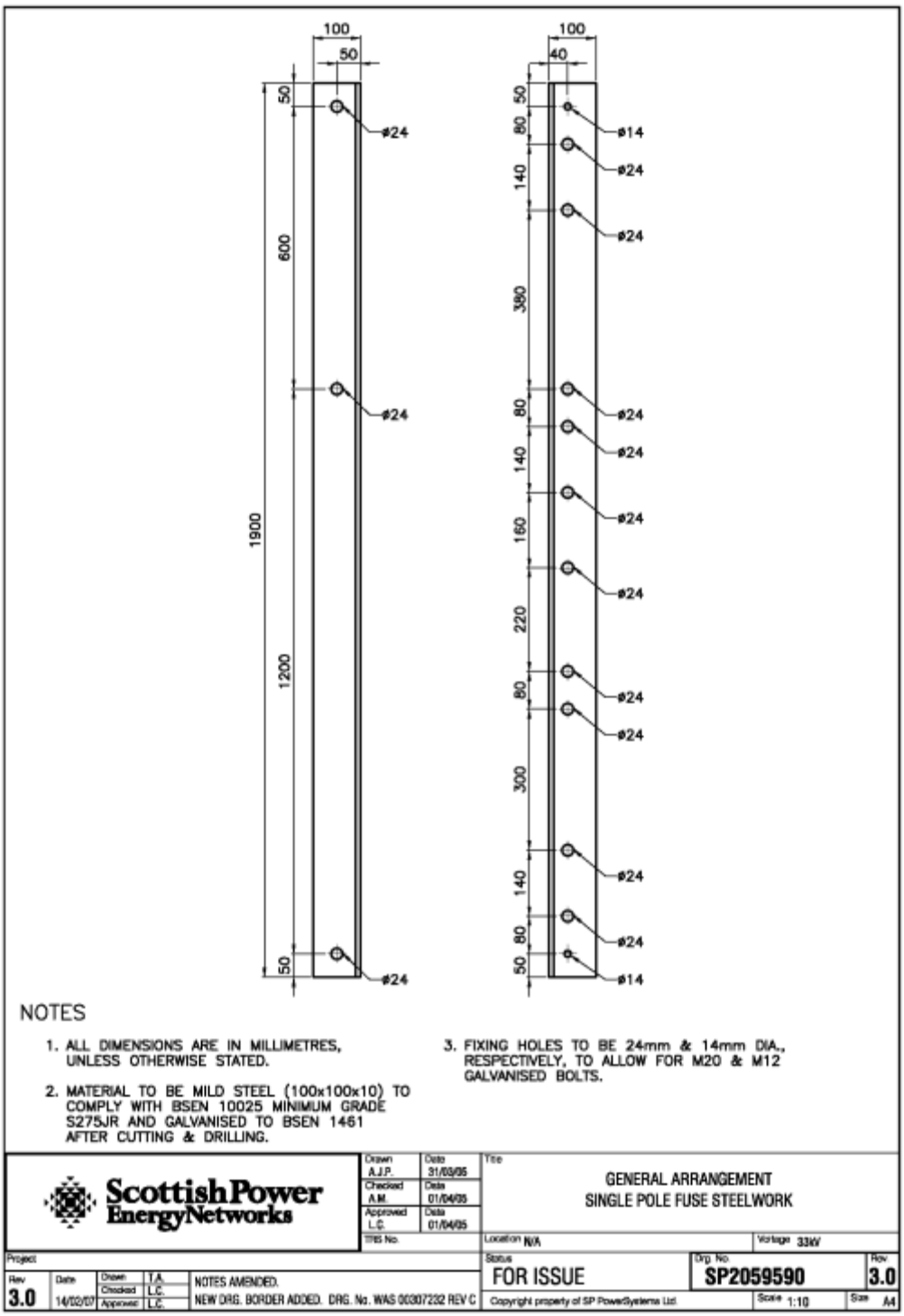
22.46 Figure 46 General Arrangement "H" Pole Cable Cleat / Coffin Support Steelwork (Drawing No. SP2143955)



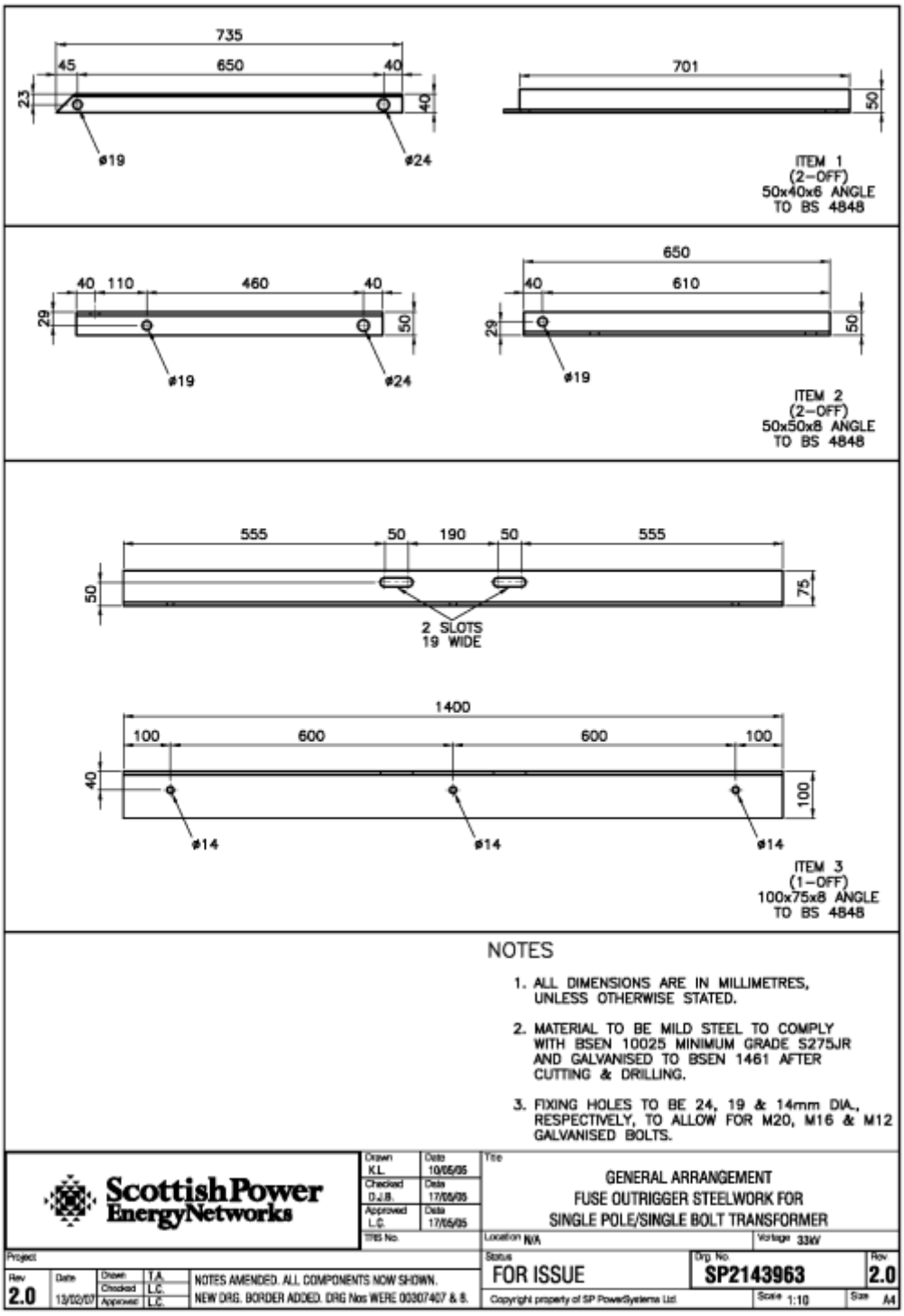
22.47 Figure 47 General Arrangement "H" Pole Crucifix Support Steelwork (Drawing No. SP2143957)



