NSP/004/044 - Specification for HV Wood Pole Lines of Compact Covered Construction up to and including 33kV

1. Purpose

The purpose of this document is to provide a specification detailing the requirements for new high voltage overhead lines constructed using Compact covered conductor. This specification has been prepared to satisfy the requirements of "The Electricity Safety, Quality and Continuity Regulations 2002". In essence the regulations require distribution plant to be fit for purpose and in the context of overhead lines this has been interpreted as requiring lines to be designed, constructed, used and maintained to adequately withstand all likely weather conditions.

Additionally, this specification confirms the reference OHL7/06 as the reference to be quoted to the Department of Energy for all new lines.

This document supersedes the following documents, all copies of which should be destroyed.

Document Reference	Document Title	Version	Published Date
NSP/004/044	Specification for HV Wood Pole Lines of Compact Covered Construction up to and including 33kV	1.2	Feb 2019

2. Scope

This specification covers the constructional requirements for the erection of 3-phase overhead lines on wood poles, using a compact form of construction and XLPE covered conductors. It has been designed to be in accordance with ENATS 43-121, 43-122 and BS-EN 50397-1 for operation at high voltage up to and including 33 kV and designed to the requirements of BS EN 50341-1

This specification has been designed to comply with the "Empirical" design approach as detailed in the scope of ENA TS 43-121.

2.1. Contents

3. Specification

3.1. Design Data

3.1.1. Weather Loading

Two following weather loadings which are dependent upon conductor cross sectional area will be utilized within the Company's geographic area.

a) *"Normal"* altitudes

- For conductors with a CSA > 35mm^2 copper equivalent, Wind pressure 380 N/m^2 with a radial ice thickness of 9.5 mm.
- For conductors up to and including 35mm^2 copper equivalent area (60mm^2 aluminium based conductors), wind pressure 380 N/m^2 with a radial ice thickness of 5.0 mm.

b) *"High"* altitudes

- For conductors with a CSA > 35mm^2 copper equivalent, wind pressure 570 N/m^2 with radial ice thickness 12.5 mm.
- For conductors up to and including 35mm^2 copper equivalent area (60mm^2 aluminium based conductors), wind pressure 380 N/m^2 with a radial ice thickness of 5.0 mm.
- See Note 1

"Normal" altitude is defined as all locations with site altitudes not exceeding 300 m above sea level.

"High" altitude is defined as all locations with site altitudes above 300m but **not** exceeding 500 m.

Ice / snow densities shall be considered as being equivalent to "glaze ice" at 913 kg/m3.

Notes

1) Discussions are currently taking place with the ENA (Energy Networks Association) over the applicable factors of safety that should be applied to the windspan capability of poles situated in "high" altitudes using conductors with a CSA greater than 35mm2 copper equivalent. Consequently, no design tables have been issued for this scenario until the discussions are resolved. Lines that fall into this category that are situated at altitudes greater than 300 m shall be subject to discussions with the Company's Overhead Line Engineer.

3.1.2. Conductors

Conductors of cross-sectional area up to and including 35 mm2 copper equivalent area (60mm2 aluminium based conductors), shall utilise a minimum factor of safety of 2.5 on their nominal breaking load. The minimum factors of safety on all conductors with a larger cross-sectional area shall be 2.0 on their nominal breaking loads. This limitation in conductor tension is known as Maximum Working Tension (MWT) and occurs at minimum conductor temperature, taken as -5.6°C.

The use of large CSA conductors with high RBS limits can result in very high MWT's. To simplify on-site construction works an additional design limitation has been built into this specification to ensure that MWT's above 17.793kN (1814 kgf) are not encountered. This limit also covers for the historical practice of maintaining a minimum factor of safety of 3.0 on 70kN tension insulator fittings (2379 kgf).

Consequently, the MWT's used in the conductor design and erection tables within this specification are based on the limiting factor between the Minimum conductor factor of safety requirements, 17.793kN limit and the vibration limit given below.

Vibration

Covered conductors have self-damping characteristics that reduce the amplitude of damaging aeolian vibrations. The self-damping effect increases with conductor size but decreases as strands become locked more tightly together with increasing tension or compaction. Experience has shown that the self-damping of 50 mm² aluminium alloy covered conductor requires a maximum Everyday Design Stress (EDS) of 28 N/mm² (at 5°C) to reduce Aeolian vibrations to an acceptable level.

Vibration tests have shown that an EDS of 35 N/mm² is acceptable for larger conductor sizes. The EDS can be increased where lines are located in hilly / wooded terrain or where vibration dampers are installed. Vibration tests have shown that large diameter covered conductors do not appear to have serious vibration problems at tensions around 20 % RBS. This equates to EDS values of 59 N/mm² and 63 N/mm² for 120CC and 185CC, respectively.

The followings EDS values have been adopted for covered conductors:-

a) 50 mm² aluminium alloy covered conductor requires a maximum Everyday Design Stress (EDS) of 28 N/mm² (at 5°C).

b) 120 mm² aluminium alloy covered conductor requires a maximum Everyday Design Stress (EDS) of 59 N/mm² (at 5°C).

c) 185 mm² aluminium alloy covered conductor requires a maximum Everyday Design Stress (EDS) of 63 N/mm² (at 5°C).

3.1.3. Conductor Spacing to avoid Clash

Maximum span lengths to avoid clash for any conductor and associated tension regime have been calculated within this design. The method employed assumes smoothed gust and lull wind pressures of 1.832 times the mean- and 0.546 times the mean- wind pressures respectively for a gust factor of 1.5. The likely mean wind and ice accretion levels for a specific locality and elevation are indicated as "weather zones" on the maps included in section 8 of ENA TS 43-40. The numeral indicates the wind pressure in 190 N/m2 increments and the letter as 10 mm diametric ice thickness increments for the indices A through to E, respectively. The worst combination of wind and ice loading is used for the calculation, with the actual wind and ice loads employed enhanced by a withstand factor of 1.1.

For lines at "Normal" altitudes the conductor spacing has been related to a "2C" weather zone, whilst for "High" altitudes the conductor spacing has been related to a "3C" weather zone.

In the production of the design tables, conductor clashing has been ignored as it will have no impact on number of transient faults.

3.1.4. Crossarm Assemblies

Crossarm assemblies have been designed in accordance with ENA TS 43-121 clause 4.3 utilising a 2.5 factor of safety for all steelwork and bolts. All crossarm arrangements are constructed using standard crossarms detailed in ENA TS 43-95.

Insulator Pins

ENA TS 43-121 recommends that 10kN MFL insulator pins should be designed using a maximum design stress equivalent to the ultimate stress of mild steel 430 N/mm2 divided by a factor of safety of 2.5 which equals 172N/mm2. (Which effectively rates 10kN insulator pins at 4kN). This rating is at variance with the previous version of ENA TS 43-40, which designed steel components to operate within their elastic limit.

Based on the good service history provided by ENA TS 43-40, this specification has been designed to limit the maximum design stress to the yield strength of steel (430/275 = a factor of 1.56).

This factor has been enhanced with a survival factor of 1.1 providing the traditional 10kN insulator pin with a maximum available rating of (10 / 1.56x1.1) = 5.83kN.

Note - for simplicity reasons all references to 10kN pins in the attached design tables, describe the pins with their full MFL rating even though the reduced rating has been used in the calculations.

Irrespective of the pin loading, the maximum angle of deviation allowable on an insulator pin has been restricted to 30°.

3.1.5. Supports

Within this specification the stresses created in intermediate supports are considered as bending stresses only due to wind load on conductors and insulators, the loading point being approximately 160 mm above pole tops for 11 kV lines. (Note: this dimension is the standard for 11/20 kV construction and equates to 260 mm above the top flange of the crossarm).

See clause 3.2.4 for details on available "Wind Loading Spans" and the associated factors of safety applied within this design.

The stresses created in stayed supports are crippling stresses due to stay tension, conductor weight / downpull and crossarm hamper loads acting at the pole top. The distribution of stresses in the limbs of "H" supports on which stays are equally deployed on the two poles and are adjusted to equal tension is considered to be 50 % of stress in each limb. Unequal staying (two stays on one limb and one on the other) the strut load is assumed to be 60 % or 40 % respectively.

The following data details the factors of safety that have been used within this specification to determine the strut capability of poles.

Three Phase Construction & Single Phase Construction

a) *"Normal"* altitudes - : Angle/Term. Pole, Min Pole Factor of safety shall be 2.5

b) *"High"* altitudes - : Angle/Term. Pole Min Factor of safety shall be 2.5

Note - factors of safety have been applied to poles based on minimum pole top diameters.

The strength of supports is derived from formulae contained in BS 1990 part 1 and in respect of *Pinus Sylvestris* wooden products; the pole producers in the UK have confirmed the following parameters:

Mean ultimate extreme fibre stress 53.3 N/mm²

Average modulus of elasticity 10 054 N/mm²

These parameters are based on a wood pole population whose southern border occurs at 60° latitude. Where some other species and / or pole population is considered, other strength parameters may be applicable and in this respect, amended support capabilities may need to be calculated.

A Schedule of approved structure arrangement drawings used within this specification is provided in Appendix 1.

3.1.6. Fasteners

All fasteners are dimensionally in accordance with ENA TS 43-96 and have been designed utilising the criteria detailed in ENA TS 43-121 clause 4.5.

3.2. Technical Requirements

3.2.1. Span Lengths

The basic span (recommended span) is used in the sag tension calculations to provide a theoretical mathematical design model for an overhead line. In conjunction with the selected weather severity level, it produces a series of horizontal and vertical loads which are then applied to each structure in the proposed design to determine the structures capabilities. One or more basic spans have been assigned against each conductor to provide the best economical balance between structure capabilities and risk of failure.

Where two basic span lengths have been assigned it normally indicates that the larger of the two values is likely to be susceptible to a higher risk of conductor failure due to conductor clashing. Hence the users need to balance the need for larger spanning with the additional requirements of failure containment.

Typically, a Basic Span will be in the range of 80 m to 120 m. Use of different basic spans within one overhead line is only approved where effective back staying, or other means, are provided to stabilise the out of balance tensions between the different sections at the transition structure.

The maximum span shown in the design tables is typically within +20 % of the basic span length. In this design specification the maximum span is determined by the clashing capabilities available from the phase to phase spacing on a standard support.

Unlike bare conductors, conductor clashing will not result in transient fault conditions. However, the maximum clashing span parameter still provides a good guide as to the preferable maximum span that should be employed when using covered conductors.

Where the line design tables offer users a choice of available basic span options, users shall attempt to utilise the options that have the FCD required box set to "No". Where this cannot be economically justified, and the FCD "Yes" option is selected, users shall ensure that additional FCD measures are included within the line in accordance with clause 3.2.3

In certain cases the design tables may identify a requirement to enhance the pole in order to meet the full capabilities of the design basic span. This limit known as the "windspan limit", means the conductor horizontal loading has increased beyond the limit of the selected pole.

Where the combination of conductor / weather environment / basic span indicates span lengths that are considered too short or uneconomical, it is recommended that a stronger conductor be employed.

3.2.2. Construction of Single Phase Lines

This specification is essentially a specification for 3 phase construction. Where new single-phase lines are required they shall be constructed to cater for ultimate uprating to 3 phase. Single Phase lines shall be limited in conductor size to 50mm2 XLPE covered conductor.

3.2.3. Failure Containment Policy

For the purpose of this specification, failure containment measures shall be deemed to include one of a range of designated structures that incorporate additional strength to assist in the reduction of cascade pole failure.

Regardless of the requirement to check for the inclusion of failure containment measures within the design tables associated with a particular conductor and to improve line security, no section of line shall exceed 1000m or 10 spans without a section or angle structure being inserted into the line, which meets the requirements of failure containment as detailed below.

The failure containment arrangements shown below are considered appropriate when any of the following situations occur:-

a) Where a line is to be built in a particularly exposed location.

b) Where an enhanced security of supply is required for a line.

c) Where the applicable conductor design table has identified the spanning as being susceptible to conductor clashing and hence has recommended the use of failure containment measures.

Where failure containment measures are required, the structures that incorporate them shall normally be separated by no more than 5 spans.

1) Intermediate supports to 1004312104.

2) Pin angle arrangements to 1004312104 at least equipped with twin splayed stays spread at 45° to the pole. Not recommended for higher security feeders.

3) Section supports to 1004312106 of a pole grade at least able to support 125 % of the windspan that applies in practice unless the pole grade is Stout, in which case this grade shall be adequate to satisfy this clause. Where the line is constructed in a severe environment and a high security is required, additional stays shall be employed on both sides of the structure in the plane of the line.

4) Any of the “H” section, section angle or terminal structures installed in accordance with this specification. Where the line is constructed in a severe environment and a high security is required, additional stays shall be employed on both sides of the structure in the plane of the line.

3.2.4. Wind Loading Spans

The additional covering incorporated into covered conductors significantly restricts the available windspan capabilities of poles.

The maximum wind loading figures have been derived through the use of two weather related loading situations. These shall be used on level conditions up to 1:10 declination.

Three Phase Construction & Single Phase Construction

a) *"Normal"* altitudes

- CSA > 35mm2 copper equivalent - Min intermediate pole Factor of Safety = 2.5.
- CSA < or = 35mm2 copper equivalent - Min intermediate pole Factor of Safety = 2.5

b) *b)"High"* altitudes

- CSA > 35mm^2 copper equivalent - Min intermediate pole factor of safety = 2.0. (See note 1).
- CSA < or = to 35mm^2 copper equivalent - Min intermediate pole factor of safety = 3.0

Note - all factors of safety have been applied to poles based on minimum pole top diameters.

Notes

1) Discussions are currently taking place with the ENA (Electricity Networks Association) over the applicable factors of safety that should be applied to the windspan capability of poles situated in "high" altitudes using conductors with a CSA greater than 35mm2 copper equivalent. Consequently, no design tables have been issued for this scenario until the discussions are resolved. Lines that fall into this category that are situated at altitudes greater than 300 m shall be subject to discussions with the Company's Overhead Line Standards Manager.

The factor of safety on intermediate poles subjected to transverse loads shall be increased with increasing declination (The minimum factors of safety detailed above shall be increased by +0.5 for 1:7.5 declination and by +1.0 for a 1:5 declination).

3.2.5. Maximum Angles of Deviation

Maximum angles of line deviation are determined by five aspects;

i) The mechanical capability of the Insulator Pin – See Clause 3.1.4 for available pin strengths

ii) The mechanical capability of the complete crossarm assembly.

iii) The available stay wire mechanical strength

iv) The wood pole strut load capability.

The maximum angles of deviation permissible on each support type to achieve the most economically advantageous arrangement whilst balancing the risks to the structures have been tabulated against each conductor type / weather severity. See the appropriate design table for details.

The recommended maximum angle of line deviation on any standard single pole structure has been limited to a 60°.

Strut Load

The calculated strut loads used to determine the pole selection in the design tables have been generated on the basis that angle supports are located on level ground. Angle structures located on sloping ground with gradients of less or equal to 1:10 will generate additional strut loads approx. equal to an additional 5° of line deviation. Reference shall be made to the appropriate design table to ensure that the chosen pole grade/stay spread is still suitable for the on-site angle of deviation. Where the check identifies that this can no longer be achieved, an alternative arrangement designed for larger angles of deviation shall be chosen from the design table.

Both "*Normal*" and "*High*" altitude stay arrangements have been prepared using a Factor of Safety of 2.5 for all stay wire and stay fittings.

Note – For loading purposes, 60° angles of deviations shall be assumed as being equivalent to terminal loads.

Where the line design requires the use of 90° angles of deviation, this may be achieved through the use of structures to drawing 1004312113 (1.8m centred H pole).

3.2.6. Stay Arrangements

Stay spreads will normally be such that an angle of 45° is provided between stay and pole. (I.e. stay and the vertical). As a general rule, therefore, the stay spread on horizontal ground will be equal to the length of the pole less its sinking depth. In circumstances when tighter stay spreads are unavoidable because of the location of physical obstructions, reduced values in line with the data provided in the appropriate design tables may be used. See appendix 2 - 7 for details. In all cases the minimum allowed stay angle shall be 30º.

NSP/004/104 provides details on converting minimum stay angles into actual stay spreads

However, it must be accepted that use of these minima will reduce the normal capacity of the structure to withstand extreme conditions and it is expected that the vast majority of angle situations will be planned to avoid recourse to the use of minimum values.

In extreme weather conditions, stayed supports may be required to afford appreciable failure containment capability. In practice the design loading when applied to the case of large angles of line deviation and terminals, is generally more onerous than abnormal cases associated with broken conductors when applied to the same structures with correctly installed and maintained stays. A correctly stayed 'H'

structure is deemed to provide an acceptable level of failure containment when used up to the ultimate loading case.

In the case of small angles of line deviation, single stays set at the minimum angle required to resist the normal design loading case do not offer significant failure containment capability.

At single pole angle supports, if a single stay is used then it shall be set so as to bisect the complement of the angle of deviation to counteract the side pull. When two or more stays are fitted, they shall be arranged in a splayed formation.

Triple stays shall comprise two splayed stays as above set at the approved angle to the pole, the third stay being placed to bisect the two and entering the ground at least one metre behind them viewed from the pole

Multiple stay baulks shall be installed so that the length of undisturbed ground between stay pits is not less than 3.0m.