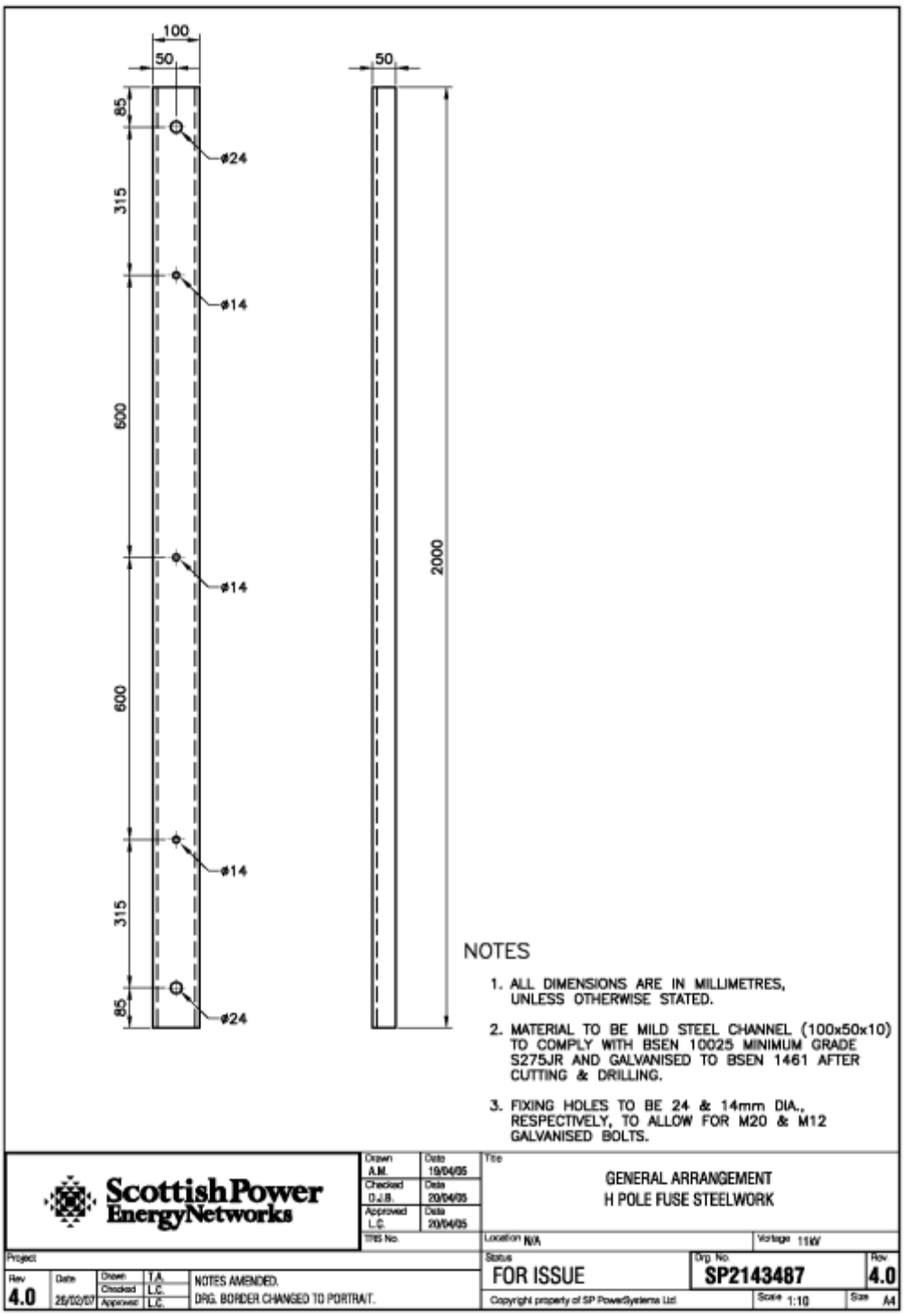
22.48 Figure 48 General Arrangement Single Pole Fuse Steelwork (Drawing No. SP2059590)



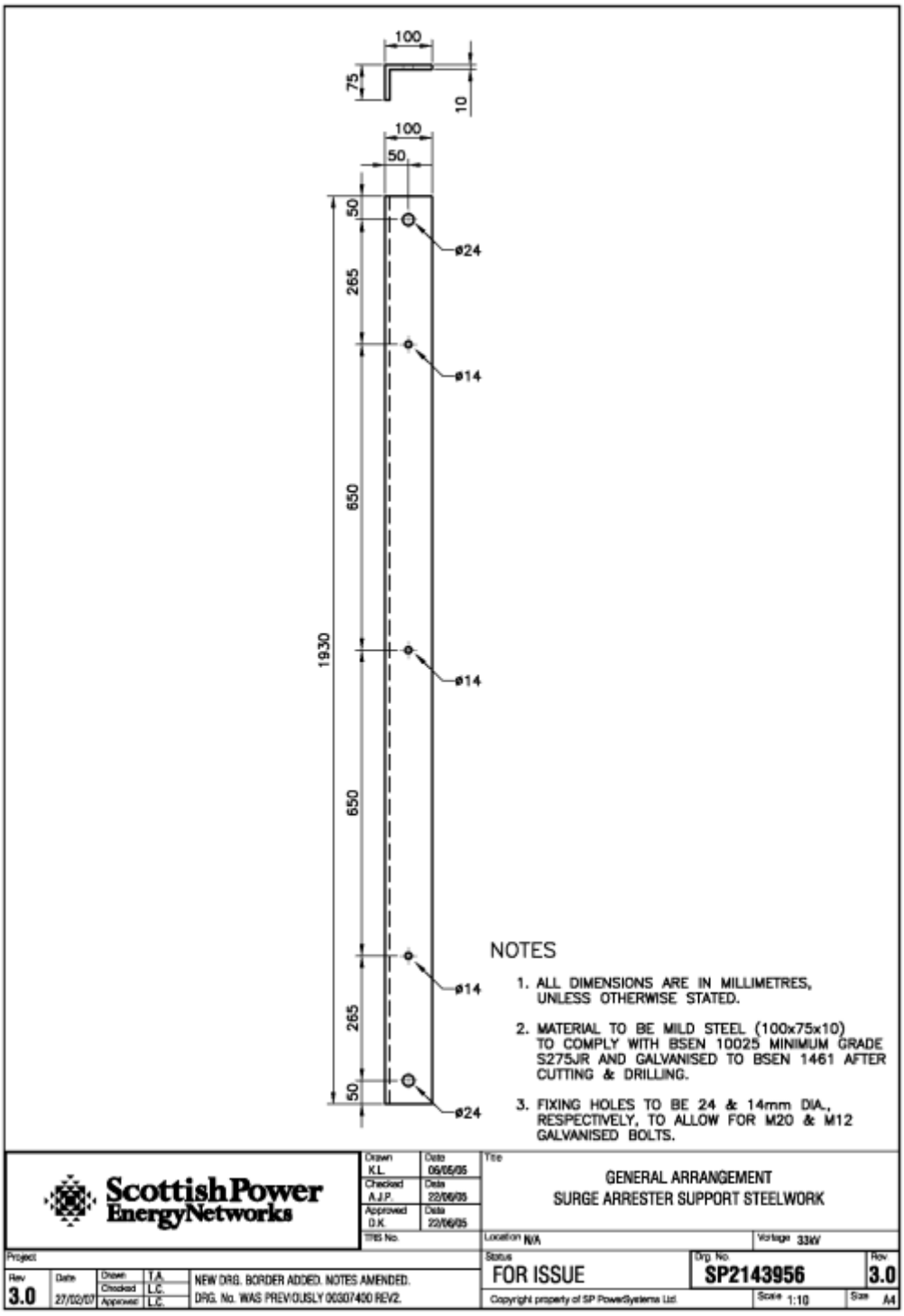
22.49 Figure 49 General Arrangement Single Pole Fuse Outrigger Steelwork (Drawing No. SP2143963)



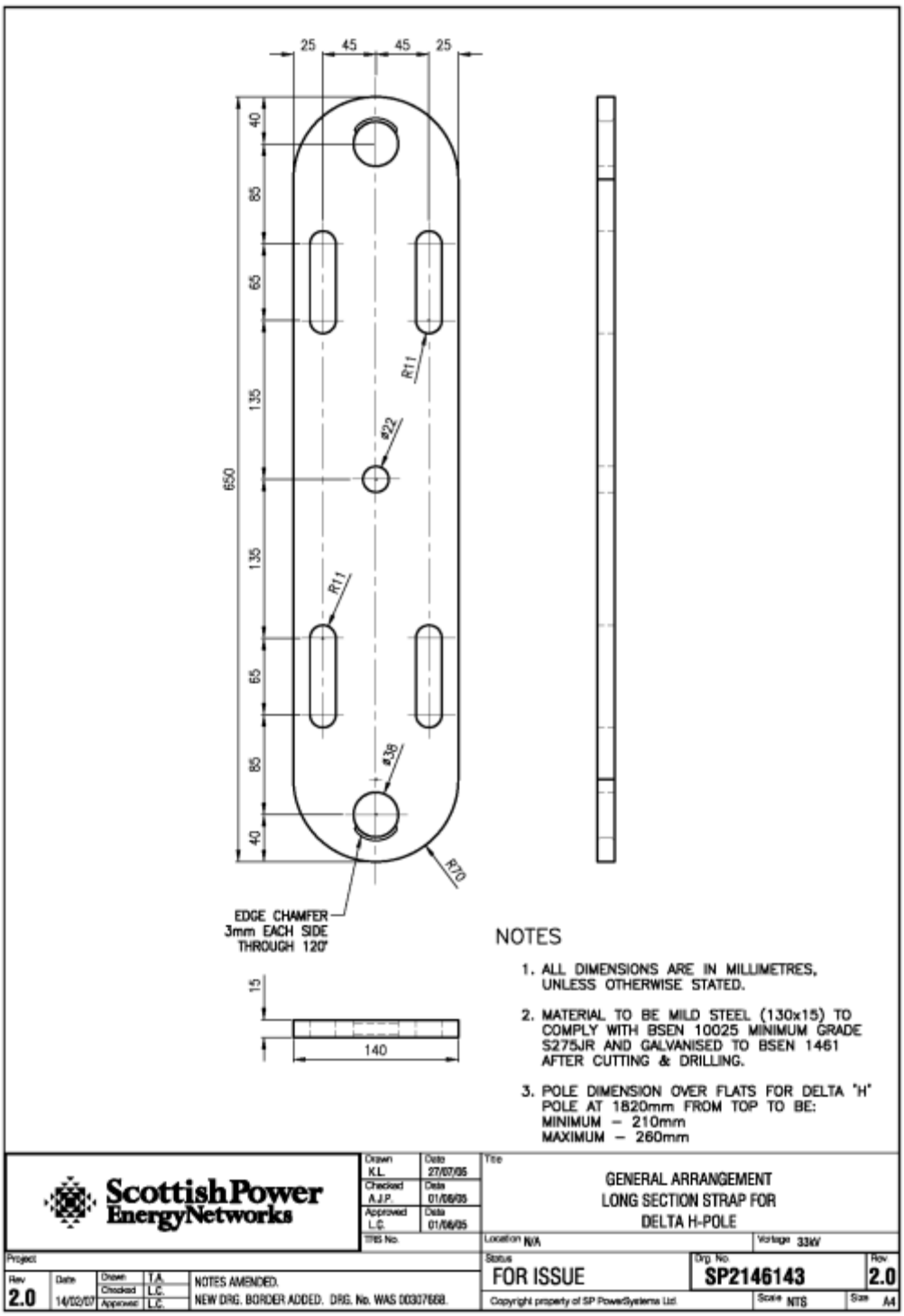
22.50 Figure 50 General Arrangement "H" Pole Fuse Steelwork (Drawing No. SP2143487)



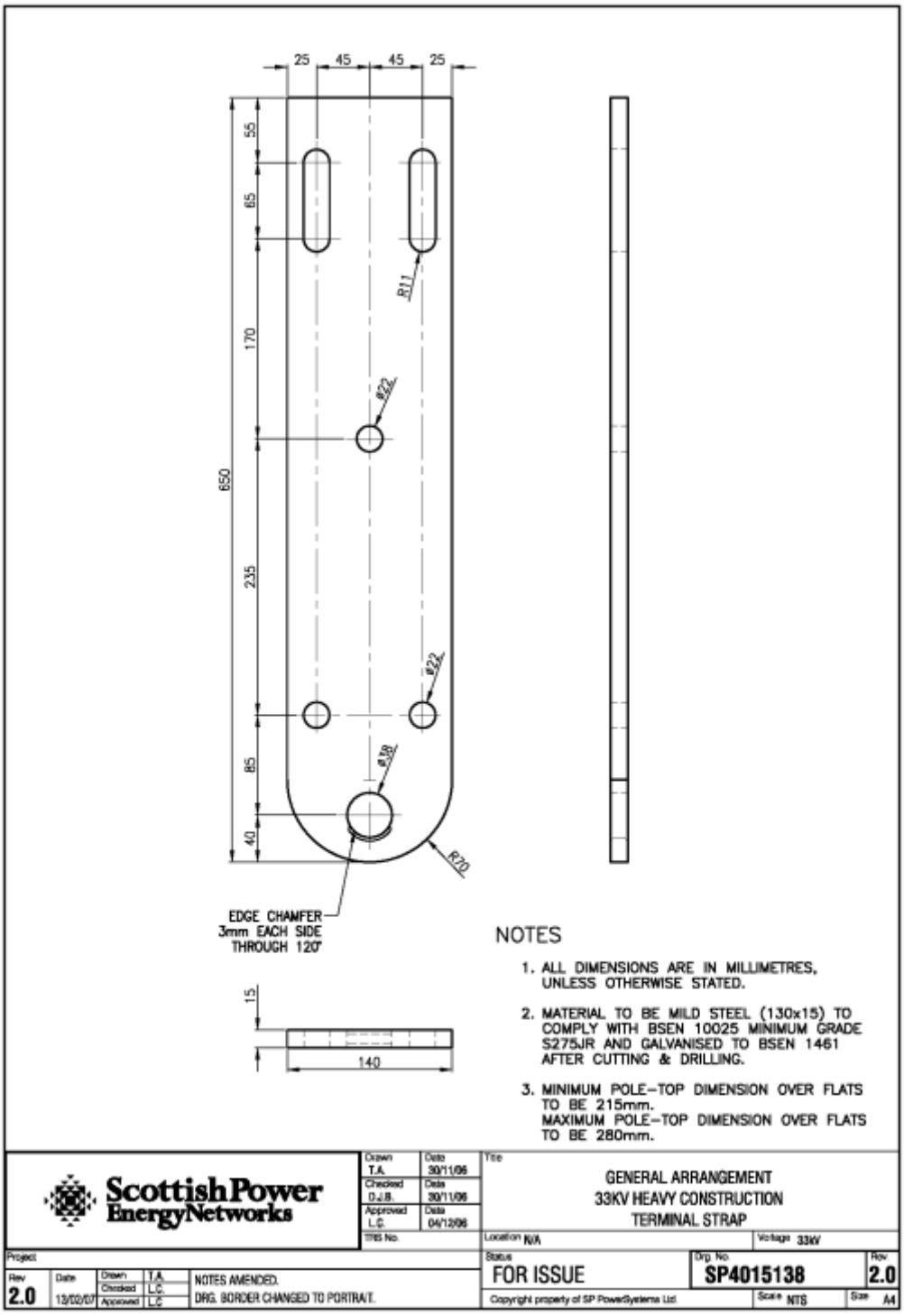
22.51 Figure 51 General Arrangement Surge Arrester Support Steelwork (Drawing No. SP2143956)



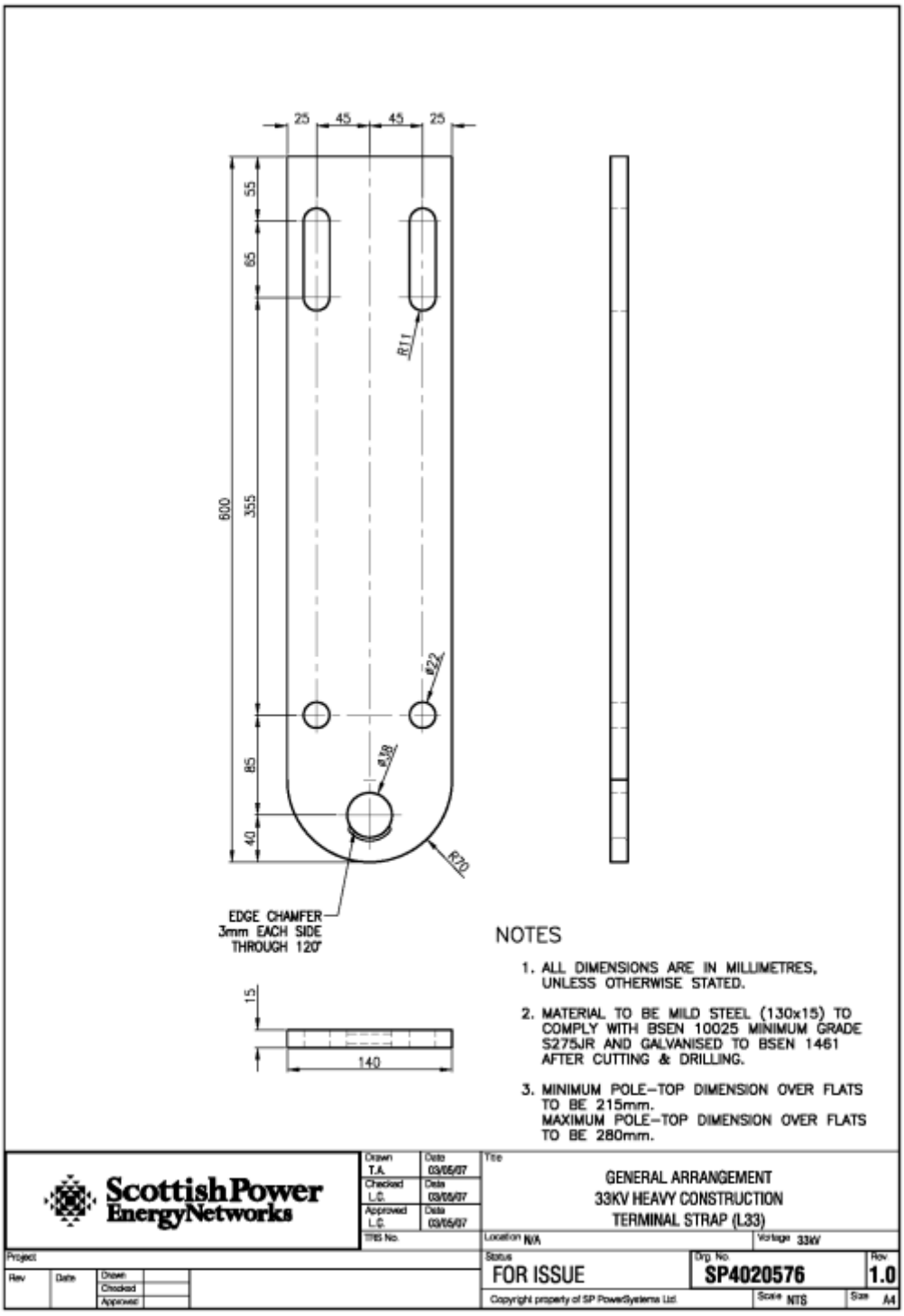
22.52 Figure 52 General Arrangement Delta "H" Section Strap (Drawing No. SP2146143)