At section positions where change of conductor type or sag chart gives rise to the need for out of balance stays, single or double splayed stays per leg will normally be fitted to provide an angle of 45° between pole and stay. Normally, out of balance stays will be set under the line in each direction sufficient in number to be capable of terminating the line in each direction, unless by examination of the appropriate sag charts it can be shown that out of balance tensions do not reverse with change of temperatures, in which case stays may only be fitted against the higher tension conductors.

All stays supporting HV lines shall be effectively bonded at the top of the line crossarm. The method of bonding stays is to take one wire from the stay strand, or centre 'king' wire from a pre-formed pole top make off, and connect it to the designated bolt on the HV crossarm. Stays shall be considered to be effectively bonded where they are either terminated direct onto a stay plate which itself is bolted direct to pole top steelwork, or where one wire is taken from the pole top make off and connected to a designated bolt on the HV crossarm as stipulated in ENA TS 43-91.

Out of balance stays will be required wherever a transition occurs between bare and covered conductors. This will require the installation of a single 7/4.00mm stay wire against the conductors with the highest MCT. Reference shall be made to the conductor sag/tension charts for each conductor to determine the MCT values.

3.2.7. Conductor Design / Erection Sags and Tensions

Conductor design and erection charts are provided in Appendix 9 - 14

Lines constructed to this specification shall be designed such that the specified clearances in clause 3.2.10 of this specification are not infringed with the following conductor design temperatures:

For conductor sizes of 50 mm^2 AAAC XLPE Covered ..... 50°C

For conductor sizes greater than 50 mm^2 AAAC XLPE Covered ..... 75°C

3.2.8. Strut Loading of Supports

Supports shall be in accordance with the general arrangement drawings that form part of this Specification. It is recommended that all stays on angle and terminal poles be set at the maximum stay angle possible to afford the structure the greatest level of failure containment capability.

See applicable factors of safety applied to strut loaded supports in clause 3.1.5

3.2.9. Pole Foundations

The maximum available windspan capability of poles is dependent upon the effectiveness of the associated pole foundations. ENA TS 43-121 details three soil grades with the lateral rupture capacity of

soil, 628 kN/m2, 471 kN/m2 and 314 kN/m2 per metre depth for good, good / average and average / poor soils, respectively.

Unless specific soil strength information is available, all calculations shall be based on 628 kN/m2 or "good" as described in ENA TS 43-121. This design premise is based on the use of soil additives.

All pole foundations used in this specification have been designed with a minimum factor of safety of 2.5

Standard Pole Foundations

All poles shall be fitted with two wood foundation blocks (1300 x 250 x 125mm) as detailed in ENA TS 43-91 fig 8 (DWG No. 439103), Type 2 or Company drawing 1000439103 sht1. The blocks shall be placed as follows:

Ground line to Top Block Pole Bolt = 500mm

Ground line to Bottom Block Pole bolt = 880mm.

All pole foundations shall incorporate the use of the backfill "Perma-Soil backfill additive as detailed below.

25kg of Perma-Soil should be added to the excavated spoil in layers throughout the excavation of the pole hole, half of this amount shall be added to augured holes. Reinstatement/Compaction should be completed in lifts as per the existing re-instatement practice.

Research work has shown that where average to poor foundations are identified, the Perma-Soil stabiliser will normally provide sufficient improvements in the foundation capability to improve the soil quality to that of a ‘ Good ’ backfill.

Augured Pole Foundations

May be utilised as an alternative to standard wood block foundations detailed above. Care shall be taken during the installation of these poles to ensure that the auger sizes match as close as possible the pole base diameters.

The table shown below details the pole foundation sinking depths that shall be used with this specification to obtain the acceptable windspan capabilities from the poles.

Standard Pole Sinking Depths

Pole Length	Pole Sinking Depth Standard Block Founds Medium / Stout Poles	Augured Pole Foundations Medium Grade Poles	Augured Pole Foundations Stout Grade Poles
9.0 - 1.5m	1900 mm	2100mm	2400mm
12.0 - 14.0	2100 mm	2400mm	2600mm
15.0 - 18.0	2400 mm	2400mm	2600mm
19.0 - 22.0	3000 mm	Not Allowed	Not Allowed

Foundation Strut Loadings

The maximum allowable strut loading utilised within this specification has been designed to be less than the respective value for the available soil bearing strength. An average soil bearing capacity of 429 kN/m^2 (4 tons/ft^2) has been used within this specification. This value will be utilised for all soil grades.

3.2.10. Clearances

The minimum height of all line conductors and clearances to other objects shall be compliant with Code of Practice NSP/004/011. The above document supplements the basic clearance requirements as recommended by ENA TS 43-8 "Overhead Line Clearances" with any additional Company requirements to compensate for long term conductor creep etc.

From a touch or contact point of view covered conductor is classed as a "lightly insulated conductor" i.e. a line conductor that is insulated against momentary phase to phase or phase to earth contact and is considered as a bare conductor for clearance purposes.

In reality covered conductors can provide sustained (but not indefinite) contact with other phases or phases and earth. However, because it does not have a properly grounded sheath and leakage currents may be present, we cannot call it an insulated conductor.

3.2.11. Reduced Tree Clearances

Whilst MNT/013 – "*Policy for the Management and Control of Vegetation near Overhead Lines*" provides guidance for the management of vegetation near overhead lines, the following minimum tree clearances shall typically be applied when constructing new lines with XLPE covered conductor.

a) Conifers - 3m from the ultimate tree extremities i.e. a tree clearance corridor of 7m

b) Hardwoods - 2m from the ultimate tree extremities i.e. a tree clearance corridor of 5m.

3.2.12. Lightning Protection

3.2.12.1. General

Covered conductors are susceptible to lightning damage and action shall be taken to avoid conductor burn-down caused by sustained arcs initiated by a flashover following a lightning strike. Lightning can strike a phase conductor of an overhead line (a direct strike) or strike an object on the ground nearby (an indirect strike). In all cases over-voltage surges will travel from the strike point in both directions on all phases whether the line is energised or not. Overhead lines up to 33 kV are susceptible to both types of lightning strike.

3.2.12.2. Indirect Strike

In an indirect strike the voltages induced on each phase will be very similar and so there is no likelihood of a phase-to-phase flashover or damage at unearthed poles. At poles with earthed cross-arms, equipment or with cable junctions, there is a chance of flashover across insulators or internally within equipment. The use of overvoltage protection devices (based on arc gaps or surge arresters connected phase-to-earth) is therefore necessary at all poles containing equipment and at all OHL / cable junctions.

3.2.12.3. Direct Strike

In the case of a direct strike there will be pinhole damage at the strike point and the struck phase will have a considerably higher voltage surge than the other phases. There is therefore a likelihood of phase-phase breakdown at the struck point or at unearthed poles. If a phase-phase arc occurs then, since the conductor is covered, the arc will not travel along the line as is normally the case with bare conductors. The stationary arc may be of such a magnitude as to burn through the conductor or severely damage the pole-top insulator within one second. The use of protection devices based on arc protective devices connected phase-to-phase is therefore necessary at intervals along the line.

3.2.12.4. Protection Guidance

The frequency and type of protection used is dependent on the local lightning intensity, the line location and the supply quality desired.

To protect covered conductors from direct strikes, arc protection devices (APD's) shall be installed on every other pole. (Unless it is a section pole which by default includes a built-in arc gap system). This equipment aims to strike an arc between electrodes mounted on the conductor and the

crossarm. It will operate at any phase spacing or fault current level and can be mounted on either side of the pole.

Where supply quality is an issue, triggered arc gaps shall also be installed to provide additional protection to the line and associated equipment from indirect strikes. This equipment is pole mounted and allows breakdown to occur between the centre phase and earth, thereby reducing the overvoltage surge level. The arc gap is so designed as to encourage self-extinction and avoid circuit breaker operation.

3.2.12.5. Work on the Conductors - Application of Earthing Points

When work is required on or near covered conductor lines, this shall be carried out in accordance with the requirements of the Distribution Safety Rules and Operation Practice Manual as would be applicable for bare lines with the following exceptions.

It is not practicable to gain access to the metallic conductors in the same way as is possible with traditional bare conductors. Instead, earths shall be fitted to either the integral arcing horns at the compression dead ends or via the arcing horns at the APD's. Preference shall always be given to the dead end location for any main earth's with APD's being used only for additional earths.

3.2.12.6. Conductor Erection Guidance

Conductors shall be erected using winches and braked drum stands or trailers, under no circumstances shall the conductor be dragged out across the ground.

Conductors shall be terminated using compression dead-ends with two bolt flags for jumper connections and arcing/earthing points. Once compressed, the excess grit grease expelled from the fitting shall be removed and an insulating shroud shall be applied over the conductor and compression fitting barrel to prevent the ingress of moisture and reduce the area of live exposed metalwork.

Any conductor insulation removed for the purposes of conductor erection and pre-stressing shall have its insulation integrity replaced through the use of self-amalgamating tape or cold shrink insulated sleeves. Although not suitable for the permanent termination of covered conductors, helical dead-ends may be utilised as a pulling up device to remove the need to expose bare conductor.

3.3. Materials

3.3.1. Anti-Climbing Devices & Safety Signs

Anti-climbing devices and Safety Signs shall be designed in accordance with material specification NPS/001/005. They shall be installed in accordance with NSP/004/109.

3.3.2. Safety Signs, Labels and Notices

Safety Signs, labels & notices shall be designed in accordance with material specification NPS/001/010. They shall be installed in accordance with NSP/004/109.

3.3.3. Covered Conductor

50CC:AL3, 120CC:AL3 & 185CC:AL3 covered conductor shall be manufactured and tested in accordance with NPS/001/007 and ENA TS 43-122 Table 1B. Conductors manufactured to these standards will allow their use up to and including 33kV whilst still providing a maximum permissible current from contact with the covering of 1mA.

3.3.4. Conductor Terminations and Joints and other Fittings

Conductor terminations shall be designed in accordance with NPS/001/016 and ENA TS 43-120.

Conductors shall be terminated at terminal/section structures using compression dead-ends complete with jumper jugs and earthing points. See drg no. 1091010667 sht1 for details. All terminations shall be installed as detailed in NSP/004/106.

All terminations and joints shall be installed as detailed in NSP/004/106, NSP/004/107.

Full tension joints shall not be utilised in the construction of new lines. Where they are required as a repair medium, they shall be constructed using compression connectors appropriate to the conductor size and material. See drawing 1091010102 for details. Under no circumstances shall they ever be used over road or rail crossings.

Non tension joints shall be constructed using compression connectors appropriate to the conductor size and material. See drawing 1000439202 or 9204 for details of approved components.

Bi-metal connections shall be made using non-tension joints designed in accordance with NPS/001/016. Care shall be taken to ensure that conductors are thoroughly cleaned before the conductors are inserted, and the joint shall be arranged with the aluminium in the uppermost position so that it is not possible for water to drain copper salts down onto the aluminium.

Upon completion of all jointing the fittings shall be insulated with self-amalgamating tape or suitable cold shrink insulated fittings.

To maintain the protective covering on covered conductors, tee-off's to other lines shall be created using an IPC Insulation Piercing Connector design of bail clamp. Drawing 1091010667 sht2 provides details on this clamp.

3.3.5. Conductor Binders

Conductors shall be secured to pin insulators using helical fittings designed in accordance with material specification NPS/001/002 and NSP/004/106.

Straight line and pilot pins shall be secured using fittings as detailed in drawing 1091010660

Pin Angle and jumper pins shall be secured using fittings as detailed in drawing 1091010662

Covered conductor shall be secured to pin insulators using helical ties similar to those applicable to bare conductors. Ties shall be selected that are appropriate to the outside diameter of the conductor with its insulation intact. Prior to the installation of the tie, a wrap of semi-conducting material (normally tape) shall be applied around the conductor extending approx. 50mm beyond the ends of the tie.

3.3.6. Fasteners & Washers

Fasteners and Washers shall be designed in accordance with material specification NPS/001/001.

3.3.7. Insulators and Associated Fittings

Insulators manufactured from composite materials shall be used for both pin and disc arrangements.

Insulators and fittings shall be designed in accordance with material specifications NPS/001/006 and NPS/001/005. See NSP/004/127 for information on the applicable types and design of insulator and insulator assemblies.

3.3.8. Arc Protection Devices

Arc Protection devices (APD's) shall be designed in accordance with material specification NPS/001/016. See drawing number 1091010667 for further details on these devices. Clause 3.2.12.4 provides details on the frequency of application of these devices.

3.3.9. Vibration Dampers

Vibration dampers shall be designed in accordance with material specification NPS/001/002.

To reduce the risk of premature conductor failure vibration dampers shall be installed at both ends of the span in all lines constructed using 120 mm² or 185 mm² covered conductor. Installation instructions for the dampers can be found on drawing number 1091010667.

New lines constructed with 50 mm² covered conductor have been designed with significantly reduced erection tensions to remove the risk of aeolian vibration. However, lines constructed prior to the issue of this specification or lines situated in very exposed locations shall also be fitted with vibration dampers.

3.3.10. Stays and Wood Baulks

All stays shall utilise 7/4.00mm grade 1150 galvanised steel stay strand supplied in accordance with material specification NPS/001/013.

Wood baulks shall be supplied in accordance with material specification NPS/001/001.

- See NSP/004/104 for details of approved stay assemblies and installation arrangements.
- Stay blocks shall be to ENA TS 43-91 drawing no. 439103 type 2 and installed at a depth of 1.8m below ground level.
- Every stay shall be
    a) Fitted with an approved type of stay insulator(s) positioned as specified on drawing number 1000439108 sht1.
    b) Bonded at the top to the line crossarm.

In situations where a broken jumper or a broken stay may result in the stay becoming 'live', the insulator shall be placed below any likely point of contact with live metal, but not below a position which would maintain a minimum of 3.0 m above the ground with the stay swung vertically.

3.3.11. Steelwork

All steelwork shall be in accordance with ENATS 43-95, designed to BS 5950: Part 1 and supplied in accordance with material specification NPS/001/005.

3.3.12. Wood Poles

Wood poles shall be fabricated in accordance with the requirements of ENATS 43-88 supplied in accordance with material specification NPS/001/001.

For "H" poles, the minimum pole top diameters for Stout-grade poles is 210 mm, as indicated on drawing 434002.

The pole assembly drawing 1004312110 utilised on single pole terminal arrangements requires a fixed pole top dimension of 210mm to facilitate the installation of the crossarm bracing straps. Additionally, the presence of a fixed pole top dimension ensures a minimum strut load capability in this pole.

3.3.13. Provision of Safety Signs

Each support shall be provided with at least one safety sign to ENATS 43-90. The sign shall be mounted approximately 3 m above the ground level, above any anti-climbing guard and clearly visible to an observer on the ground. See additional guidance notes on the application of signs & notices.

3.3.14. Precautions Against Access

The types of support requiring precautions against access and the methods to be employed are detailed in ENATS 43-90 and NSP/004/109.

3.3.15. Erection of Auxiliary Plant

Allowances have been made in the basic support design for the additional mechanical loading that would be imposed by auxiliary equipment and additional conductors / cables. (I.e. the additional weight due to pole mounted transformers etc).

A selection of standard arrangement drawings is available for all Substation/Plant poles (including their associated pole fabrication drawings).

New pole arrangements shall wherever practical make use of pre-fabricated poles as opposed to standard poles being drilled and fabricated on site.

Reference shall be made to the Company's Overhead Line Engineer for proposed arrangements not available within the existing standard arrangements.

See NSP/004/120 for details of Standard arrangement drawings and jumper connections to auxiliary plant.

To maintain the integrity of the conductor insulation, wherever practicable, connections to Auxiliary plant shall be provided through the use of "live line" bail clamps. In this case, purpose designed aluminium stirrups connected to the line using special insulation piercing connectors. Insulated jumpers may then be attached to the bails using "live line" taps in the normal way.

IPC Bail clamps shall be designed in accordance with material specification NPS/001/016

3.3.16. Relationships with Other Bodies

Where lines to this standard are erected over or alongside the plant of Telecommunications Operators or Network Rail operators, then the provisions of the relevant joint agreements shall apply. Details of the required clearances and any special provisions are available in Company Code of Practice NSP/004/011.

Additionally, the requirements of Waterways Authorities may also be found in Company Code of Practise NSP/004/011.

3.4. Conductor Erection Guidance - Long Term Creep - Compensation

3.4.1. Conductor Creep

Suspended conductors are subject to longitudinal stresses that cause permanent long-term elongation termed conductor creep. This results in an increase in sag in the conductors. In order to ensure satisfactory ground clearance exists throughout the life of the line, a combination of compensation techniques have been employed within this specification.

i) Pre Tensioning

Prior to final sagging, all newly erected conductors shall be pre-tensioned to reduce the amount of elongation that will occur in service. Pre-tensioning conductors has the additional advantage of proof testing other line components e.g. loading up stay assemblies to ensure all movement has been taken up.

For safety reasons, the selected pre-tension values have been selected to ensure that the following limit conditions are never exceeded (MWT or 50 % of the conductor rated breaking strength).

The pre-tensioning regime consists of the conductor being tensioned to this value for one hour. At 15 minute intervals during this period, the tension shall be adjusted to maintain the pre-tension value. At the end of the period, the conductors shall be tensioned in accordance with the appropriate erection tension table and then terminated. Further details of this process can be found in NSP/004/105.

ii) Over-Tensioning

The reduction of sag due to the increased tension compensates for the increase in sag due to conductor creep during the life of the line. The amount of over tension applied is expressed as an equivalent temperature shift.

The following values have been incorporated into the conductor erection charts.

50CC	-10°C
120 / 185CC	-15°C

iii) Ordinate Shift

The Company utilises the "Optimal, PoleCad Software" to design overhead lines and ensure all statutory clearance requirements have been complied with. The calculations used in the production of ground clearance curves apply a technique of modifying the clearance ordinates by reducing the conductor tension with a percentage reduction. This process builds in a very small hidden safety factor into the clearances. All percentage reduction values are based on an application temperature of 15°C. The following table details the % reduction applicable to each conductor type.

50CC	5%
120/185CC	10%

3.5. Weather Co-ordinate Maps

See ENA TS 43-121 clause 8.0 for details of weather maps.

3.6. Recreational Areas

For the purposes of this specification, recreational areas shall be as described in EATS 43-90 Appendix A, clause A.1"Land Use affecting probability of unauthorised climbing" as below:

a) Children's' Play Areas (authorised an unauthorised):

b) Other recreational areas:

c) Caravan and/or camping sites:

d) Traveller encampments:

e) Chalet type developments where the occupancy is for a short period.

f) Permanent showgrounds for agricultural, festival or similar purposes.

g) Areas with high levels of vandalism or crime

Covered conductors shall be used in place of bare conductors in all recreational areas, together with all fishing areas.

3.7. Survey and Profiling

Survey and profiling shall be carried out in accordance with NSP/004/031. All proposed routes shall be surveyed to ensure conformance with company design and clearance criteria.

The survey data together with the proposed pole type and position shall be presented back to the Company in an electronic design file format for inspection and approval.

The company uses the Optimal Software PoleCad package and will provide any necessary Cell or Conductor Libraries for use with the system.

In addition way-leaves shall be obtained and forwarded together with plans to a 1 : 10,000 scale to enable Form B, Section 37 DTI consents to be applied for.

Upon completion of a satisfactory design and receipt of wayleaves and consents, line schedules shall be produced for construction and line record purposes. All CAD designs shall be given a unique file reference, related to the line feeder route number and archived.

When the line is ready for connection to the Company's distribution system, all network diagrams and asset databases shall be updated.

3.7.1. Conductor Design Checks

a) Proposed lines shall be checked for possible conductor uplift conditions through the use of an unloaded, -6.0°C conductor catenary curve. The check shall ensure that 0.5m exists between the top of the insulator and the cold curve position.

b) Where uplift conditions are designed out of the line, this process shall not result in excessive pole heights (i.e. under normal circumstances due to ground clearance requirements only it is envisaged that poles will not exceed 14m, poles in excess of this value shall be sectioned).

c) Lines shall be checked for conformance with the clearance requirements of clause 3.2.10 of this specification.

3.8. Inspection

All lines shall be inspected prior to commissioning.

4. References

4.1. External Documentation

Reference	Title
BS 3288	"Insulator and Conductor Fittings for Overhead Power Lines"
ENA TS 43-120	Fittings for covered conductors for overhead lines (having rated voltages U0/U greater than 0.6/1 kV up to and including 19/33 kV)
ENA TS 43-121	Specification for single circuit overhead lines of compact covered construction on wood poles for use at high voltage up to and including 33 kV
ENA TS 43-122	XLPE covered conductors for overhead lines (having rated voltages Uo/U greater than 0.6/1 kV up to and including 19/33 kV)
ENA TS 43-40	High Voltage single circuit overhead lines on wood poles – Specification and user guide
ENA TS 43-8	Overhead line clearances
ENA TS 43-88	Selection and treatment of wood poles and associated timber for overhead lines
ENA TS 43-90	Anti-climbing measures and safety signs for overhead lines
ENA TS 43-91	Stay strands and stay fittings for overhead lines
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
ESQCR	The Electricity Safety, Quality and continuity Regulations 2002, SI 2665
BS EN 50397	Covered conductors for overhead lines and the related accessories for rated voltages above 1 kV a.c. and not exceeding 36 kV a.c. Accessories for covered conductors
BS EN 50341	Overhead electrical lines exceeding AC 1 kV : General Requirements - Common Specifications

4.2. Internal Documentation

Reference	Title
MNT/013/001	Code of Practice for Avoidance of Danger from Overhead Electric Lines during Vegetation Management Activities
NPS/001/001	Technical Specification for Wood Poles and Associated Products for Overhead Lines
NPS/001/002	Technical Specification for Helical Products
NPS/001/005	Technical Specification for Overhead Line Steelwork, Conductor Fittings, Insulator Fittings and Stay Fittings
NPS/001/006	Technical Specification for Insulators for Overhead Lines up to and including 132kV
NPS/001/007	Technical Specification for Overhead Line Conductors
NPS/001/010	Technical Specification for Fasteners and Fixings for Wood Pole Overhead Lines and General Construction Works
NPS/001/011	Technical Specification for Notice Plates and Signs
NPS/001/013	Technical Specification for Galvanised Steel Stay Wire
NPS/001/015	Technical Specification for Barbed Wire
NPS/001/016	Technical Specification for Compression and Mechanical Fittings for Overhead Lines
NPS/001/020	Technical Specification for Ground Anchor Systems for Use in Overhead Lines
NPS/001/021	Technical Specification for Overhead Line Tower, Steel Pole and Substation Plant Paint Systems
NSP/004/011	Guidance on Overhead Line Clearances
NSP/004/031	Overhead Line route Survey and profiles
NSP/004/042	Specification for High Voltage Single Circuit Lines on Wood Poles for Voltages up to and including 33kV
NSP/004/104	(OHI 4) Guidance on the Types and Installation Requirements for Stays
NSP/004/105	(OHI 5) Guidance on the selection, erection and sagging of O/H line conductors
NSP/004/106	(OHI 6) Guidance on the Selection and Application of Conductor Joints, Terminations & Binders
NSP/004/107	(OHI 7) Guidance on the selection of conductor jumpers and non-tension connections
NSP/004/109	(OHI 9) Guidance on Anti-Climbing Devices, Safety Signs and Labels Required on Overhead Line Supports

NSP/004/112	(OHI 12) Guidance for the Inspection and Testing of Wood & Steel Poles
NSP/004/120	(OHI 20) Guidance on mounting OHL plant and equipment on HV poles
NSP/004/127	(OHI 27) Guidance on the selection and application of insulators

4.3. Amendments from Previous Version

Reference	Description
Clause 2.0 Scope	Modification to design reference documents – this document has been designed to be in accordance with ENATS 43-121, 43-122 and BS EN 50397-1 for operation at high voltage up to and including 33 kV and designed to the requirements of BS EN 50341-1
Clause 3.2.11 Reduced Tree Clearances	Reduced tree clearance guidance information updated
Clause 3.6 Recreational Areas	List of defined recreational areas where covered conductor normally expected to be used has been updated to more closely follow ENA TS 43-90
Clause 4.1 External Documentation	BS EN 50341 Overhead electrical lines exceeding AC 1 kV : General Requirements - Common Specifications added and BS1990 removed as required technical content added in to ENA TS 43-88 instead
Clause 4.2 Internal Documentation	NPS/001/023 – invalid reference document removed
Whole Document	Updated to current CDS Document Template, including Information Classification

5. Definitions

Term	Definition
Aeolian Vibration	Conductor Oscillation caused by low winds (1 m/s to 7 m/s) blowing steadily across the conductor.
Auxiliary Equipment	Equipment other than that forming part of the design that may be erected 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
Clashing	The electrical contact between two dissimilar line conductors of an overhead line displaced from their normal position by environmental forces such that the conductors are likely to touch.
Compact Covered Conductor	Stranded conductor that has been compacted and served overall with a radial layer of cross linked polyethylene (XLPE)
Conductor Creep	Permanent long-term elongation of the conductor
Conductor Downpull	The vertical loading imposed by conductors corresponding to a gradient measured between adjacent pole tops
Crossarm Hamper	A descriptive term used to include all pole top crossarm components and fixings
Everyday Tension	The design stress in an unloaded conductor at 5°C. Used in sag / tension calculations to limit harmful conductor vibrations
Freezing Point Tension	The design tension of an unloaded conductor at 0°C in still air.
Ice Co-ordinate	The intercept on the ice axis of the weather incidence load line (See ENA TR 111) whose value is given for differing height and UK locations in the associated weather maps
Intermediate Support	A support in a straight run of line on which the conductors are supported on pin insulators.
Maximum Conductor Pressure (MCP)	The maximum transverse component of applied conductor load when subjected to a wind load.
Maximum Conductor Weight (MCW	The maximum vertical component of applied conductor load, including the weight of accreted ice, if present.
Maximum Span	The maximum permitted length of any span

Maximum Working Tension (MWT)	The absolute maximum conductor tension assessed at -5.6°C with wind and ice loading.
Minimum Failing Load	The minimum applied mechanical load that will cause failure by breakage of a component.
OHI	Northern Powergrid Overhead Line Instructions
Over tensioning	Excess tension applied above normal tension at time of erection to compensate for conductor creep.
Pin Angle Support	A support at which a line deviates and the conductors are supported on pin insulators
Pre- tensioning	The tension treatment applied to a conductor for a short duration before final erection tension is established to remove a proportion of conductor creep
Rated Breaking Strength (RBS)	The rating assigned to a component (usually conductors) that defines the maximum mechanical load that the component will withstand without damage.
Recommended Span	The average span length in any section to which the line shall be planned. Individual spans will normally be within +/- 20% of the chosen basic span.
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 insulator sets
Section Support	A support in a straight line on which the conductors are made off on either side of the crossarm on tension insulator sets
Span	The horizontal distance between adjacent supports. Individual spans will normally be within 20% of the chosen basic span
Weather Zone	A geographical area in which the likely mean wind pressure and absolute maximum ice accretion thickness may be described by a numeral and letter, respectively. The wind co-ordinate is described in 190N/m^2 increments, whilst the ice co-ordinate is measured in 10mm diametric thickness increments.
Wind Co-ordinate	The intercept on the wind axis of the weather incidence load line (See ENA TR 111) whose value is given for differing height and UK locations in the associated weather maps
Wind Loading Span	Half the sum of the spans adjacent to the support

6. Authority for Issue

6.1. CDS Assurance

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

		Date
Liz Beat	Governance Administrator	22/05/2023

6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

Review Period - This document should be reviewed within the following time period.

Standard CDS review of 3 years?	Non Standard Review Period & Reason	
Yes	Period: n/a	Reason: n/a
Should this document be displayed on the Northern Powergrid external website?		Yes
		Date
G Hammel	Senior Policy & Standards Manager	23/05/2023

6.3. Technical Assurance

I sign to confirm that I am satisfied with all aspects of the content and preparation of this document and submit it for approval and authorisation.

		Date
Mingyin Chung	Policy and Standards Engineer	23/05/2023
Steve Salkeld	Policy and standards Engineer	23/05/2023

6.4. Authorisation

Authorisation is granted for publication of this document.

		Date
Paul Black	Head of System Engineering	24/05/2023

Appendix 1 - Schedule of Structure Drawings for Use with Covered Conductor Lines

Drawing Number and brief Description	Application
434001	Pole fabrication drawing for all single pole structures
434002	Pole fabrication drawing for all 'H' pole structures
4312103 - Single xarm	Intermediate straight line and pin angles poles
4312104 - Double xarm	Intermediate straight line and pin angles poles
4312106 - Double xarm	Straight line section
4312108 - Double xarm	Angle section 0° - 60°
4312110 - Double xarm	Terminal pole
4312110 sht2 - Double xarm	Terminal pole – fabrication drawing (Single Pole terminal)
4312111 - Single xarm	Tee- off
4312113 - Double xarm	'H' pole angle section 0° - 90°
4312114 - Double xarm	'H' terminal pole

Appendix 2 - Design Tables - 50mm² XLPE Covered - Normal Altitude

Basic Design Span	80	100
Max Span	96	120
FCD Required	No	No
Clashing Weather Zone	2C	2C
Windspan factor of Safety applied to Wood poles	2.5	2.5
Strut Load factor of Safety applied to Wood poles	2.5	2.5

In Line Structures

Drawing No	Support Type	Support Class	Pin Type	Windspan Limit
4312103	Intermediate	Medium	10kN	95m
4312103	Intermediate	Stout	10kN	187m
4312106	Section	Stout	-	187m

Angle Structures

Drawing No.	Support Type	Support Class	Pin Type	Line Deviation	No of Stays
4312103	Pin Angle	Medium	10kN	30°	1 @ 45°
4312103	Pin Angle	Medium	10kN	15°	1 @ 30°
4312103	Pin Angle	Stout	10kN	30°	1 @ 30°
4312108	Sect Angle	Stout	-	60°	2 @ 45°
4312108	Sect Angle	Stout =15m	-	60°	2 @ 30°
4312113	H Sect Angle	Stout H	-	90°	3 @ 45°
4312113	H Sect Angle	Stout H	-	90°	3 @ 30°

Terminal Structures

Drawing No.	Support Type	Support Class	Stays
4312111	Tee Off	Stout	1 @ 45°
4312111	Tee Off	Stout <=15m	2 @ 30°
4312110	Terminal	Stout	1 @ 45°
4312110	Terminal	Stout <=15m	2 @ 30°

- Stay requirements are based on the total number of 7/4.00mm Grade 1150 stays per structure.

Appendix 3 - Design Tables - 120mm² XLPE Covered - Normal Altitude

Basic Design Span	100
Max Span	120
FCD Required	No
Clashing Weather Zone	2C
Windspan factor of Safety Applied to Wood Poles	2.5
Strut load factor of Safety Applied to Wood Poles	2.5

In Line Structures

Drawing No	Support Type	Support Class	Pin Type	Windspan Limit
4312103	Intermediate	Stout	10kN	117m
4312106	Section	E/Stout	-	157m

Angle Structures

Drawing No.	Support Type	Support Class	Pin Type	Line Deviation	Stays
4312103	Pin Angle	Stout	10kN	21°	1 @ 45°
4312103	Pin Angle	Stout <=14m	10kN	21°	1 @ 30°
4312108	Sect Angle	Stout <=13m	-	45°	2 @ 45°
4312108	Sect Angle	Stout <=12m	-	25°	2 @ 30°
4312108	Sect Angle	E/Stout <=16m	-	45°	2 @ 30º
4312108	Sect Angle	E/Stout	-	60°	2 @ 45º
4312108	Sect Angle	E/Stout <=13m	-	60°	2 @ 30º
4312113	H Sect Angle	Stout H	-	90°	3 @ 45°

Terminal Structures

Drawing No.	Support Type	Support Class	Stays
4312110	Terminal	Stout <=11m	2 @ 45°
4312110	Terminal	E/Stout <=13m	2 @ 30°
4312114	Terminal	Stout H <=14m	4 @ 30°

- Stay requirements are based on the total number of 7/4.00mm Grade 1150 stays per structure.

Appendix 4 - Design Tables - 185mm² XLPE Covered- Normal Altitude

Basic Design Span	100
Max Span	120
FCD Required	No
Weather	2C
Windspan factor of safety applied to Wood Poles	2.5
Strut Load factor of safety applied to Wood Poles	2.5

In Line Structures

Drawing No	Support Type	Support Class	Pin Type	Windspan Limit
4312103	Intermediate	Stout	10kN	107m
4312103	Intermediate	E/Stout	10kN	144m
4312106	Section	E/Stout	10kN	144m

Angle Structures

Drawing No.	Support Type	Support Class	Pin Type	Line Deviation	Stays
4312103	Pin Angle	Stout	10kN	15°	1 @ 45º
4312103	Pin Angle	Stout <=13m	10kN	15°	1 @ 30º
4312108	Sect Angle	Stout	-	28°	1 @ 45°
4312108	Sect Angle	E/Stout	-	43°	2 @ 45°
4312108	Sect Angle	E/Stout <=13m	-	43°	2 @ 30°
4312108	Sect Angle	E/Stout	-	60°	3 @ 45°
4312113	H Sect Angle	Stout H <=11m	-	60°	4 @ 30°
4312113	H Sect Angle	Stout H <=13m	-	60°	4 @ 35°
4312113	H Sect Angle	Stout H <=14m	-	90°	4 @ 45°

Terminal Structures

Drawing No.	Support Type	Support Class	Stays
4312114	Terminal	E/Stout	3 @ 45°
4312114	Terminal	Stout H	4 @ 45°
4312114	Terminal	Stout H <=13m	4 @ 35°

- Stay requirements are based on the total number of 7/4.00mm Grade 1150 stays per structure.