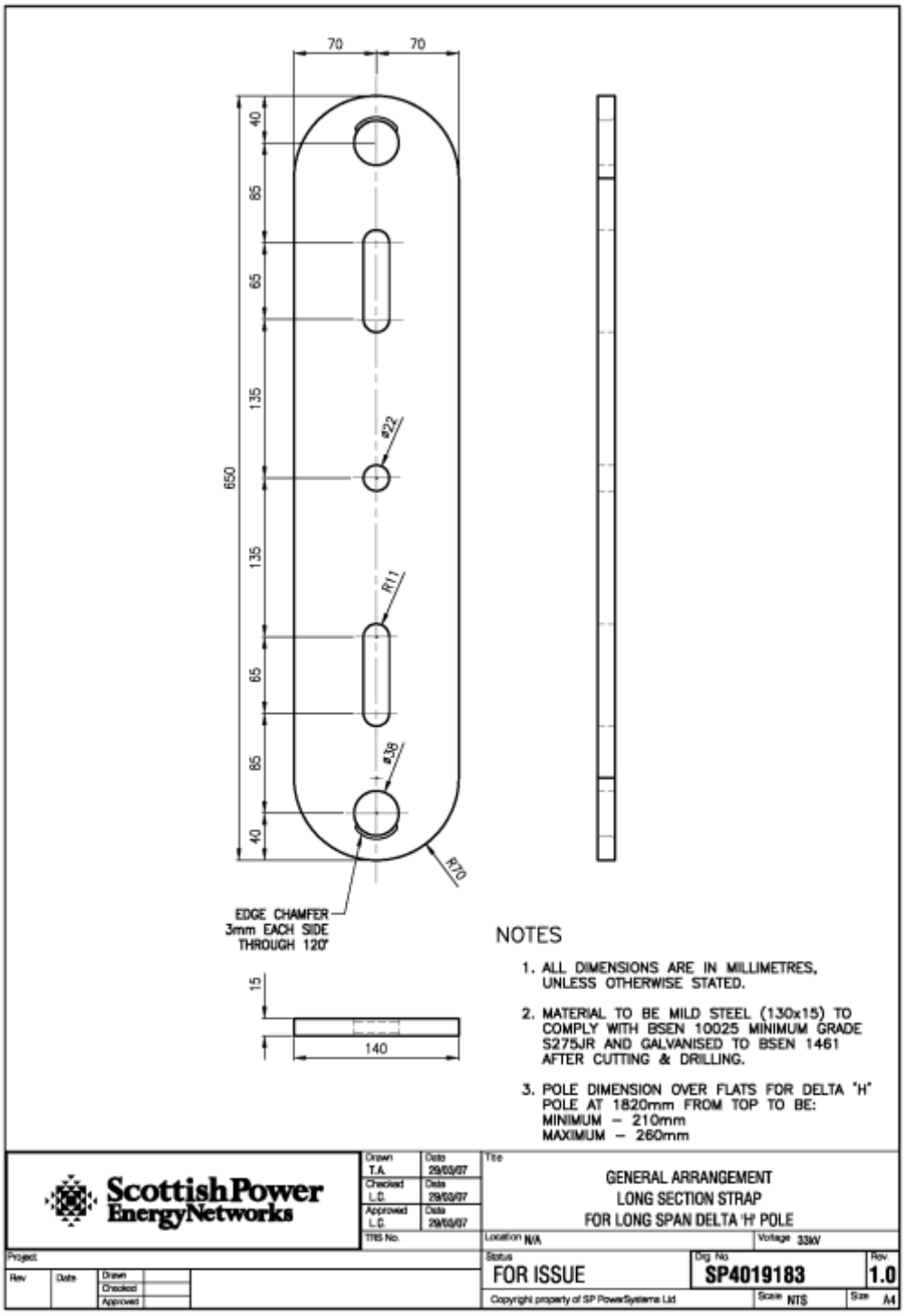
22.53 Figure 53 General Arrangement Terminal Bracing Strap 300mm² (Drawing No. SP4015138)



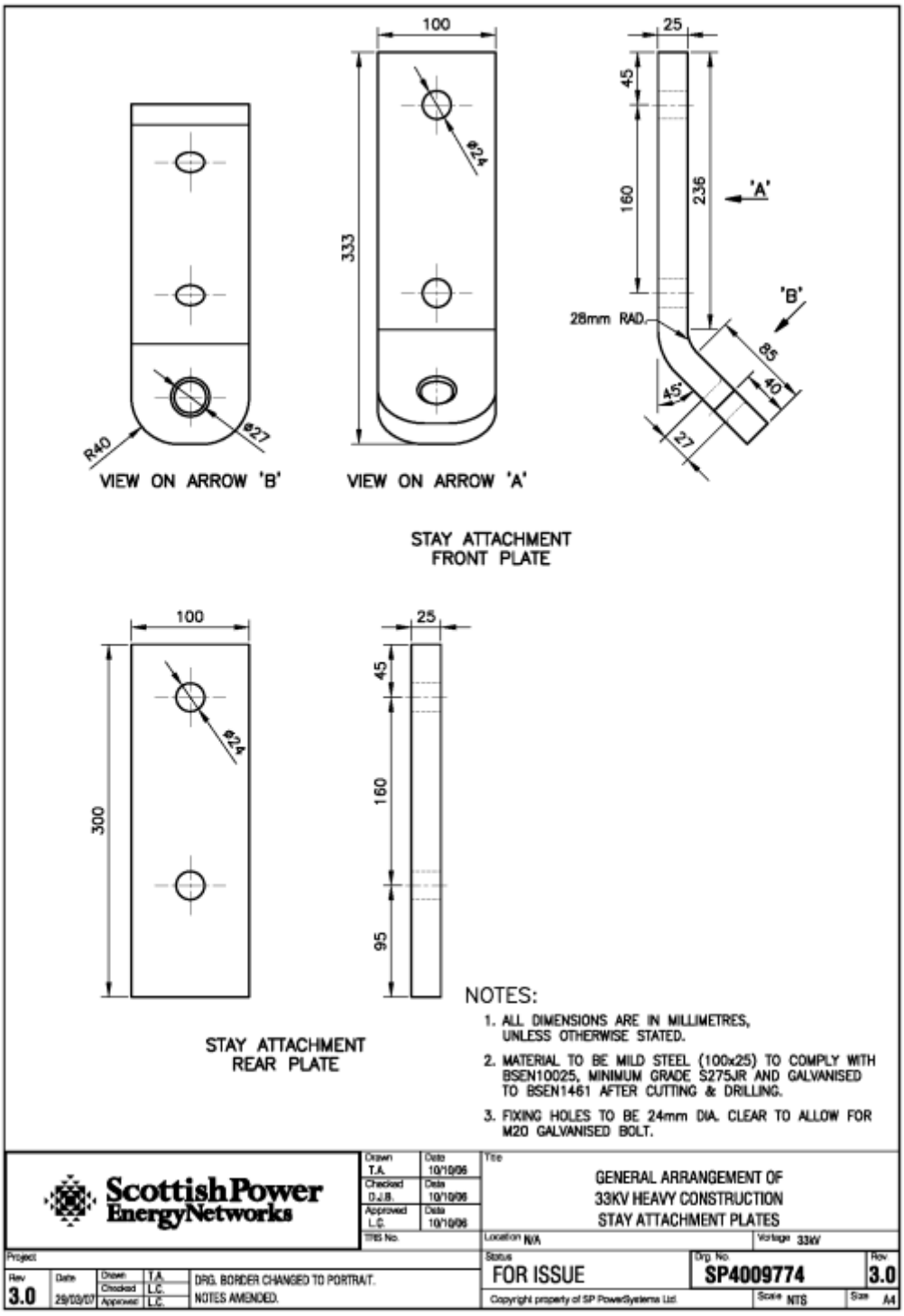
22.54 Figure 54 General Arrangement Terminal Bracing Strap 200mm² (Drawing No. SP4020576)