Appendix 5 - Design Tables - 50mm² XLPE Covered - High Altitude

Basic Design Span	90
Max Clashing Span *	108
FCD Required	No
Clashing Weather Zone	3C
Windspan factor of safety applied to Wood Poles	3.0
Strut Load factor of safety applied to Wood Poles	2.5

In Line Structures

Drawing No	Support Type	Support Class	Pin Type	Windspan Limit
4312103	Intermediate	Medium	10kN	78m
4312103	Intermediate	Stout	10kN	153m
4312106	Section	Stout	-	153m

Angle Structures

Drawing No.	Support Type	Support Class	Pin Type	Line Deviation	Stays
4312103	Pin Angle	Medium	10kN	30°	1 @ 45°
4312103	Pin Angle	Stout	10kN	30°	1 @ 30°
4312108	Sect Angle	Stout	-	45°	1 @ 45°
4312108	Sect Angle	Stout	-	45°	1 @ 30°
4312108	Sect Angle	Stout	-	60°	1 @ 45°
4312108	H Sect Angle	Stout	-	60°	1 @ 30°
4312113	H Sect Angle	Stout H	-	90°	3 @ 45°

Terminal Structures

Drawing No.	Support Type	Support Class	Stays
4312111	Tee Off	Stout	1 @ 45°
4312111	Tee Off	Stout	1 @ 30°
4312110	Terminal	Stout	1 @ 45°
4312110	Terminal	Stout	1 @ 30°

- * Spanning has been constrained to 108m spans to provide a more robust design in this more aggressive environment. Since conductor clashing is not an issue with his conductor, alternative larger basic spans can be provided to utilise the abilities of the stout grade pole.
- Stay requirements are based on the total number of 7/4.00mm Grade 1150 stays per structure.

Appendix 6 - Design Tables - 120mm² XLPE Covered - High Altitude

Basic Design Span	80
Max Clashing Span	96
FCD Required	No
Clashing Weather Zone	3C
Windspan factor of safety applied to Wood Poles	2.0
Strut Load factor of safety applied to Wood Poles	2.5

In Line Structures

Drawing No	Support Type	Support Class	Pin Type	Windspan Limit
4312104	Intermediate	Stout	10kN	82m
4312104	Intermediate	E/Stout	10kN	115m
4312106	Section	E/Stout	-	115m
4312113	Section H	Stout H	10kN	160m

Angle Structures

Drawing No.	Support Type	Support Class	Pin Type	Line Deviation	Stays
4312104	Pin Angle	Stout	10kN	14°	1 @ 45°
4312104	Pin Angle	Stout <=13m	10kN	14°	1 @ 30º
4312108	Sect Angle	Stout <=15m	-	29°	1 @ 45°
4312108	Sect Angle	E/Stout	-	29°	2 @ 30°
4312108	Sect Angle	E/Stout	-	45°	2 @ 45°
4312108	Sect Angle	E/Stout <=13m	-	45°	2 @ 30°
4312113	H Sect Angle	Stout H	-	60°	3 @ 45°
4312113	H Sect Angle	Stout H <=14m	-	60°	4 @ 35°
4312113	H Sect Angle	Stout H <=16m		90°	4 @ 45°

Terminal Structures

Drawing No.	Support Type	Support Class	Stays
4312110	Terminal	E/Stout	2 @ 45°
4312110	Terminal	E/Stout <=12m	3 @ 30°
4312114	Terminal	Stout H	4 @ 45°
4312114	Terminal	Stout H <=14m	4 @ 35°

- Stay requirements are based on the total number of 7/4.00mm Grade 1150 stays per structure.

Appendix 7 - Design Tables - 185mm^2 XLPE Covered - High Altitude

Basic Design Span	80	90
Max Clashing Span	96	108
FCD Required	No	No
Clashing Weather Zone	3C	3C
Windspan factor of safety applied to Wood Poles	2.0	2.0
Strut load factor of safety applied to Wood Poles	2.5	2.5

In Line Structures

Drawing No	Support Type	Support Class	Pin Type	Windspan Limit
4312103	Intermediate	E/Stout	10kN	103m
4312106	Section	E/Stout	-	103m
43121113	Section	Stout H	-	152m

Angle Structures

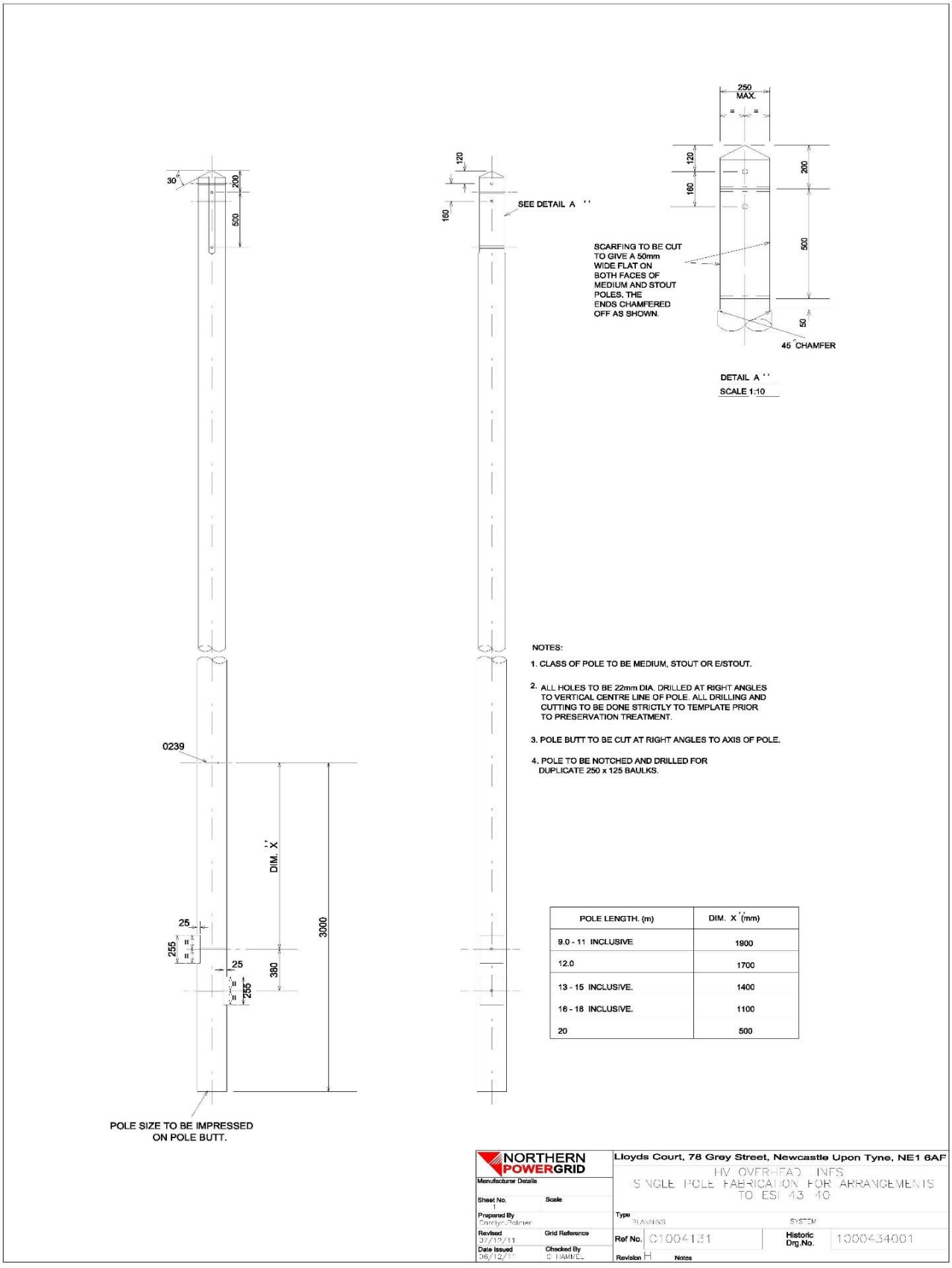
Drawing No.	Support Type	Support Class	Pin Type	Line Deviation	Stays
4312103	Pin Angle	E/Stout	10kN	10°	1 @ 45°
4312103	Pin Angle	E/Stout	10kN	10°	1 @ 30º
4312108	Sect Angle	E/Stout	-	19°	1 @ 45°
4312108	Sect Angle	E/Stout <=17m	-	19°	2 @ 30°
4312108	Sect Angle	E/Stout <=16m	-	45°	2 @ 45°
4312108	Sect Angle	E/Stout <=12m	-	45°	2 @ 30°
4312113	H Sect Angle	Stout H <=16m	-	60°	4 @ 45°
4312113	H Sect Angle	Stout H <=13m	-	60°	4 @ 40°
4312113	H Sect Angle	Stout H <=11m	-	90°	4 @ 45°

Terminal Structures

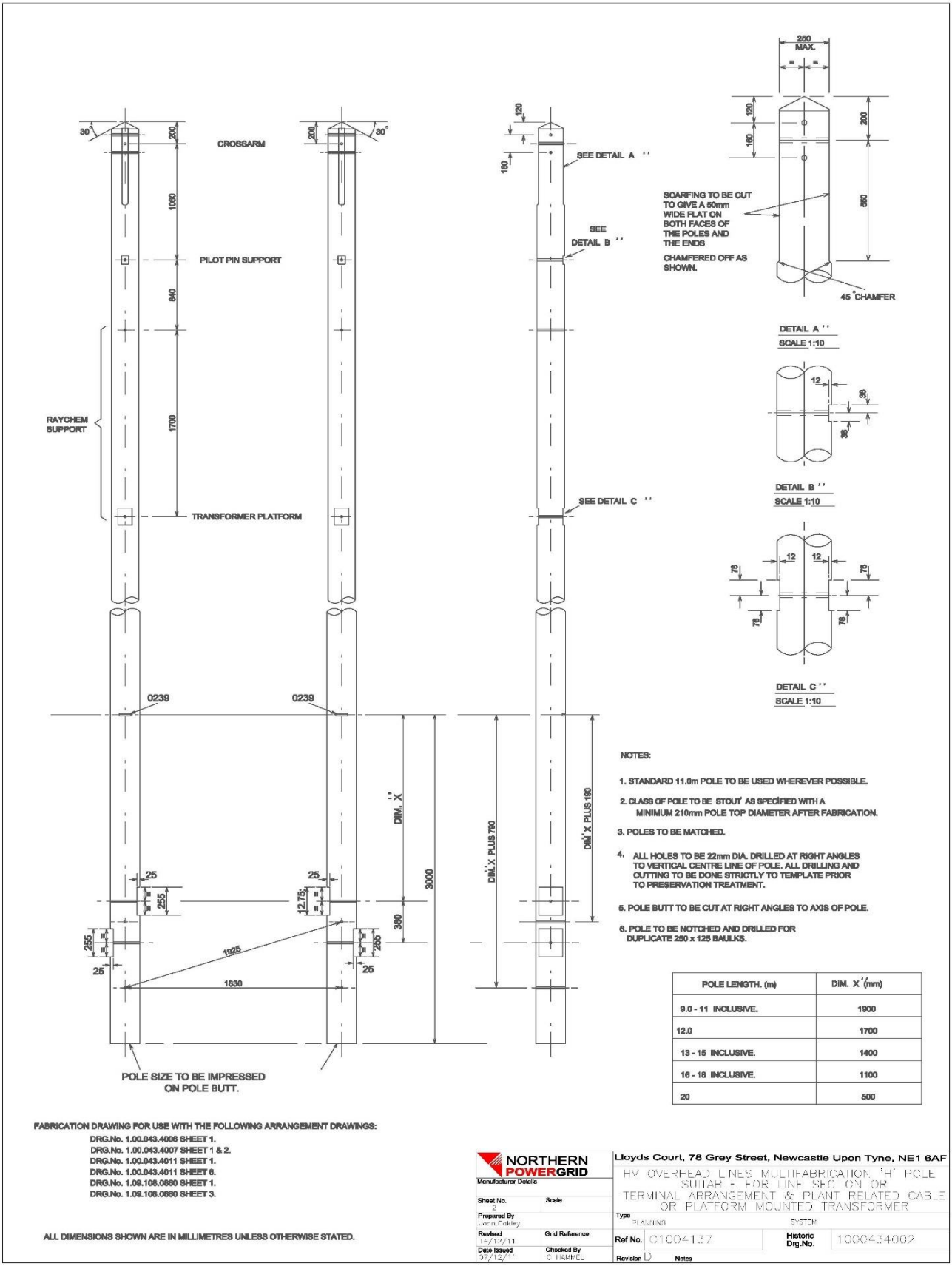
Drawing No.	Support Type	Support Class	Stays
4312114	Terminal	Stout H <=16m	4 @ 45°
4312114	Terminal	Stout H <=13m	4 @ 40°

- Stay requirements are based on the total number of 7/4.00mm Grade 1150 stays per structure.

Appendix 8 - Arrangement Drawings and Materials Lists



POLE LENGTH. (m)	DIM. X ''(mm)
9.0 - 11 INCLUSIVE	1900
12.0	1700
13 - 15 INCLUSIVE.	1400
16 - 18 INCLUSIVE.	1100
20	500

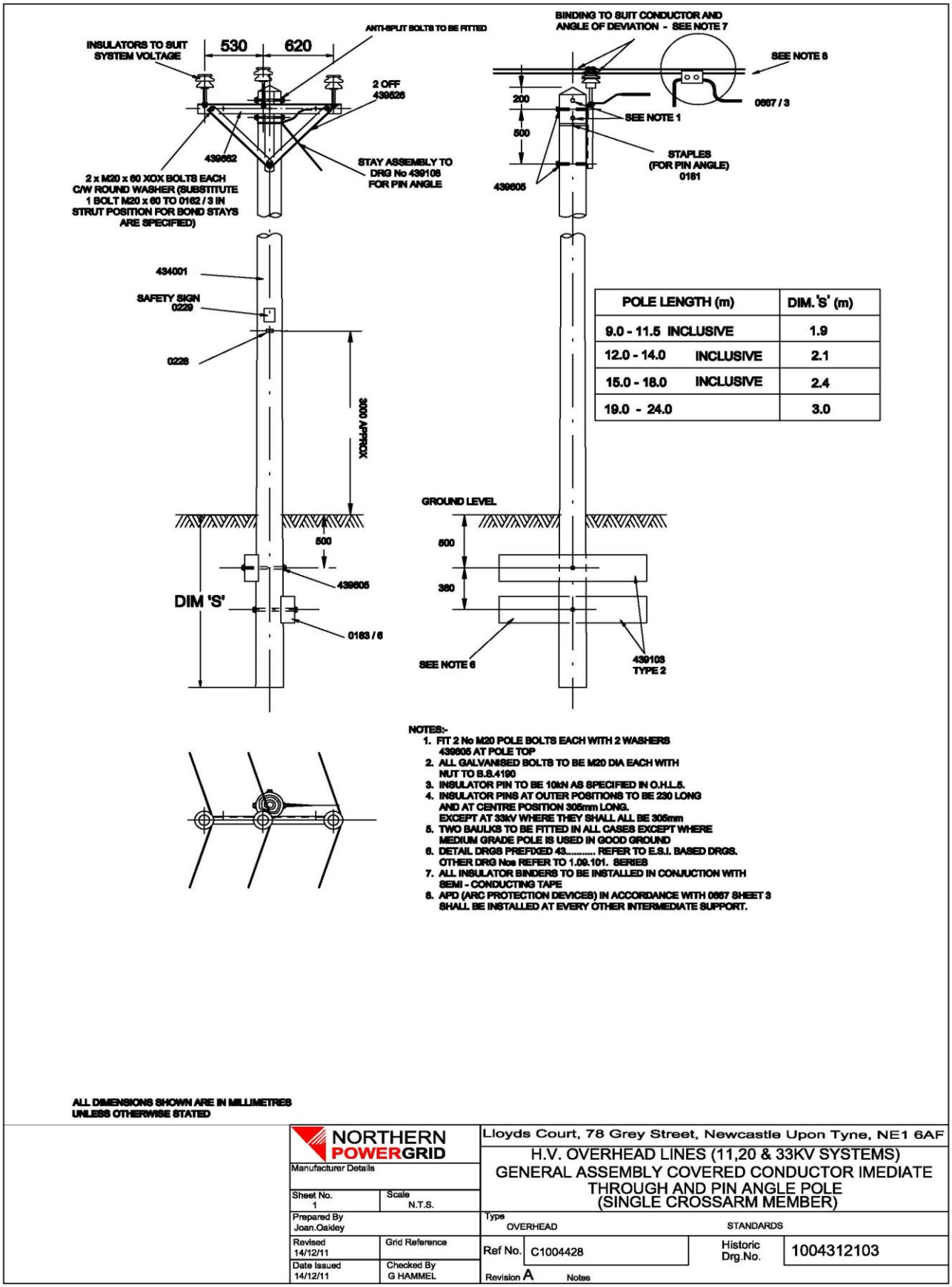


POLE LENGTH. (m)	DIM. X'' (mm)
9.0 - 11 INCLUSIVE.	1900
12.0	1700
13 - 15 INCLUSIVE.	1400
16 - 18 INCLUSIVE.	1100
20	500

COMPONENT	DRAWING NO	QUANTITY				CAT NO
		11 & 20 kV		33 kV		
		Strt Line (PS)	Pin Angle (PA)	Strt Line (PS)	Pin Angle (PA)	
Wood Pole	434001	1	1	1	1	-
Kicking Blocks	439103 Type 2	2	2	2	2	235124
Bolts M20 x 400 (Medium)		2	2	2	2	372904 or
Bolts, M20 x 530 (Stout)	-	2	2	2	2	372815
Washer, Square, Flat	0183/6	2	2	2	2	368063
Washer, Square, Curved	439605	2	2	2	2	368078
Crossarm Member	439562	1	1	1	1	251475
Crossarm Strut	439526	2	2	2	2	237581
Bolts, M20 x 220 (Medium)	-	4	4	4	4	378756 or
Bolts, M20 x 300 (Stout)	-	4	4	4	4	378794
Bolts, M20 x 60	-	2	1	2	1	378703
Bolts, M20 x 60 (Earthing)	0162/3	-	1	-	1	370504
Washers, Round, M20	-	2	2	2	2	375616
Washers, Square, Curved	439605	6	6	6	6	368078
Pin Insulators (as specified)						
70 kV Rating (All 11 and 20kV earthed & unearthed poles)	0486/13	3	3	-	-	253833
90kV Rating (33kV)	0486/4	-	-	3	3	253423
Insulator Pins, 50 mm shank (as specified)						
10 kN, 230 mm stalk	0527/1	2	2	-	-	261824
10 kN, 305 mm stalk	0527/2	1	1	3	3	261843
Distribution Ties (See Work Specs)						
04/043 PS (select pole type)	0660	3	-	3	-	See drawing for details
04/042 PA	0662	-	3	-	3	
Semi conducting Tape (20mm * 5m rolls)		2	2	2	2	365328
Arc Protection Devices (every other pole)	0667/3	3	3	3	3	243991
Notices (See Work Spec 04/055)	-	As spcd	As spcd	As spcd	As spcd	See work spec
Stays (See Work Specs 04/027 & 04/028)	-	-	As spcd	-	As spcd	See work spec
Wood Plugs 24 mm x 75 mm Long (where required)	0247/3	2	2	2	2	263073