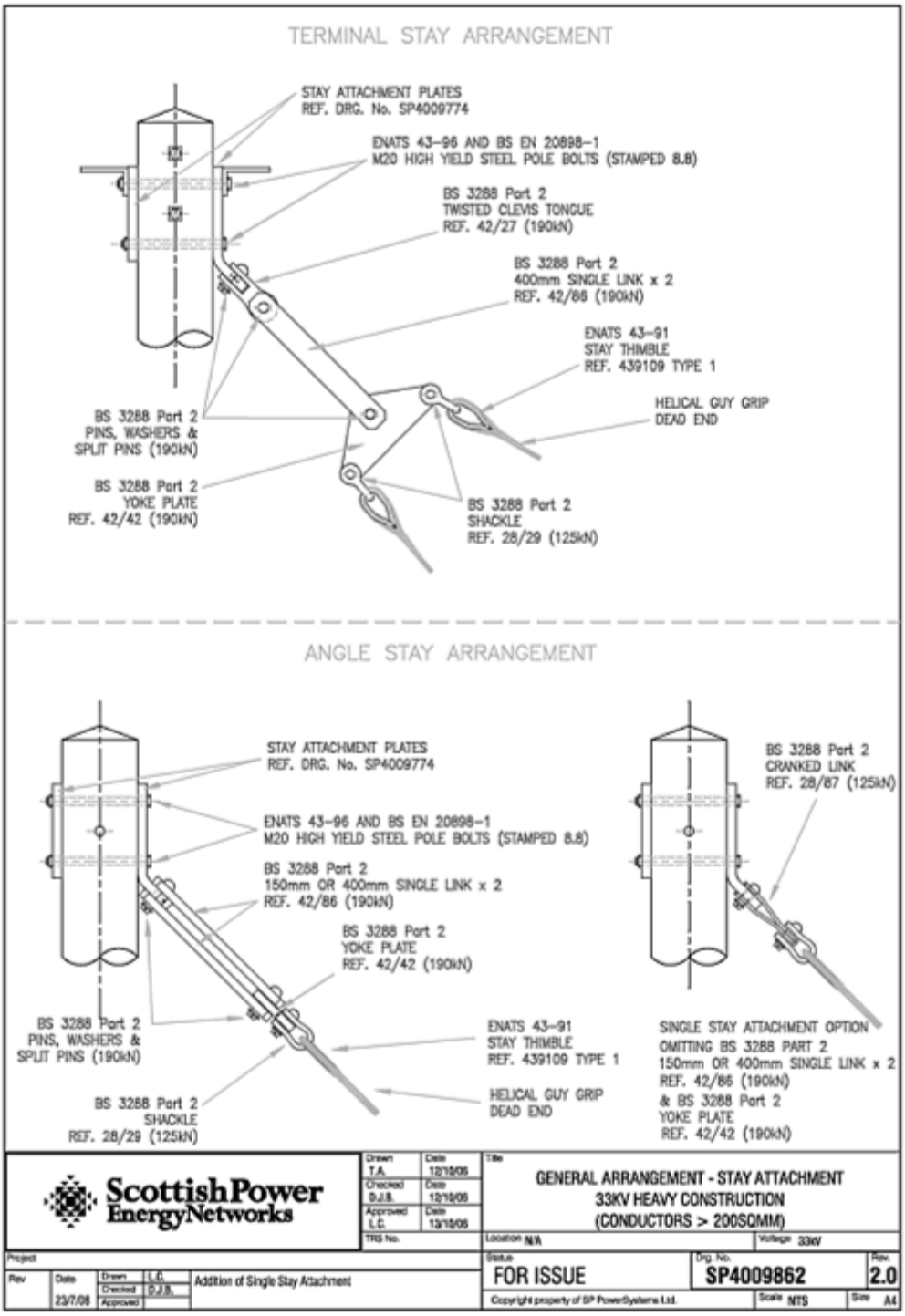
22.55 Figure 55 General Arrangement Long Section Strap for Long Span Delta "H" Pole (Drawing No. SP4019183)



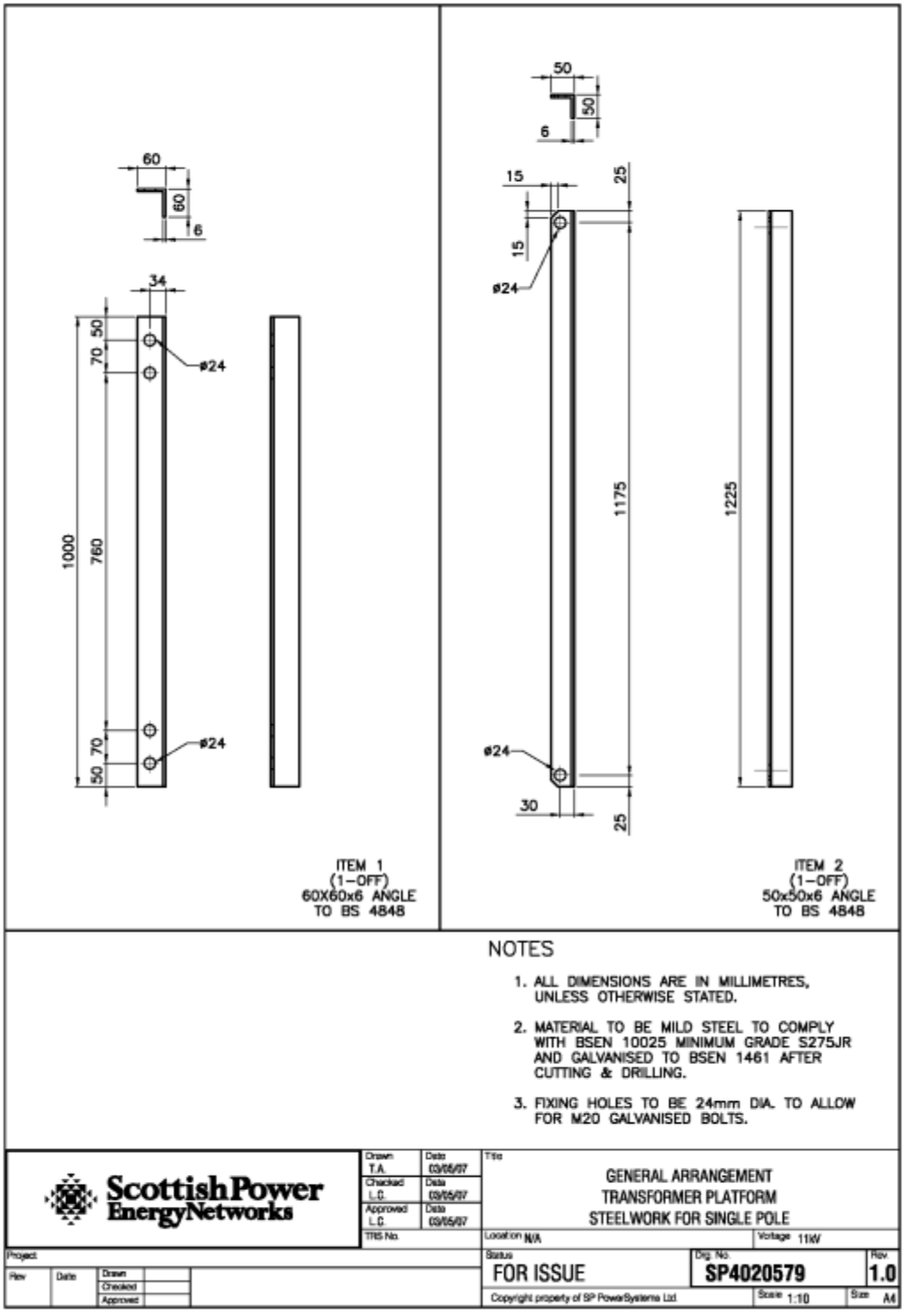
22.56 Figure 56 General Arrangement Heavy Construction Stay Attachment Plates (Drawing No. SP4009774)