11 kV, 20 kV & 33 kV OVERHEAD THREE PHASE LINES
STRAIGHT LINE OR PIN ANGLE POLE (SINGLE MEMBER CROSSARM)

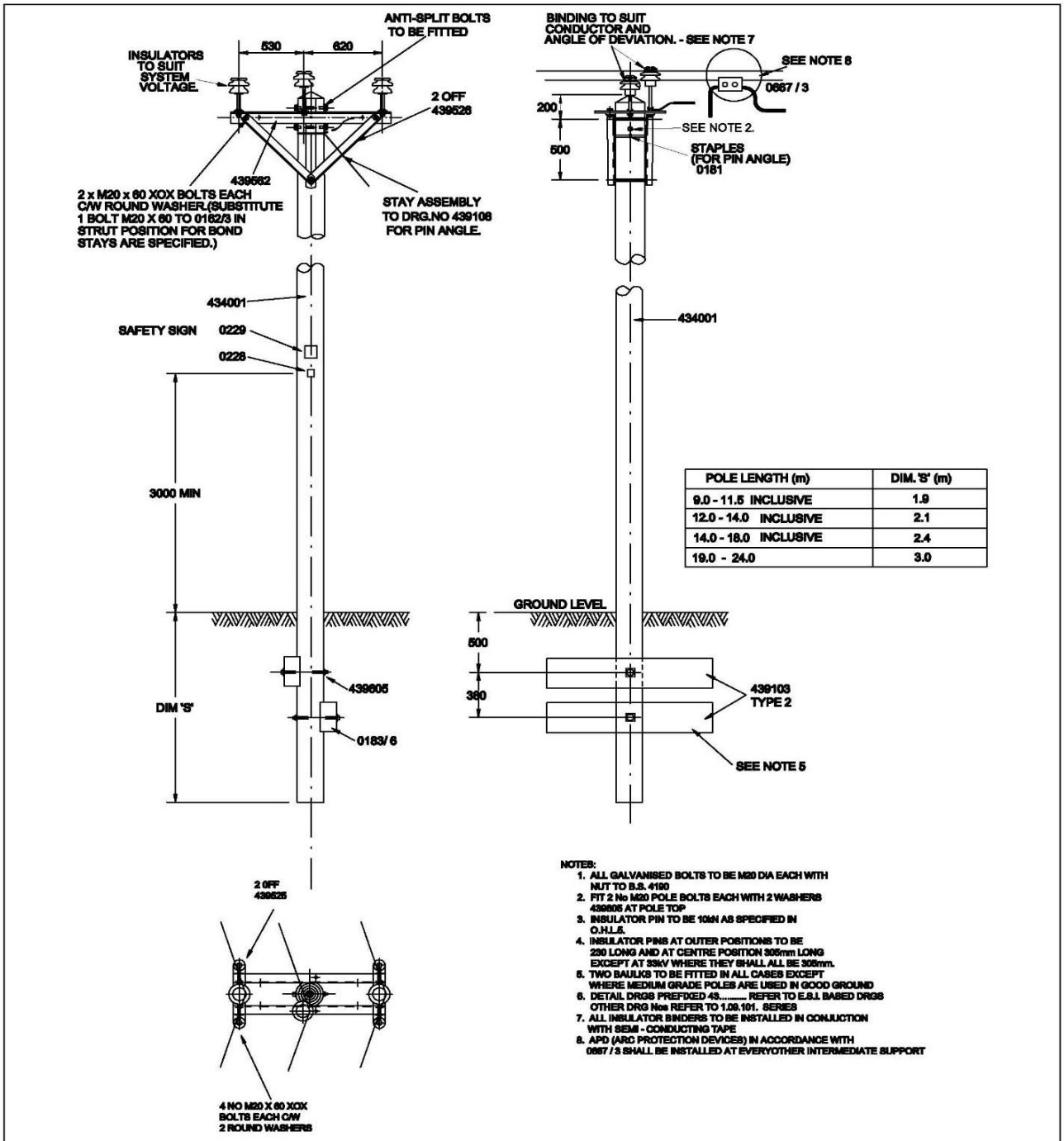
Drg No 1.00.431.2103


INSULATORS TO SUIT SYSTEM VOLTAGE
530
620
ANTI-SPLIT BOLTS TO BE FITTED
2 OFF 439626
439602
2 x M20 x 60 XOX BOLTS EACH C/W ROUND WASHER (SUBSTITUTE 1 BOLT M20 x 60 TO 0162 / 3 IN STRUT POSITION FOR BOND STAYS ARE SPECIFIED)
STAY ASSEMBLY TO DRG No 439108 FOR PIN ANGLE
BINDING TO SUIT CONDUCTOR AND ANGLE OF DEVIATION - SEE NOTE 7
SEE NOTE 8
0667 / 3
200
500
SEE NOTE 1
STAPLES (FOR PIN ANGLE) 0161
439605
434001
SAFETY SIGN 0229
0228
3000 APPROX
500
439605
DIM 'S'
0163 / 6
GROUND LEVEL
500
380
SEE NOTE 6
439103 TYPE 2
POLE LENGTH (m) | DIM. 'S' (m)
9.0 - 11.5 INCLUSIVE | 1.9
12.0 - 14.0 INCLUSIVE | 2.1
15.0 - 18.0 INCLUSIVE | 2.4
19.0 - 24.0 | 3.0
NOTES:-
1. FIT 2 No M20 POLE BOLTS EACH WITH 2 WASHERS 439605 AT POLE TOP
2. ALL GALVANISED BOLTS TO BE M20 DIA EACH WITH NUT TO B.S.4190
3. INSULATOR PIN TO BE 10kN AS SPECIFIED IN O.H.L.S.
4. INSULATOR PINS AT OUTER POSITIONS TO BE 230 LONG AND AT CENTRE POSITION 305mm LONG. EXCEPT AT 33kV WHERE THEY SHALL ALL BE 305mm
5. TWO BAULKS TO BE FITTED IN ALL CASES EXCEPT WHERE MEDIUM GRADE POLE IS USED IN GOOD GROUND
6. DETAIL DRGS PREFIXED 43..... REFER TO E.S.I. BASED DRGS. OTHER DRG Nos REFER TO 1.09.101. SERIES
7. ALL INSULATOR BINDERS TO BE INSTALLED IN CONJUCTION WITH SEMI - CONDUCTING TAPE
8. APD (ARC PROTECTION DEVICES) IN ACCORDANCE WITH 0667 SHEET 3 SHALL BE INSTALLED AT EVERY OTHER INTERMEDIATE SUPPORT.
ALL DIMENSIONS SHOWN ARE IN MILLIMETRES UNLESS OTHERWISE STATED
NORTHERN POWERGRID
Manufacturer Details
Lloyds Court, 78 Grey Street, Newcastle Upon Tyne, NE1 6AF
H.V. OVERHEAD LINES (11,20 & 33KV SYSTEMS)
GENERAL ASSEMBLY COVERED CONDUCTOR IMEDIATE THROUGH AND PIN ANGLE POLE (SINGLE CROSSARM MEMBER)
Sheet No. 1
Scale N.T.S.
Prepared By Joan.Oakley
Type OVERHEAD
STANDARDS
Revised 14/12/11
Grid Reference
Ref No. C1004428
Historic Drg.No. 1004312103
Date Issued 14/12/11
Checked By G HAMMEL
Revision A
Notes

COMPONENT	DRAWING NO	QUANTITY				CAT NO
		11 & 20 kV		33 kV		
		Strt Line (PS)	Pin Angle (PA)	Strt Line (PS)	Pin Angle (PA)	
Wood Pole	434001	1	1	1	1	-
Kicking Blocks	439103 Type 2	2	2	2	2	235124
Bolts, M20 x 400 (Medium)		2	2	2	2	372904 or
Bolts, M20 x 530 (Stout)	-	2	2	2	2	372815
Washer, Square, Flat	0183/6	2	2	2	2	368063
Washer, Square, Curved	439605	2	2	2	2	368078
Crossarm Member	439562	2	2	2	2	251475
Crossarm Strut	439526	4	4	4	4	237581
Section Strap	439525	2	2	2	2	237609
Bolts, M20 x 220 (Medium)	-	4	4	4	4	378756 or
Bolts, M20 x 300 (Stout)	-	4	4	4	4	378794
Bolts, M20 x 60 (Earthing)	0162/3	-	1	-	1	370504
Bolts, M20 x 60 (sc'd 46)	-	8	7	8	7	378703
Washers, Round, M20	-	14	14	14	14	375616
Washers, Square, Curved	439605	4	4	4	4	368078
Pin Insulators (as specified)						
70 kV Rating (All 11 and 20kV earthed & unearthed poles)	0486/13	3	3	-	-	253833 or
90kV Rating (33 kV)	0486/4	-	-	3	3	253423 or
Insulator Pins, (as specified)						
10 kN, 230 mm stalk	0527/1	2	2	-	-	261824
10 kN, 305 mm stalk	0527/2	1	1	3	3	261843
Distribution Ties (See Work Specs)	-					
04/043 PS 04/042 PA	0660 0662	3 -	- 3	3 -	- 3	See drawing for details
Semi conducting Tape (20mm * 5m rolls)		2	2	2	2	365328
Arc Protection Devices (every other pole)	0667/3	3	3	3	3	243991
Notices (See Work Spec 04/055)	-	As spcd	As spcd	As spcd	As spcd	See work spec
Stays (See Work Specs 04/027 & 04/028)	-	As spcd	As spcd	As spcd	As spcd	See work spec
Wood Plugs 24 mm x 75 mm Long (if Required)	0247/3	2	2	2	2	263073

11 kV, 20 kV & 33 kV OVERHEAD LINES
THREE PHASE STRAIGHT LINE OR PIN ANGLE POLE (DOUBLE MEMBER CROSSARM)

Drg No 1.00.431.2104 Sheet 1



POLE LENGTH (m)	DIM. 'S' (m)
9.0 - 11.5 INCLUSIVE	1.9
12.0 - 14.0 INCLUSIVE	2.1
14.0 - 18.0 INCLUSIVE	2.4
19.0 - 24.0	3.0

NOTES:
1. ALL GALVANISED BOLTS TO BE M20 DIA EACH WITH NUT TO B.S. 4190
2. FIT 2 No M20 POLE BOLTS EACH WITH 2 WASHERS 439605 AT POLE TOP
3. INSULATOR PIN TO BE 10kN AS SPECIFIED IN O.H.L.S.
4. INSULATOR PINS AT OUTER POSITIONS TO BE 230 LONG AND AT CENTRE POSITION 305mm LONG EXCEPT AT 33kV WHERE THEY SHALL ALL BE 305mm.
5. TWO BAULKS TO BE FITTED IN ALL CASES EXCEPT WHERE MEDIUM GRADE POLES ARE USED IN GOOD GROUND
6. DETAIL DRGS PREFIXED 43..... REFER TO E.S.I. BASED DRGS OTHER DRG Nos REFER TO 1.09.101. SERIES
7. ALL INSULATOR BINDERS TO BE INSTALLED IN CONJUCTION WITH SEMI - CONDUCTING TAPE
8. APD (ARC PROTECTION DEVICES) IN ACCORDANCE WITH 0667 / 3 SHALL BE INSTALLED AT EVERYOTHER INTERMEDIATE SUPPORT

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED

NORTHERN POWERGRID
Manufacturer Details

Lloyds Court, 78 Grey Street, Newcastle Upon Tyne, NE1 6AF

H.V. OVERHEAD LINES (11,20 & 33KV SYSTEMS)
GENERAL ASSEMBLY COVERED CONDUCTOR
INTERMEDIATE THROUGH & PIN ANGLE POLE
(DOUBLE CROSSARM MEMBER)

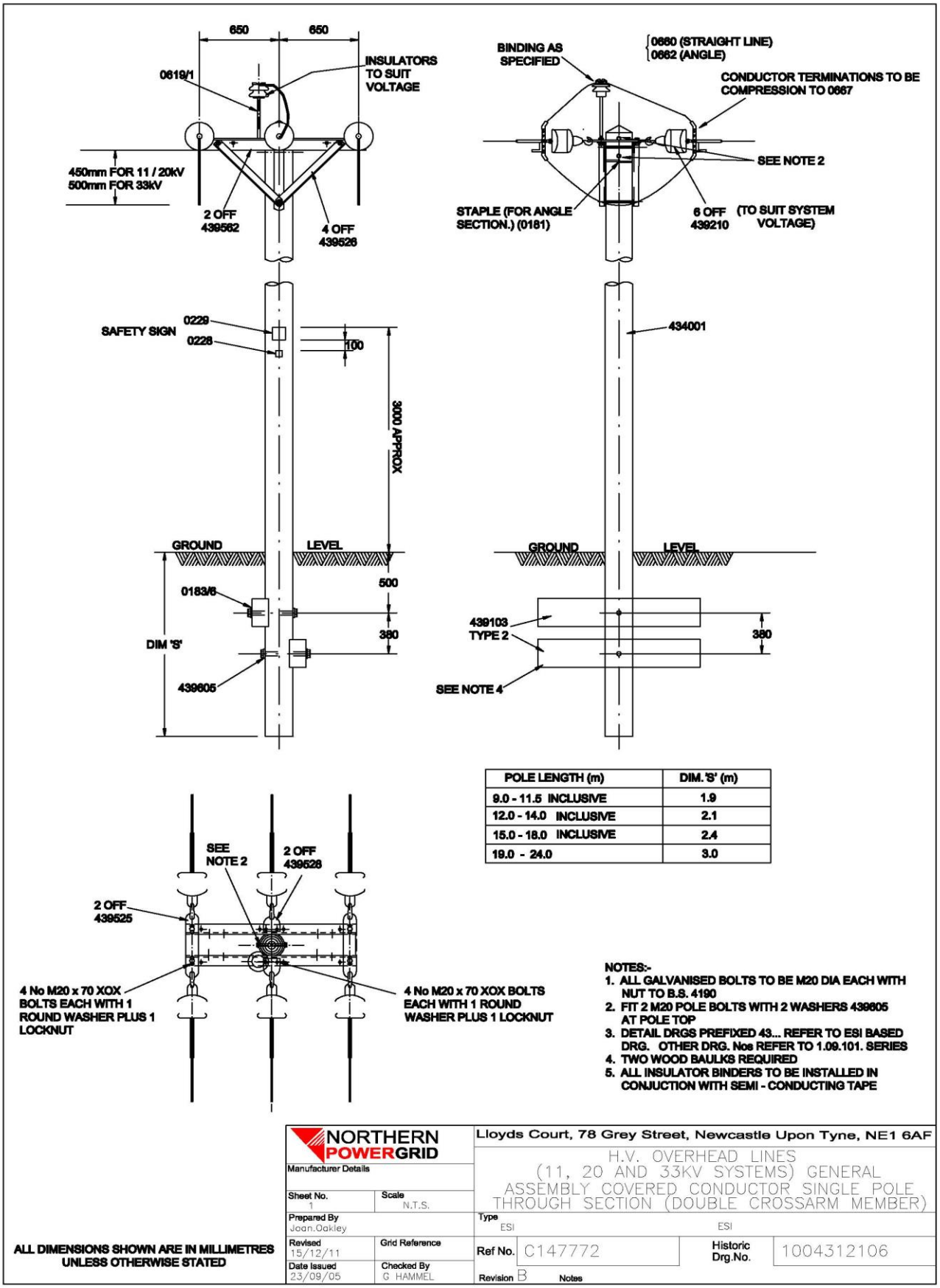
Sheet No. 1	Scale N.T.S.
Prepared By Joan.Oakley	
Revised 14/12/11	Grid Reference
Date Issued 14/12/11	Checked By G HAMMEL

Type OVERHEAD STANDARDS
Ref No. C1004431
Historic Drg.No. 1004312104
Revision A Notes