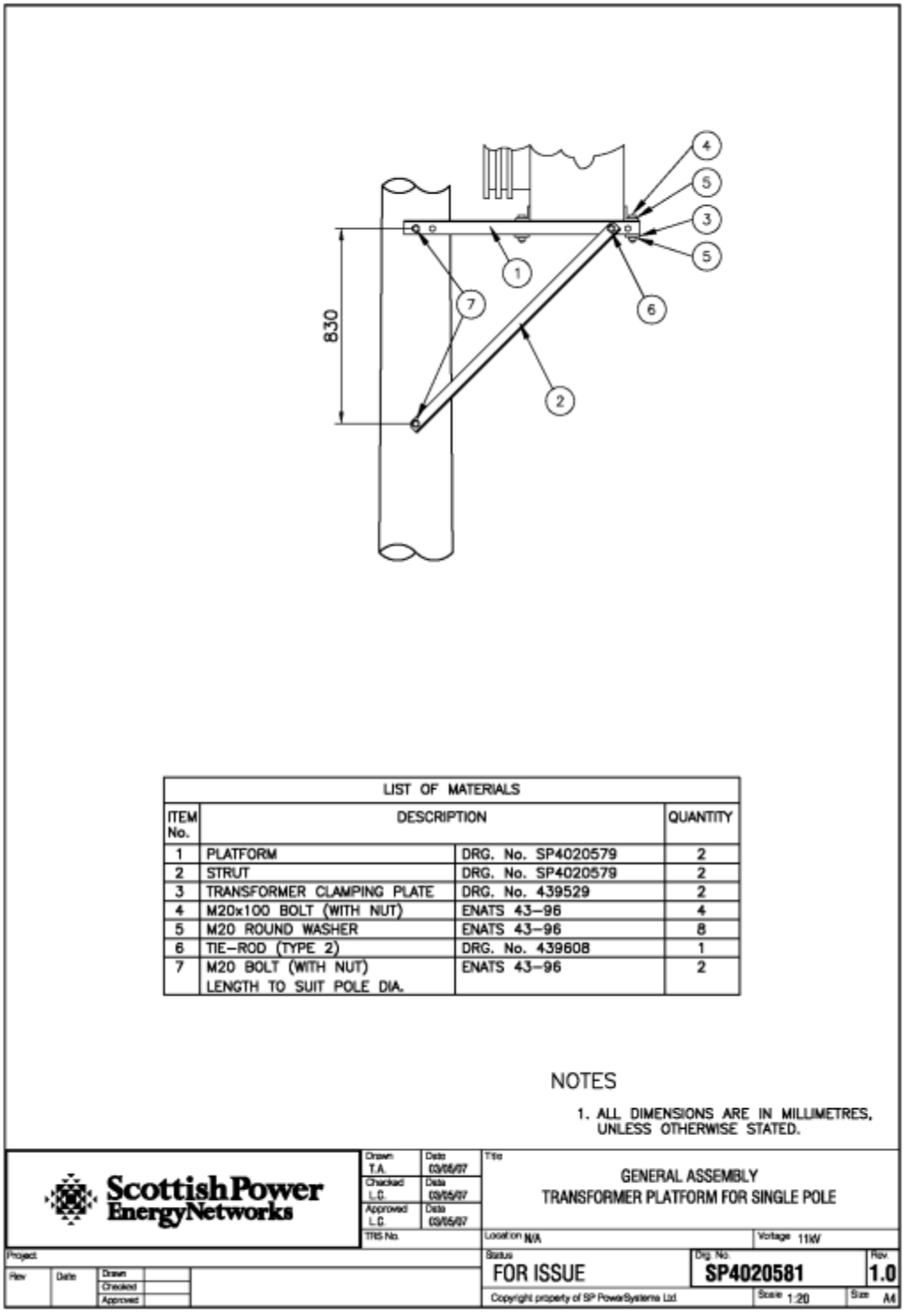
22.57 Figure 57 General Arrangement Heavy Construction Stay Attachment (Drawing No. SP4009862)



22.58 Figure 58 General Arrangement Transformer Platform Steelwork for a Single Pole (Drawing No. SP4020579)



22.59 Figure 59 General Assembly Transformer Platform Steelwork for a Single Pole (Drawing No. SP4020581)



LIST OF MATERIALS			
ITEM No.	DESCRIPTION		QUANTITY
1	PLATFORM	DRG. No. SP4020579	2
2	STRUT	DRG. No. SP4020579	2
3	TRANSFORMER CLAMPING PLATE	DRG. No. 439529	2
4	M20x100 BOLT (WITH NUT)	ENATS 43–96	4
5	M20 ROUND WASHER	ENATS 43–96	8
6	TIE–ROD (TYPE 2)	DRG. No. 439608	1
7	M20 BOLT (WITH NUT) LENGTH TO SUIT POLE DIA.	ENATS 43–96	2

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES, UNLESS OTHERWISE STATED.

ScottishPower EnergyNetworks

Drawn T.A. Date 03/05/07
Checked L.C. Date 03/05/07
Approved L.C. Date 03/05/07
TRS No.

Title: GENERAL ASSEMBLY TRANSFORMER PLATFORM FOR SINGLE POLE

Location N/A Voltage 11kV

Project:

Rev	Date	Drawn	
		Checked	
		Approved	

Status: FOR ISSUE
Dig. No: SP4020581
Rev: 1.0
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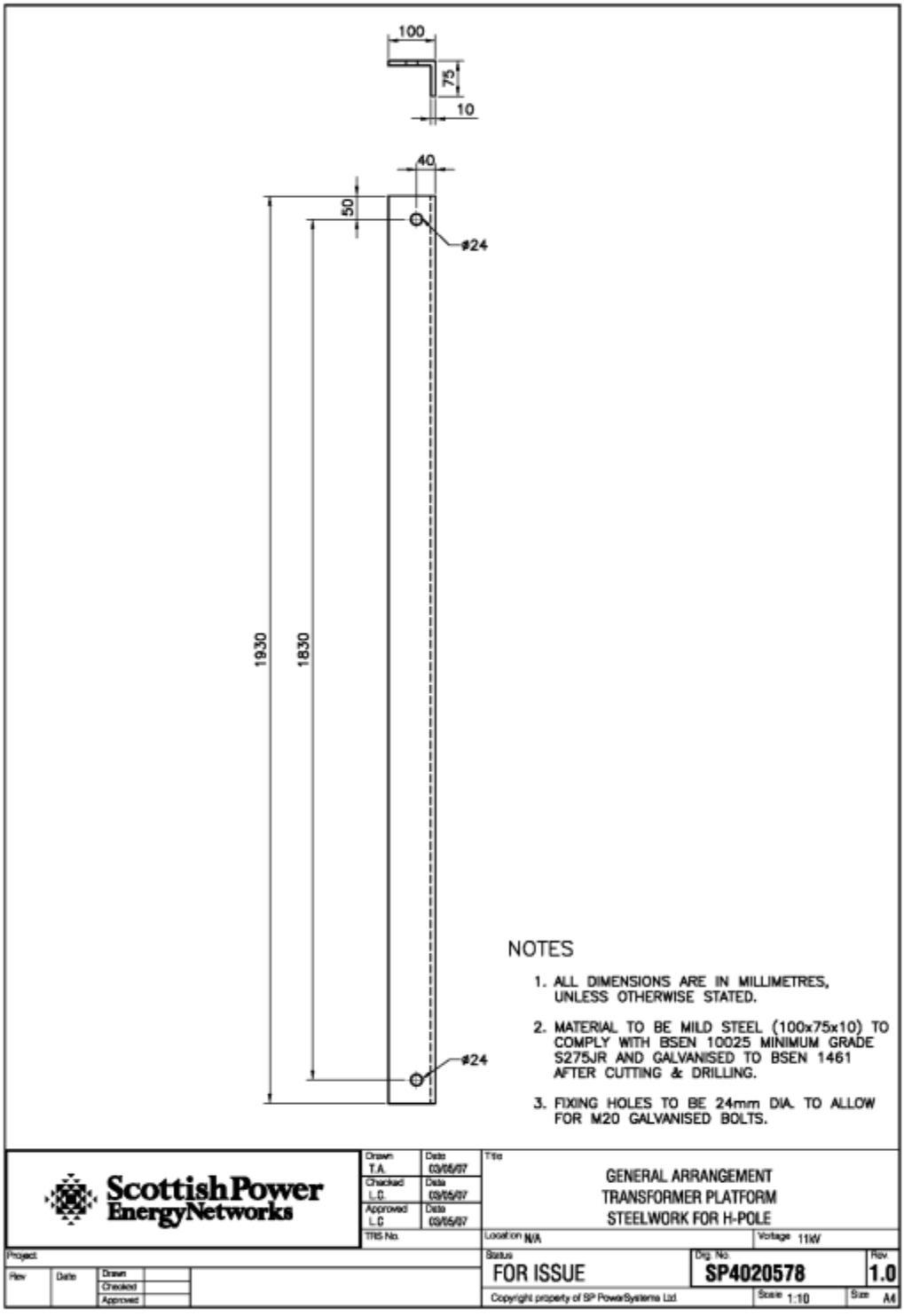
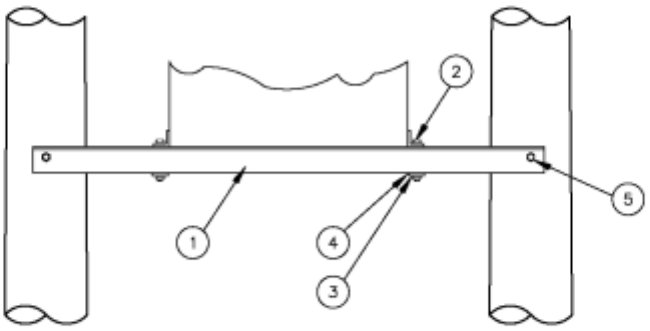
Scale 1:20 Size A4

22.60 Figure 60 General Arrangement Transformer Platform Steelwork for an "H" Pole (Drawing No. SP4020578)



22.61 Figure 61 General Assembly Transformer Platform Steelwork for an "H" Pole (Drawing No. SP4020580)



LIST OF MATERIALS

ITEM No.	DESCRIPTION		QUANTITY
1	PLATFORM	DRG. No. SP4020578	2
2	M20x160 BOLT (WITH NUT)	ENATS 43-96	4
3	M20 ROUND WASHER	ENATS 43-96	8
4	TRANSFORMER CLAMPING PLATE	DRG. No. 439529	2
5	M20 BOLT (WITH NUT) LENGTH TO SUIT POLE DIA.	ENATS 43-96	2

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES, UNLESS OTHERWISE STATED.

ScottishPower EnergyNetworks

Drawn T.A. Date 03/05/07
Checked L.C. Date 03/05/07
Approved L.C. Date 03/05/07
TRS No.

Title: GENERAL ASSEMBLY TRANSFORMER PLATFORM FOR 'H' POLE

Location N/A Voltage 11kV

Project

Rev | Date | Drawn | Checked | Approved

Status: FOR ISSUE
Drg No: SP4020580
Rev: 1.0

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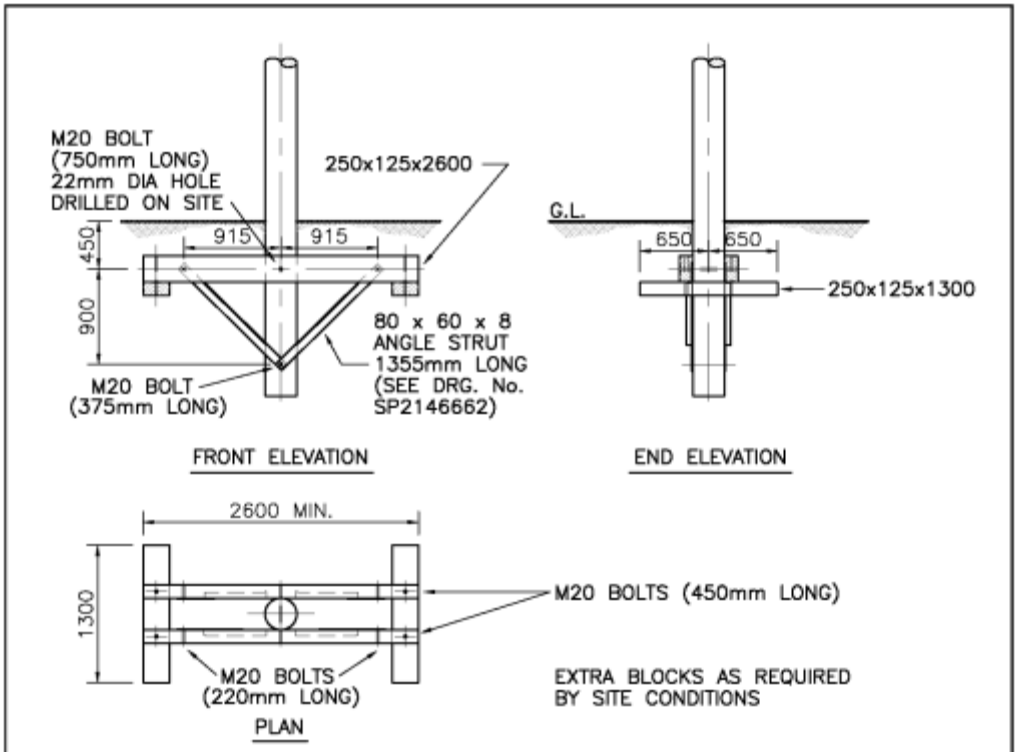
22.62 Figure 62 General Arrangement Single Pole Bog Shoe (Drawing No. SP2146665)



LIST OF MATERIALS			
ITEM No.	DESCRIPTION		QUANTITY
1	BRACE BLOCK	DRG. No. SP4019036	2
2	BRACE BLOCK	DRG. No. SP4019020	2
3	BOG SHOE STRUT	DRG. No. SP2146662	4
4	220mm ASSEMBLY BOLTS	ENATS 43-96 CLAUSE 4.2	4
5	450mm ASSEMBLY BOLTS	ENATS 43-96 CLAUSE 4.2	4
6	375mm ASSEMBLY BOLT	ENATS 43-96 CLAUSE 4.2	1
7	750mm ASSEMBLY BOLT	ENATS 43-96 CLAUSE 4.2	1
8	SQUARE WASHERS	ENATS 43-96 CLAUSE 6.2	12

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.
THE POLE IS NOT TO BE NOTCHED BUT IS TO BE TRIMMED TO MINIMUM SIZE REQUIRED TO SEAT CROSS MEMBERS AND BRACES.
THE MINIMUM AMOUNT OF EXCAVATION IS TO BE CARRIED OUT LEAVING AS MUCH AS POSSIBLE OF THE ORIGINAL GROUND UNDISTURBED.
ALL BACKFILLING TO BE CAREFULLY RAMMED AROUND FOUNDATION MEMBERS.

ScottishPower EnergyNetworks

Drawn A.J.P. 07/11/05 | Checked A.M. 09/11/05 | Approved L.C. 09/11/05 | TRS No.

Title: GENERAL ARRANGEMENT BOG SHOE FOR SINGLE POLE

Location N/A | Voltage 33kV

Project | Rev 4.0 | Date 27/02/07 | Drawn T.A. | Checked L.C. | Approved L.C. | REFERENCE DRG. No. AMENDED.

Status: FOR ISSUE | Drg. No. SP2146665 | Rev. 4.0

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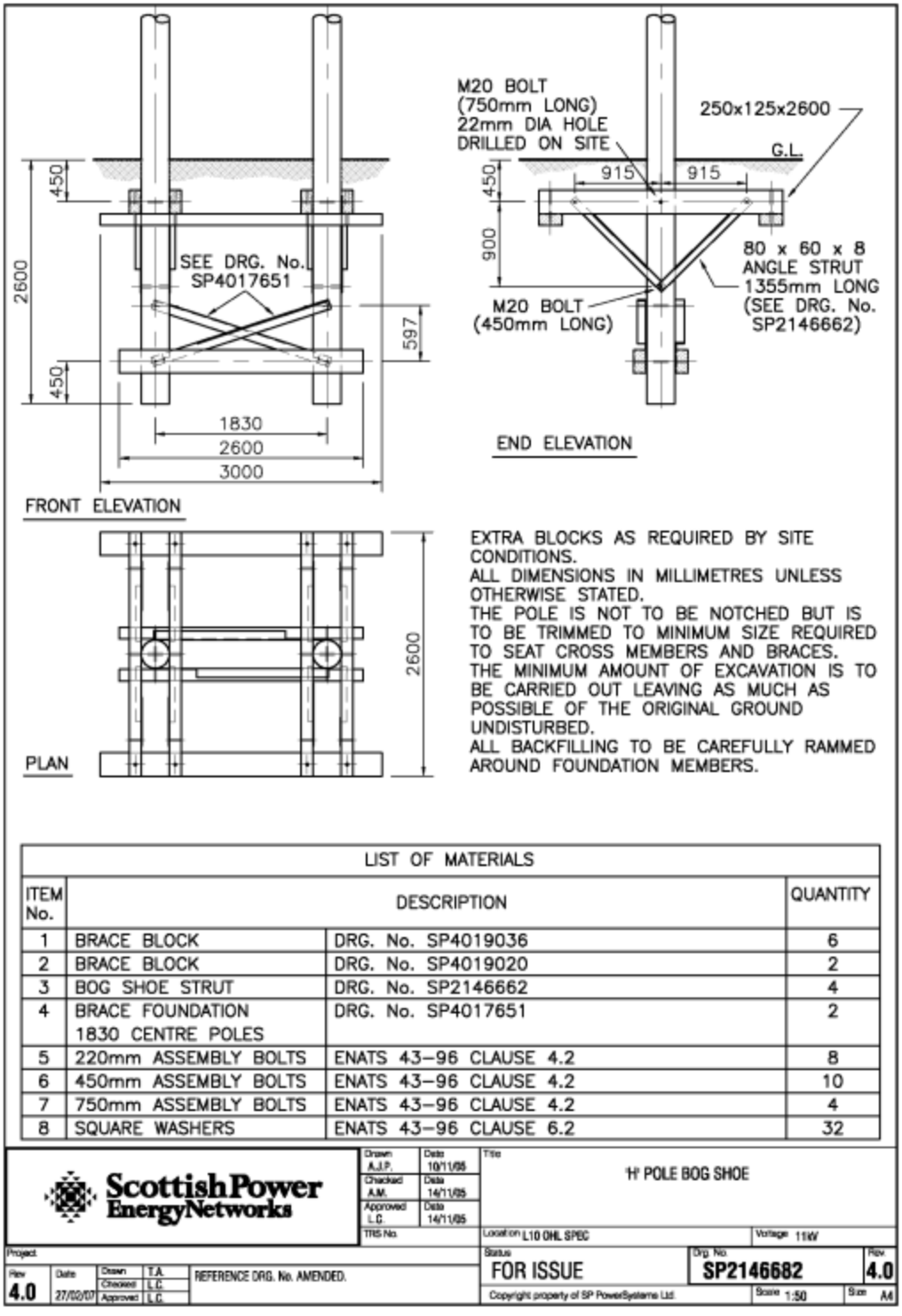
22.63 Figure 63 General Arrangement "H" Pole Bog Shoe (Drawing No. SP2146682)