COMPONENT	DRAWING NO	QUANTITY			CAT NO.
		11kV	20Kv	33kV	
Wood Pole	434001	1	1	1	-
Kicking Block	439103 Type 2	2	2	2	235124
Bolts, M20 x 400 (Medium)		2	2	2	372904 or
Bolts, M20 x 530 (Stout)	-	2	2	2	372815
Washer, Square, Flat	0183/6	2	2	2	368063
Washer, Square, Curved	439605	2	2	2	368078
Crossarm Member	439562	2	2	2	251475
Crossarm Strut	439526	4	4	4	237581
Section Strap	439525	2	2	2	237609
Terminating Plate	439528	2	2	2	237596
Bolts, M20 x 220 (Medium)	-	4	4	4	378756 or
Bolts, M20 x 300 (Stout)	-	4	4	4	378794
Bolts, M20 x 60 (sc'd 30)	-	4	4	4	378703
Bolts, M20 x 70 (sc'd 46)	-	8	8	8	373911
Bolts, M20 x 60 (Earthing)	0162/3	-	-	-	370504
Washers, Round, M20	-	22	22	22	375616
Washers, Square, Curved	439605	4	4	4	368078
Nuts M20	-	8	8	8	378915
Pin Insulators (as specified)					
70 kV Rating (All 11 and 20kV earthed & unearthed poles)	0486/13	1	-	-	25333
90 Rating (33kV)	0486/4	-	-	1	253423
Semi conducting Tape (20mm * 5m rolls)		2	2	2	365328
Pilot Pins	0619/1	1	1	1	261909
Distribution Ties	0660	1	1	1	-
Tension Set Assemblies Comprising:					-
70kV Composite Insulator (11 & 20kV)	0487/24	-	6	-	253706 or
90kV Composite Insulator (33kV)	0487/23	-	-	6	216150
439210 Assy 1 or 2 Comprising:					
Ball Ended Hook	0454	6	6	-	253071
Compression Termination	0667/1	6	6	-	235764
Jumper Lug *	0102/9	6	6	-	As rqd
Or					
439210 Assy 3 Comprising: (33 kV only)					
Ball Ended Hook	0445	-	-	6	253086
Socket Tongue	0449	-	-	6	250779
Ball Clevis	0456	-	-	6	248586
Arc Horn	0494/4	-	-	6	240480
Arc Horn	0494/6	-	-	6	240264
Compression Termination	0667/1	-	-	6	235764
Jumper Lug *	0102/8	-	-	6	As rqd
Non Tension Joints	-	3	3	3	To Suit
Notices (See OHI 9)	-	-	-	-	To Suit

11 kV 20 kV 33 kV OVERHEAD LINES
SINGLE POLE, STRAIGHT LINE SECTION SUPPORT

Drg No 1.00.431.2106 Sheet 1



POLE LENGTH (m)	DIM. 'S' (m)
9.0 - 11.5 INCLUSIVE	1.9
12.0 - 14.0 INCLUSIVE	2.1
15.0 - 18.0 INCLUSIVE	2.4
19.0 - 24.0	3.0

NOTES:-
1. ALL GALVANISED BOLTS TO BE M20 DIA EACH WITH NUT TO B.S. 4190
2. FIT 2 M20 POLE BOLTS WITH 2 WASHERS 439605 AT POLE TOP
3. DETAIL DRGS PREFIXED 43... REFER TO ESI BASED DRG. OTHER DRG. Nos REFER TO 1.09.101. SERIES
4. TWO WOOD BAULKS REQUIRED
5. ALL INSULATOR BINDERS TO BE INSTALLED IN CONJUCTION WITH SEMI - CONDUCTING TAPE

ALL DIMENSIONS SHOWN ARE IN MILLIMETRES UNLESS OTHERWISE STATED

NORTHERN POWERGRID
Manufacturer Details

Lloyds Court, 78 Grey Street, Newcastle Upon Tyne, NE1 6AF

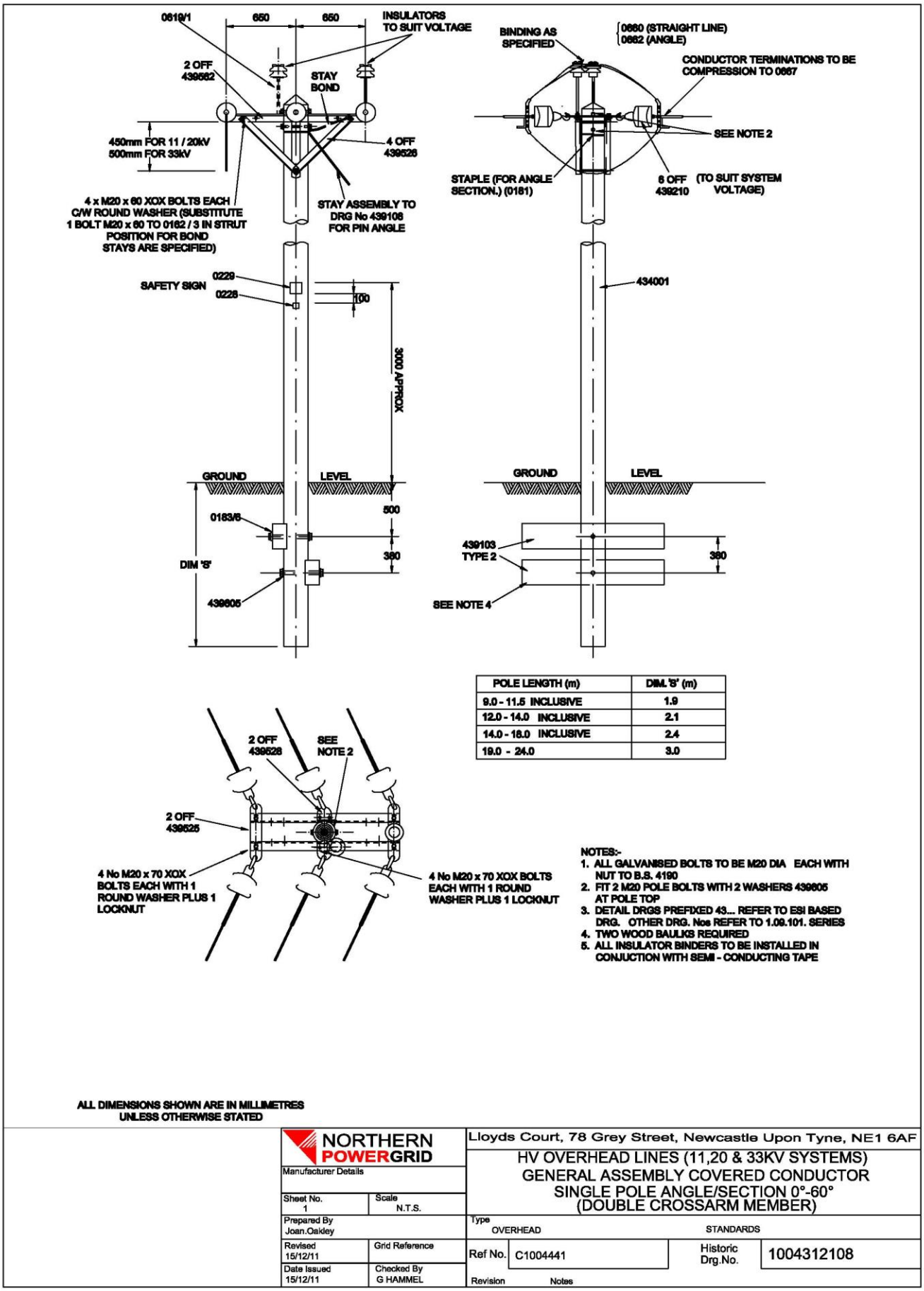
H.V. OVERHEAD LINES
(11, 20 AND 33KV SYSTEMS) GENERAL
ASSEMBLY COVERED CONDUCTOR SINGLE POLE
THROUGH SECTION (DOUBLE CROSSARM MEMBER)

Sheet No. 1	Scale N.T.S.
Prepared By Joan.Oakley	Type ESI ESI
Revised 15/12/11	Grid Reference
Date Issued 23/09/05	Checked By G HAMMEL
Ref No. C147772	Historic Drg.No. 1004312106
Revision B	Notes

COMPONENT	DRAWING NO	QUANTITY			CAT NO.
		11kV	20Kv	33kV	
Wood Pole	434001	1	1	1	-
Kicking Block	439103 Type 2	2	2	2	235124
Bolts, M20 x 400 (Medium)		2	2	2	372904 or
Bolts, M20 x 530 (Stout)	-	2	2	2	372815
Washer, Square, Flat	0183/6	2	2	2	368063
Washer, Square, Curved	439605	2	2	2	368078
Crossarm Member	439562	2	2	2	251478
Crossarm Strut	439526	4	4	4	237581
Section Strap	439525	2	2	2	237609
Terminating Plate	439528	2	2	2	237596
Bolts, M20 x 220 (Medium)	-	4	4	4	378756 or
Bolts, M20 x 300 (Stout)	-	4	4	4	378794
Bolts, M20 x 60 (sc'd 30)	-	4	4	4	378703
Bolts, M20 x 70 (sc'd 46)	-	8	8	8	373911
Bolts, M20 x 60 (Earthing)	0162/3	-	-	-	370504
Washers, Round, M20	-	22	22	22	375616
Washers, Square, Curved	439605	4	4	4	368078
Nuts M20	-	8	8	8	378915
Pin Insulators (as specified)					
50kV Rating (11 and 20kV)	0486/12	1	-	-	253701
50kV Rating (20kV earthed poles only)	0486/14	-	1	-	253833
90 Rating (33kV)	0486/4	-	-	1	253423
Pilot Pins	0619/1	2	2	2	261909
Distribution Ties	0660	2	2	2	-
Semi-conducting tape	-	**2**	**2**	2	365328
Tension Set Assemblies Comprising:					-
70kV Composite Insulator (11 & 20kV)	0487/24	-	6	-	253706 or
90kV Composite Insulator (33kV)	0487/23	-	-	6	216150
439210 Assy 1 or 2 Comprising:					
Ball Ended Hook	0454	6	6	-	253071
Compression Termination	0667/1	6	6	-	235764
Jumper Lug *	0102/9	6	6	-	As rqd
Or					
439210 Assy 3 Comprising: (33 kV only)					
Ball Ended Hook	0445	-	-	6	253086
Socket Tongue	0449	-	-	6	250779
Ball Clevis	0456	-	-	6	248586
Arc Horn	0494/4	-	-	6	240480
Arc Horn	0494/6	-	-	6	240264
Compression Termination	0667/1	-	-	6	235764
Jumper Lug *	0102/8	-	-	6	As rqd
Non-Tension Joints	-	3	3	3	To Suit
Notices (See OHI 9)	-	-	-	-	To Suit

11 kV 20 kV 33 kV OVERHEAD LINES
SINGLE POLE, SECTION ANGLE SUPPORT

Drg No 1.00.431.2108 Sheet 1



POLE LENGTH (m)	DIM. 'S' (m)
9.0 - 11.5 INCLUSIVE	1.9
12.0 - 14.0 INCLUSIVE	2.1
14.0 - 18.0 INCLUSIVE	2.4
19.0 - 24.0	3.0

NOTES:-
1. ALL GALVANISED BOLTS TO BE M20 DIA EACH WITH NUT TO B.S. 4190
2. FIT 2 M20 POLE BOLTS WITH 2 WASHERS 439605 AT POLE TOP
3. DETAIL DRGS PREFIXED 43... REFER TO ESI BASED DRG. OTHER DRG. Nos REFER TO 1.09.101. SERIES
4. TWO WOOD BAULKS REQUIRED
5. ALL INSULATOR BINDERS TO BE INSTALLED IN CONJUCTION WITH SEMI - CONDUCTING TAPE

ALL DIMENSIONS SHOWN ARE IN MILLIMETRES UNLESS OTHERWISE STATED

NORTHERN POWERGRID
Manufacturer Details

Lloyds Court, 78 Grey Street, Newcastle Upon Tyne, NE1 6AF

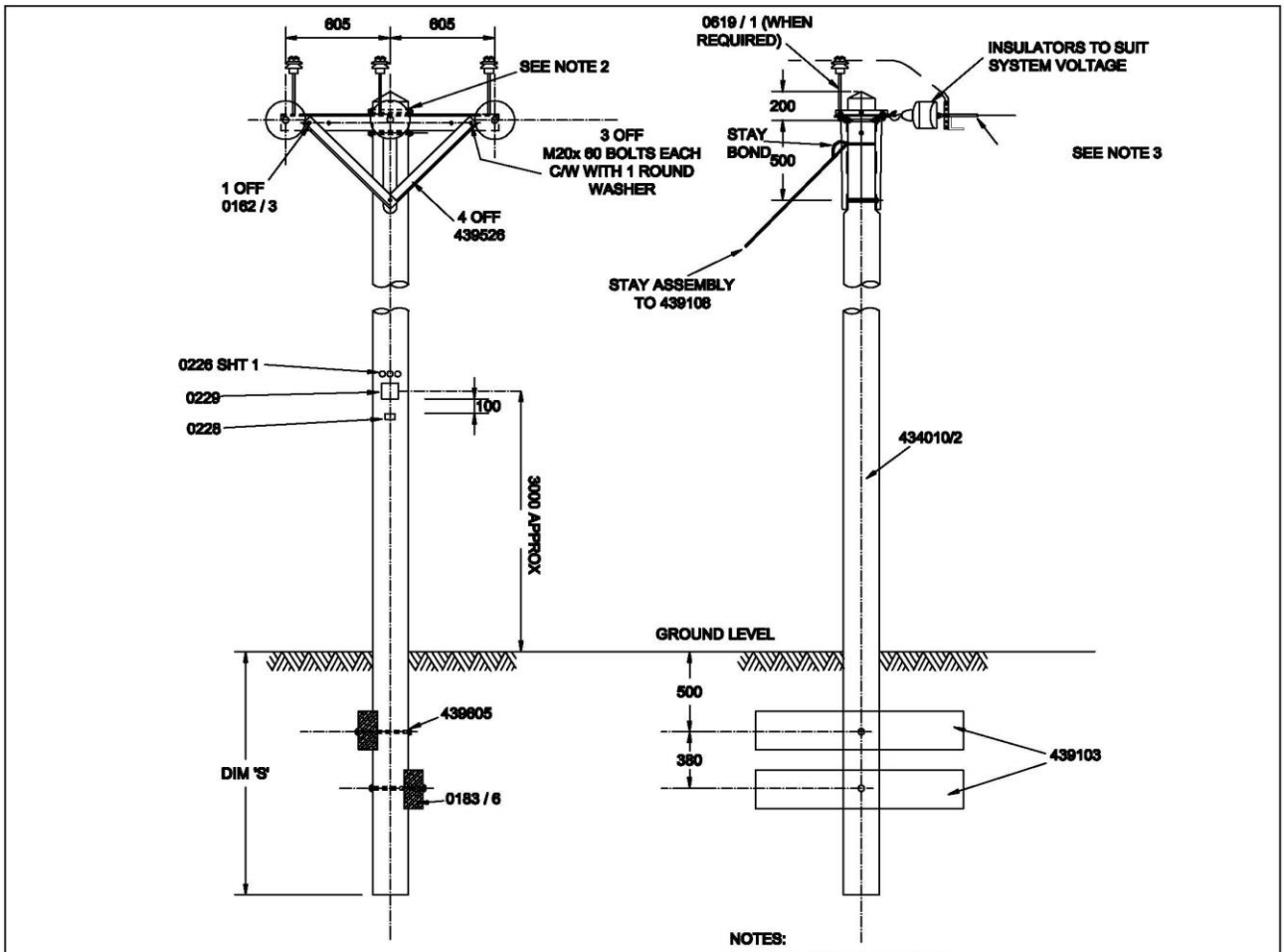
HV OVERHEAD LINES (11,20 & 33KV SYSTEMS)
GENERAL ASSEMBLY COVERED CONDUCTOR
SINGLE POLE ANGLE/SECTION 0°-60°
(DOUBLE CROSSARM MEMBER)

Sheet No. 1	Scale N.T.S.	Type OVERHEAD	STANDARDS
Prepared By Joan.Oakley			
Revised 15/12/11	Grid Reference	Ref No. C1004441	Historic Drg.No. 1004312108
Date Issued 15/12/11	Checked By G HAMMEL	Revision	Notes

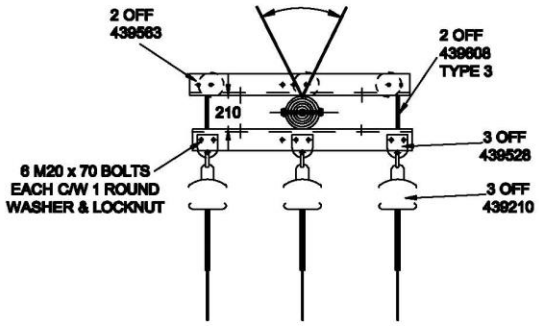
COMPONENT	DRAWING NO	QUANTITY					CAT NO
		2 WIRE				3 WIRE	
Wood Pole, Stout Grade	434010 Sht 2	1				1	As rqd
Wood Blocks	439103 Type 2	2				2	235124
Bolts, M20 x 530, Galvd (Stout)	-	2				2	372815
Washers, M20, Square, Flat, Galvd	0183/6	2				2	368063
Washers, M20, Square, Curved, Galvd	439605	2				2	368078
Crossarm Members	439563	2				2	251476
Crossarm Struts	439526	4				4	237581
Crossarm Braces	439515	2				2	237524
Terminating Plate	439528	2				3	237596
Bolts, M20 x 60, Galvd	-	7				7	378703
Bolts, M20 x 60, Galvd, Earthing	0162/3	1				1	370504
Bolts, M20 x 70, Galvd	-	4				6	373911
Bolts, M20 x 300, Galvd	-	4				4	378794
Tie Rods, M20 x 330, Galvd	439608/3	2				2	375828
Nuts, M20, Galvd	-	4				6	378915
Washers, M20, Round, Galvd	-	21				23	375616
Washers, M20, Square, Curved, Galvd	439605	4				4	368078
Tension Set Assemblies comprising:		11	20 kV	11	20	33 kV	
70kV Composite Insulators (11 & 20kV)	0487/24	-	2	-	3	-	253706 or
90kV Composite Insulators (33kV)	0487/23	-	-	-	-	3	216150
439210 Assy 1 or 2 comprising:							
Ball Ended Hook	0454	2				3	253071
Compression Termination	0667/1	2				3	As rqd
Jumper Lug	0102/8	2				3	As rqd
439210 Assy 3 comprising (33 kV only):							
Ball Ended Hook	0445	-				3	253086
Socket Tongue	0449	-				3	250779
Ball Clevis	0456	-				3	248586
Arc Horn	0494/4	-				3	240480
Arc Horn	0494/6	-				3	240264
Compression Termination *	0667/1	-				3	As rqd
Jumper Lug *	0102/8	-				3	As rqd
Number Plate	-			-			To suit
Base Plate	-			1			243258
Safety Sign	-			1			363318
Fibre Washer 9/16 in dia x 1/4 thick				6			374581
Fibre Washer 9/16 in dia x 1/16 thick				6			374577
Screws 1 in x No 8 brass				6			375777
Or							
Screw Nails, Hardened				2			371738
Stays (see Work Specs 04/027 & 04/028)	-	As				As rqd	-
70kV Rating (All 11 and 20kV earthed & Unearthed Poles)	0486/13	2				3	253833 or
90kV Rating Pin Insulator (33kV)	0486/4	2				3	216150
Pilot Pin O	0619/1	2				3	261909
Distribution Ties (see Work Spec 04/043)	0660	2				3	As rqd
Semi- conducting Tape		2				2	365328

11 kV, 20 kV AND 33 kV OVERHEAD LINES
SINGLE POLE TERMINAL
DOUBLE CROSSARM

Drg No 1.00.431.2110 Sheet 1



WHEN TWO STAYS ARE FITTED THESE MAY BE SPLAYED OR IN TANDEM GIVING A SEPARATION OF 1.5 - 2.0m AT GROUND LEVEL



NOTES:

1. STANDARD POLE LENGTH 11.0m.
2. FIT 2 M20 POLE BOLTS WITH 2 WASHERS 439605 AT POLE TOP.
3. COMPRESSION TERMINATIONS TO 1.09.101.0667 SHT 1
4. ALL POLE BOLTS TO BE M20 EXCEPT WHERE OTHERWISE STATED.
5. DETAIL DRAWINGS PREFIXED 43.... REFER TO E.S.I. DRGS. AND OTHER DETAIL DRGS. REFER TO 1.09.101. SERIES
6. ALL UNUSED BOLT HOLES SHALL BE PLUGGED.
7. ALL INSULATOR BINDERS TO BE INSTALLED IN CONJUCTION WITH SEMI - CONDUCTING TAPE

POLE LENGTH (m)	DIM. 'S' (m)
9.0 - 11.5 INCLUSIVE	1.9
12.0 - 14.0 INCLUSIVE	2.1
15.0 - 18.0 INCLUSIVE	2.4
19.0 - 24.0	3.0

ALL DIMENSIONS SHOWN ARE IN MILLIMETRES UNLESS OTHERWISE STATED

NORTHERN POWERGRID
Manufacturer Details

Lloyds Court, 78 Grey Street, Newcastle Upon Tyne, NE1 6AF

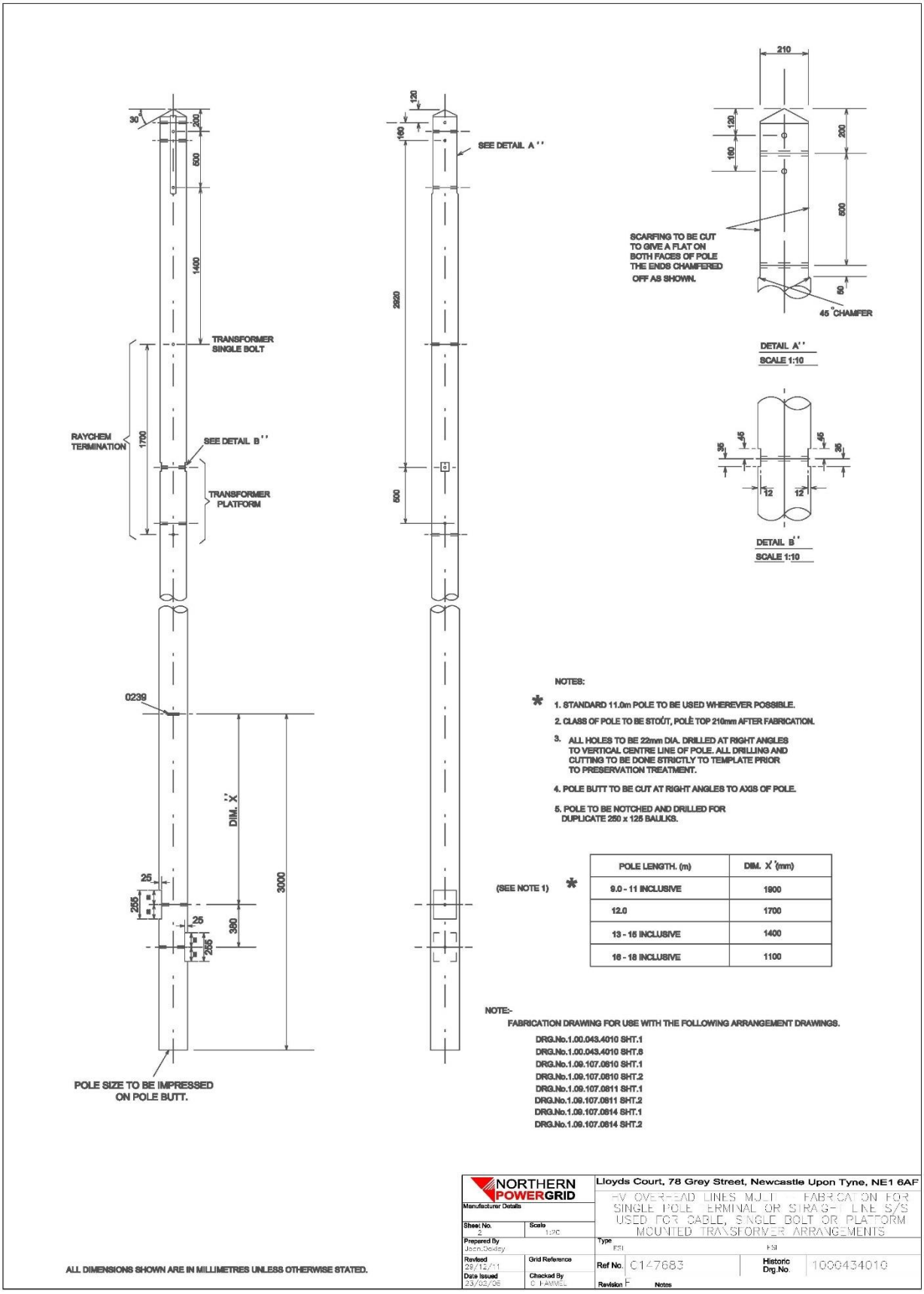
OVERHEAD LINES (11,20 & 33KV SYSTEMS)
GENERAL ASSEMBLY COVERED CONDUCTOR
SINGLE POLE TERMINAL
(DOUBLE CROSSARM MEMBER)

Sheet No. 1	Scale N.T.S.
Prepared By Joan.Oakley	
Revised 15/12/11	Grid Reference
Date Issued 15/12/11	Checked By G HAMMEL

Type OVERHEAD STANDARDS

Ref No. C1004443 Historic Drg.No. 1004312110

Revision Notes


30
200
600
1400
TRANSFORMER SINGLE BOLT
RAYCHEM TERMINATION
1700
SEE DETAIL B''
TRANSFORMER PLATFORM
0239
DIM. X'
3000
25
255
25
380
255
POLE SIZE TO BE IMPRESSED ON POLE BUTT.
120
160
SEE DETAIL A''
2920
600
210
120
160
200
600
SCARFING TO BE CUT TO GIVE A FLAT ON BOTH FACES OF POLE THE ENDS CHAMFERED OFF AS SHOWN.
60
45° CHAMFER
DETAIL A''
SCALE 1:10
35
45
45
35
12
12
DETAIL B''
SCALE 1:10
NOTES:
1. STANDARD 11.0m POLE TO BE USED WHEREVER POSSIBLE.
2. CLASS OF POLE TO BE STOUT, POLE TOP 210mm AFTER FABRICATION.
3. ALL HOLES TO BE 22mm DIA. DRILLED AT RIGHT ANGLES TO VERTICAL CENTRE LINE OF POLE. ALL DRILLING AND CUTTING TO BE DONE STRICTLY TO TEMPLATE PRIOR TO PRESERVATION TREATMENT.
4. POLE BUTT TO BE CUT AT RIGHT ANGLES TO AXIS OF POLE.
5. POLE TO BE NOTCHED AND DRILLED FOR DUPLICATE 250 x 125 BAULKS.
(SEE NOTE 1)
POLE LENGTH. (m) | DIM. X''(mm)
9.0 - 11 INCLUSIVE | 1900
12.0 | 1700
13 - 15 INCLUSIVE | 1400
16 - 18 INCLUSIVE | 1100
NOTE:-
FABRICATION DRAWING FOR USE WITH THE FOLLOWING ARRANGEMENT DRAWINGS.
DRG.No.1.00.043.4010 SHT.1
DRG.No.1.00.043.4010 SHT.6
DRG.No.1.09.107.0810 SHT.1
DRG.No.1.09.107.0810 SHT.2
DRG.No.1.09.107.0811 SHT.1
DRG.No.1.09.107.0811 SHT.2
DRG.No.1.09.107.0814 SHT.1
DRG.No.1.09.107.0814 SHT.2
ALL DIMENSIONS SHOWN ARE IN MILLIMETRES UNLESS OTHERWISE STATED.
NORTHERN POWERGRID
Manufacturer Details
Lloyds Court, 78 Grey Street, Newcastle Upon Tyne, NE1 6AF
HV OVER-HEAD LINES MULT... FABRICATION FOR SINGLE POLE TERMINAL OR STRAIGHT LINE S/S USED FOR CABLE, SINGLE BOLT OR PLATFORM MOUNTED TRANSFORMER ARRANGEMENTS
Sheet No. 2
Scale 1:20
Prepared By Jean Dooley
Type FSI
Revised 29/12/11
Grid Reference
Date Issued 23/02/06
Checked By C HAMMEL
Ref No. C147683
Historic Drg.No. 1000434010
Revision F
Notes

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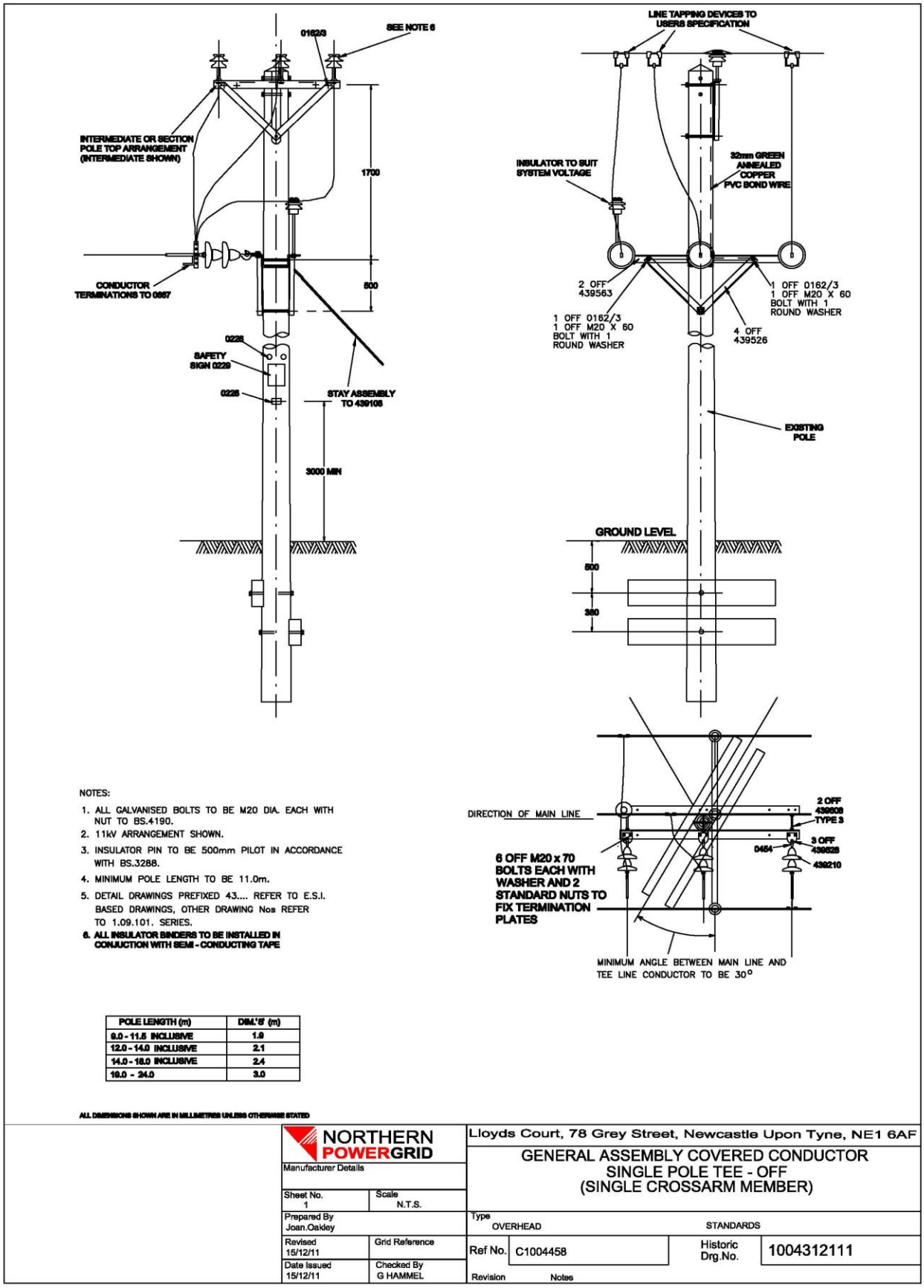
(FOR TEE OFF ARRANGEMENT ONLY)

COMPONENT	DRAWING NO	QUANTITY		CAT NO
		2 WIRE		
Crossarm Members	439563	2		251476
Crossarm Struts	439526	4		237581
Terminating Plate	439528	3		237596
Bolts, M20 x 60, Galvd	-	1		378703
Bolts, M20 x 60, Galvd, Earthing	0162/3	1		370504
Bolts, M20 x 70, Galvd	-	6		373911
Bolts, M20 x 300, Galvd	-	2		378794
Nuts, M20, Galvd	-	4		378915
Washers, M20, Round, Galvd	-	18		375616
Tension Insulator Sets Comprising:		11 kV	20 kV	
70 kV Composite insulators (11 & 20kV)	0487/24	3	3	253706 or
Items listed for 50 mm AAAC, for				
alternative conductor order compression fitting to suit				
439210 Assy 1 Comprising:				
Ball Ended Hook	0454	3		253071
Compression Termination	0667/1	3		To suit
Jumper Lug	0102/8	3		To suit
Notices (see Work Specs 04/055 & 04/056)	-	As spec'd		-
Stays (see Work Specs 04/027 & 04/028)	-	2		-
70kV Rating (All 11 and 20kV earthed & Unearthed Poles) Ø	0486/13	2		253833 or
Pilot Pin Ø	0619/1	2		261909
Distribution Ties (see Work Spec 04/043) Ø	0660	2		As rqd
Semi-conducting tape Ø	-	2		365328
Ø If required for jumper to remote phase.				