LIST OF MATERIALS

ITEM No.	DESCRIPTION		QUANTITY
1	BRACE BLOCK	DRG. No. SP4019036	6
2	BRACE BLOCK	DRG. No. SP4019020	2
3	BOG SHOE STRUT	DRG. No. SP2146662	4
4	BRACE FOUNDATION 1830 CENTRE POLES	DRG. No. SP4017651	2
5	220mm ASSEMBLY BOLTS	ENATS 43-96 CLAUSE 4.2	8
6	450mm ASSEMBLY BOLTS	ENATS 43-96 CLAUSE 4.2	10
7	750mm ASSEMBLY BOLTS	ENATS 43-96 CLAUSE 4.2	4
8	SQUARE WASHERS	ENATS 43-96 CLAUSE 6.2	32

ScottishPower EnergyNetworks

Drawn A.J.P. 10/11/05 | Checked A.M. 14/11/05 | Approved L.C. 14/11/05

Title: 'H' POLE BOG SHOE

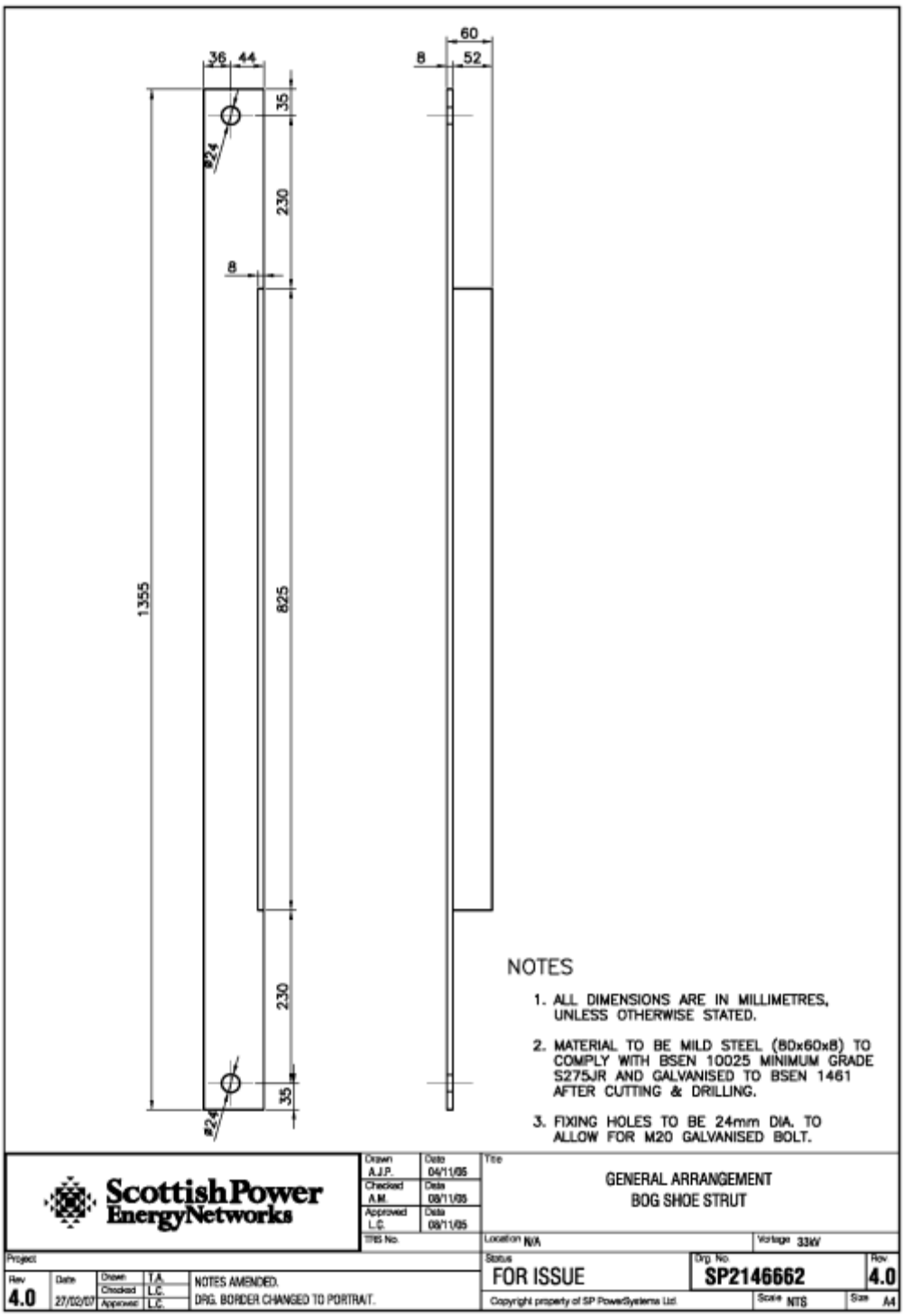
Location L10 OHL SPEC | Voltage 11kV

Status: FOR ISSUE | Drg No. SP2146682 | Rev. 4.0

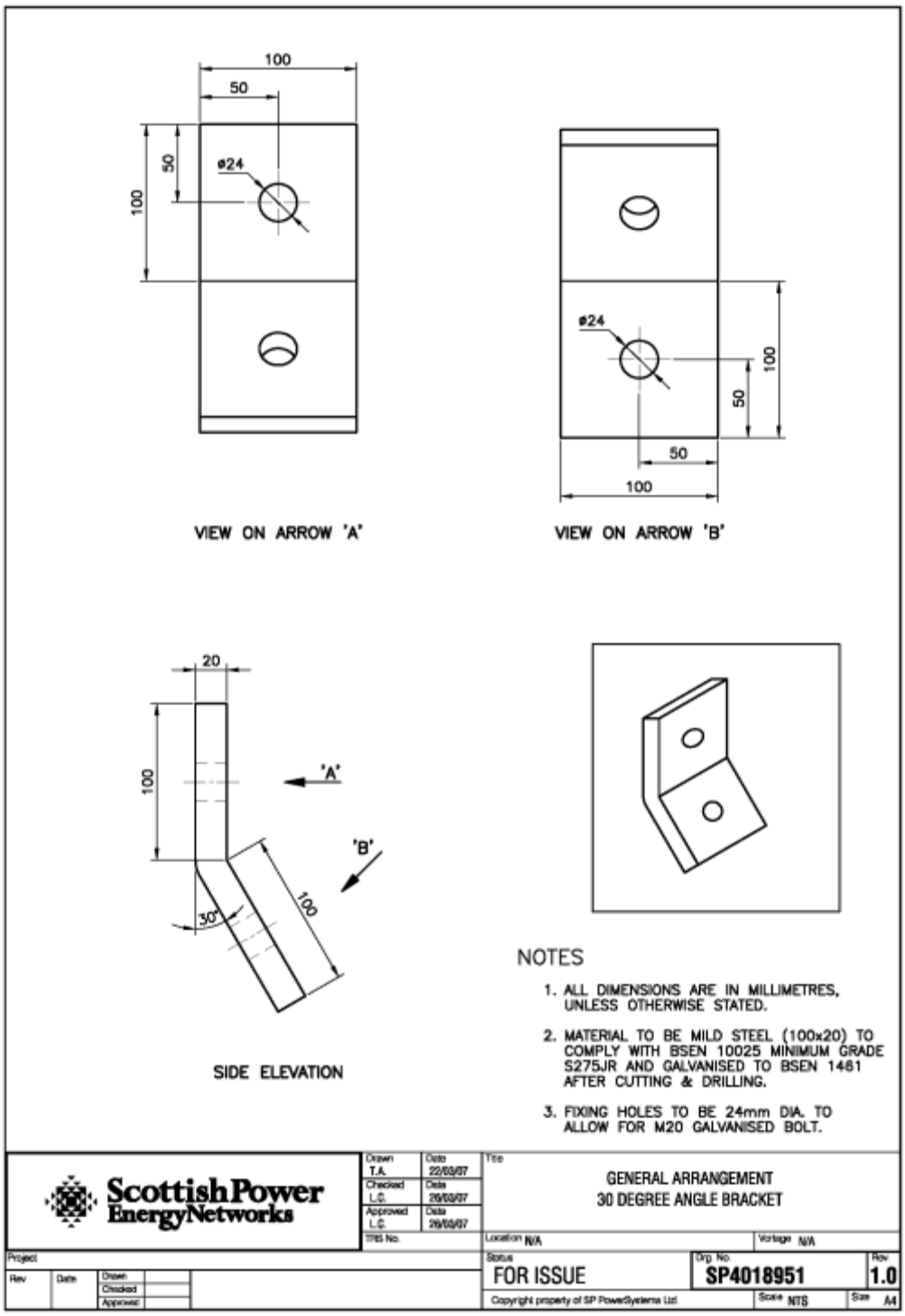
Rev 4.0 | Date 27/02/07 | Drawn T.A. | Checked L.C. | Approved L.C. | REFERENCE DRG. No. AMENDED.

Copyright property of SP PowerSystems Ltd | Scale 1:50 | Size A4

22.64 Figure 64 General Arrangement Bog Shoe Strut (Drawing No. SP2146662)



22.65 Figure 65 General Arrangement 30° Angle Bracket (Drawing No. SP4018951)



22.66 Figure 66 Wind Stay Arrangement (Drawing No. SP4000336)