11 kV, AND 20 kV OVERHEAD LINES
THREE PHASE - TEE OFF POLE

Drg No 1.00.431.2111 Sheet 1



NOTES:

1. ALL GALVANISED BOLTS TO BE M20 DIA. EACH WITH NUT TO BS.4190.
2. 11kV ARRANGEMENT SHOWN.
3. INSULATOR PIN TO BE 500mm PILOT IN ACCORDANCE WITH BS.3288.
4. MINIMUM POLE LENGTH TO BE 11.0m.
5. DETAIL DRAWINGS PREFIXED 43.... REFER TO E.S.I. BASED DRAWINGS, OTHER DRAWING Nos REFER TO 1.09.101. SERIES.
6. ALL INSULATOR BINDERS TO BE INSTALLED IN CONJUCTION WITH SEMI - CONDUCTING TAPE

POLE LENGTH (m)	DIM.'S' (m)
9.0 - 11.5 INCLUSIVE	1.9
12.0 - 14.0 INCLUSIVE	2.1
14.0 - 18.0 INCLUSIVE	2.4
19.0 - 24.0	3.0

ALL DIMENSIONS SHOWN ARE IN MILLIMETRES UNLESS OTHERWISE STATED

NORTHERN POWERGRID

Manufacturer Details

Lloyds Court, 78 Grey Street, Newcastle Upon Tyne, NE1 6AF

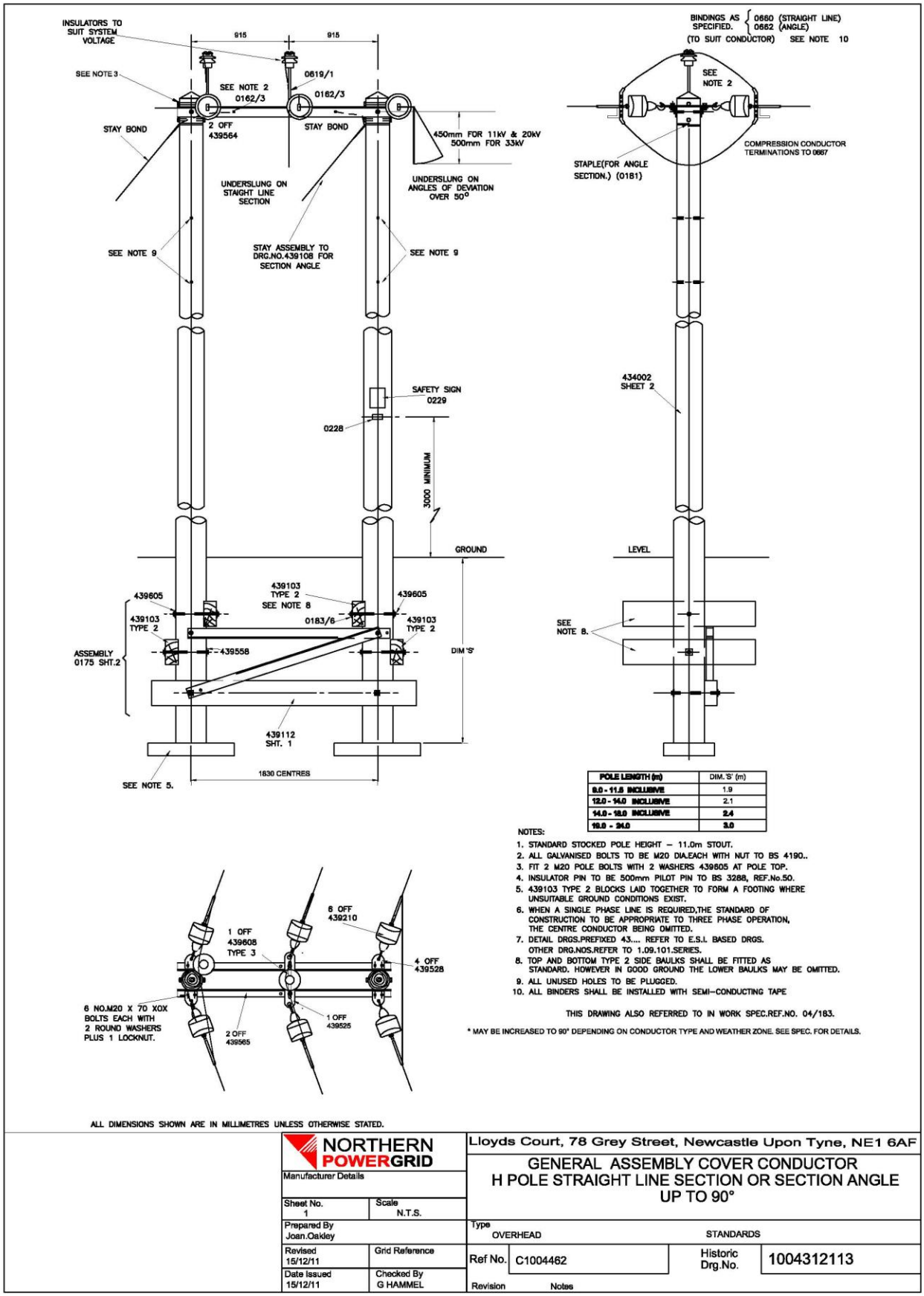
GENERAL ASSEMBLY COVERED CONDUCTOR
SINGLE POLE TEE - OFF
(SINGLE CROSSARM MEMBER)

Sheet No. 1	Scale N.T.S.		
Prepared By Joan.Oakley		Type OVERHEAD	STANDARDS
Revised 15/12/11	Grid Reference	Ref No. C1004458	Historic Drg.No. 1004312111
Date Issued 15/12/11	Checked By G HAMMEL	Revision	Notes

COMPONENT	DRAWING NO	QUANTITY				CAT NO
		11 & 20 kV		33 kV		
		Start Line	Sect Angle	Strt Line	Sect Angle	
Wood Pole, Legs	434002	2	2	2	2	-
Baulk	439112 Sht 1	1	1	1	1	234668
Baulks	439103 Type 2	4	4	4	4	235124
Steelwork, Foundation	439558	2	2	2	2	254657
Bolts, (Stout) M20 x 530	-	8	8	8	8	372815
Washer, Square, Flat	0183/6	6	6	6	6	368063
Washer, Square, Curved	439605	8	8	8	8	368078
Crossarm Member	439564	2	2	2	2	251477
Section Strap	439525	1	1	1	1	237609
Terminating Plate	439528	2	2	2	2	237596
Bolts, (Stout) M20 x 300	-	6	6	6	6	378794
Bolts, M20 x 70	-	6	6	6	6	373911
Tie Rod, M20 x 330 each with	439608 Type 3	1	1	1	1	375828
4 Standard Nuts						
Bolts, M20 x 60 (Earthing)	0162/3	-	2	-	2	370504
Washers, Round, M20	-	16	16	16	16	375616
Washers, Square, Curved	439605	8	8	8	8	368078
Nuts, M20	-	6	6	6	6	378915
Pin Insulators (as specified)						
70kV Rating (All 11 and 20kV earthed & Unearthed Poles)	0486/13	2	2	-	-	253833 or
90kV Rating (33 kV)	0486/4	-	-	2	2	253423
Pilot Pins	0619/1	2	2	2	2	261909
Distribution Ties						
(See Work Specs 04/043)	0660	2	2	2	2	-
Semi conducting tape		2	2	2	2	365328
Tension Set Assemblies		11 kV	20 kV	33 kV		
70kV Composite Insulator (11 & 20kV)	0487/24	6	6	6		253706 or
90kV Composite Insulator (33kV)	0487/23	6	6	6		216150
439210 Assy 1 or 2 Comprising:						
Ball Ended Hook		0454	6	6		253071
OR						
Compression Termination	0667 sht1	6	6	6		As rqd
Jumper Lug	0102/8	6	6	6		As rqd
439210 Assy 3 Comprising: (33 kV						
Ball Ended Hook		0445	-	-		253086
Socket Tongue	0449	-	-	6		250779
Ball Clevis	0456	-	-	6		248586
Arc Horn	0494/4	-	-	6		240480
Arc Horn	0494/6	-	-	6		240264
OR						
Compression Termination	0667/1	-	-	6		As rqd
Jumper Lug	0102/8	-	-	6		As rqd
Non-tension Joint	-	As	As	As	As	-
Notices (See Work Spec 04/055)	-	As rqd	As rqd	As rqd	As rqd	-
Stays (See Work Spec 04/027 &	-	-	As	-	As	-

11 kV 20 kV & 33 kV OVERHEAD LINES
'H' POLE STRAIGHT LINE SECTION OR SECTION ANGLE SUPPORT

Drg No 1.00.431.2113 Sheet 1



POLE LENGTH (m)	DIM. 'S' (m)
9.0 - 11.0 INCLUSIVE	1.9
12.0 - 14.0 INCLUSIVE	2.1
14.0 - 18.0 INCLUSIVE	2.4
18.0 - 24.0	3.0

NOTES:
1. STANDARD STOCKED POLE HEIGHT – 11.0m STOUT.
2. ALL GALVANISED BOLTS TO BE M20 DIA.EACH WITH NUT TO BS 4190..
3. FIT 2 M20 POLE BOLTS WITH 2 WASHERS 439605 AT POLE TOP.
4. INSULATOR PIN TO BE 500mm PILOT PIN TO BS 3288, REF.No.50.
5. 439103 TYPE 2 BLOCKS LAID TOGETHER TO FORM A FOOTING WHERE UNSUITABLE GROUND CONDITIONS EXIST.
6. WHEN A SINGLE PHASE LINE IS REQUIRED,THE STANDARD OF CONSTRUCTION TO BE APPROPRIATE TO THREE PHASE OPERATION, THE CENTRE CONDUCTOR BEING OMITTED.
7. DETAIL DRGS.PREFIXED 43.... REFER TO E.S.I. BASED DRGS. OTHER DRG.NOS.REFER TO 1.09.101.SERIES.
8. TOP AND BOTTOM TYPE 2 SIDE BAULKS SHALL BE FITTED AS STANDARD. HOWEVER IN GOOD GROUND THE LOWER BAULKS MAY BE OMITTED.
9. ALL UNUSED HOLES TO BE PLUGGED.
10. ALL BINDERS SHALL BE INSTALLED WITH SEMI-CONDUCTING TAPE

THIS DRAWING ALSO REFERRED TO IN WORK SPEC.REF.NO. 04/183.

* MAY BE INCREASED TO 90° DEPENDING ON CONDUCTOR TYPE AND WEATHER ZONE. SEE SPEC. FOR DETAILS.

ALL DIMENSIONS SHOWN ARE IN MILLIMETRES UNLESS OTHERWISE STATED.

NORTHERN POWERGRID
Manufacturer Details

Lloyds Court, 78 Grey Street, Newcastle Upon Tyne, NE1 6AF

GENERAL ASSEMBLY COVER CONDUCTOR
H POLE STRAIGHT LINE SECTION OR SECTION ANGLE
UP TO 90°

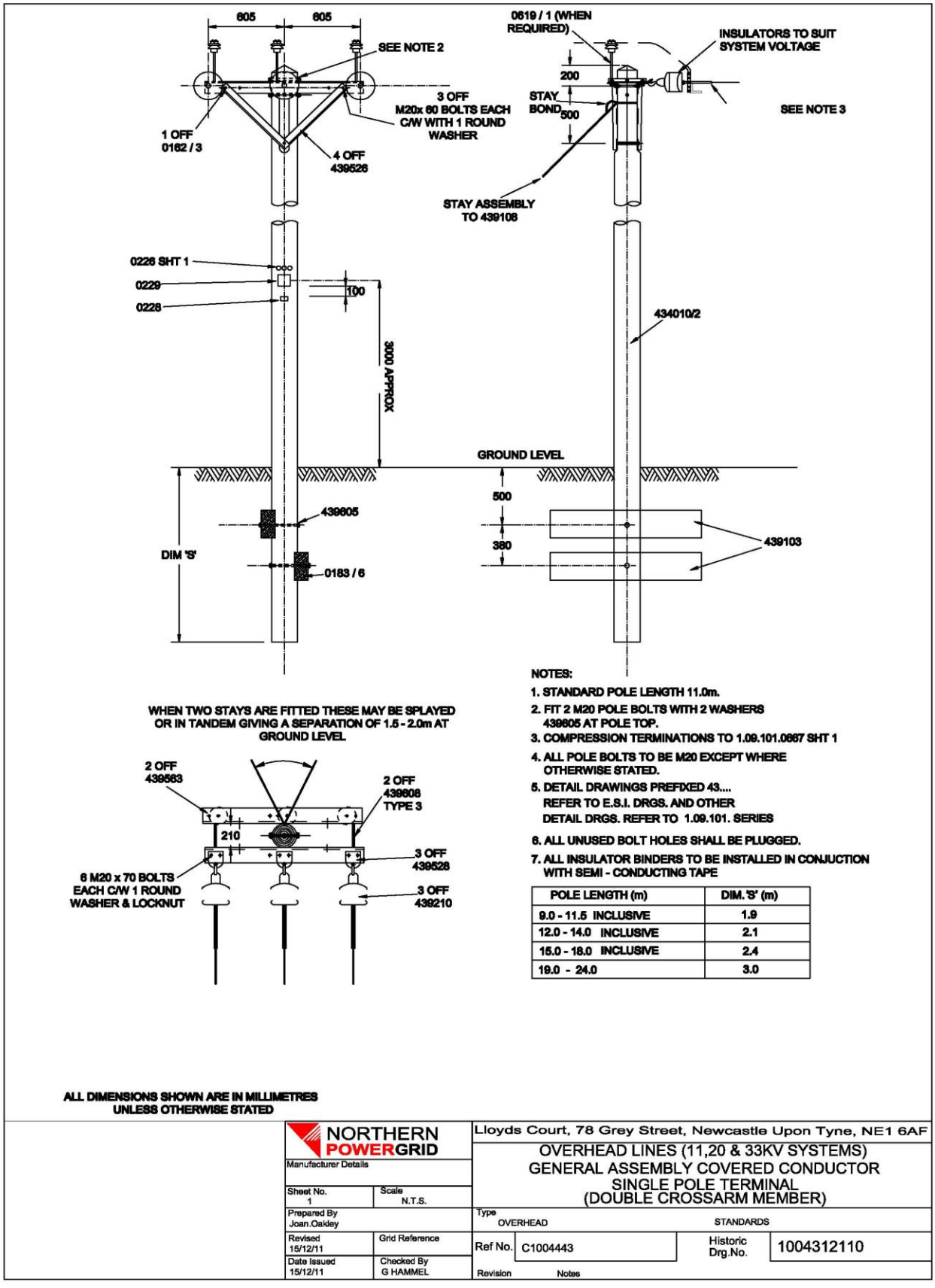
Sheet No. 1	Scale N.T.S.
Prepared By Joan.Oakley	
Revised 15/12/11	Grid Reference
Date Issued 15/12/11	Checked By G HAMMEL

Type: OVERHEAD STANDARDS
Ref No. C1004462
Historic Drg.No. 1004312113
Revision Notes

COMPONENT	DRAWING	QUANTITY					CAT NO
		2 WIRE				3 WIRE	
Wood Pole, Stout Grade	434010 Sht 2	1				1	As rqd
Wood Blocks	439103 Type 2	2				2	235124
Bolts, M20 x 530, Galvd (Stout)	-	2				2	372815
Washers, M20, Square, Flat, Galvd	0183/6	2				2	368063
Washers, M20, Square, Curved, Galvd	439605	2				2	368078
Crossarm Members	439563	2				2	251476
Crossarm Struts	439526	4				4	237581
Crossarm Braces	439515	2				2	237524
Terminating Plate	439528	2				3	237596
Bolts, M20 x 60, Galvd	-	7				7	378703
Bolts, M20 x 60, Galvd, Earthing	0162/3	1				1	370504
Bolts, M20 x 70, Galvd	-	4				6	373911
Bolts, M20 x 300, Galvd	-	4				4	378794
Tie Rods, M20 x 330, Galvd	439608/3	2				2	375828
Nuts, M20, Galvd	-	4				6	378915
Washers, M20, Round, Galvd	-	21				23	375616
Washers, M20, Square, Curved, Galvd	439605	4				4	368078
Tension Set Assemblies comprising:		11	20 kV	11	20	33 kV	
70kV Composite Insulator (11 & 20kV)	0487/24	-	2	-	3	-	253706 or
90kV Composite Insulators (33kV)	0487/23	-	-	-	-	3	216150
439210 Assy 1 or 2 comprising:							
Ball Ended Hook	0454	2				3	253071
Compression Termination	0667/1	2				3	As rqd
Jumper Lug	0102/8	2				3	As rqd
439210 Assy 3 comprising (33 kV only):							
Ball Ended Hook	0445	-				3	253086
Socket Tongue	0449	-				3	250779
Ball Clevis	0456	-				3	248586
Arc Horn	0494/4	-				3	240480
Arc Horn	0494/6	-				3	240264
Compression Termination *	0667/1	-				3	As rqd
Jumper Lug *	0102/8	-				3	As rqd
Number Plate	-			-			To suit
Base Plate	-			1			243258
Safety Sign	-			1			363318
Fibre Washer 9/16 in dia x 1/4 thick				6			374581
Fibre Washer 9/16 in dia x 1/16 thick				6			374577
Screws 1 in x No 8 brass				6			375777
Or							
Screw Nails, Hardened				2			371738
Stays (see Work Specs 04/027 & 04/028)	-	As rqd				As rqd	-
50kV Rating Pin Insulator (11/20kV)	0486/12	2				3	253701 or
55kV Rating Pin Insulator (20kV earthed)	0486/13	2				3	253833 or
90kV Rating Pin Insulator (33kV)	0486/4	2				3	216150
Pilot Pin O	0619/1	2				3	261909
Distribution Ties (see Work Spec 04/043)	0660	2				3	As rqd
Semi- conducting Tape		2				2	365328

11 kV, 20 kV AND 33 kV OVERHEAD LINES
SINGLE POLE TERMINAL
DOUBLE CROSSARM

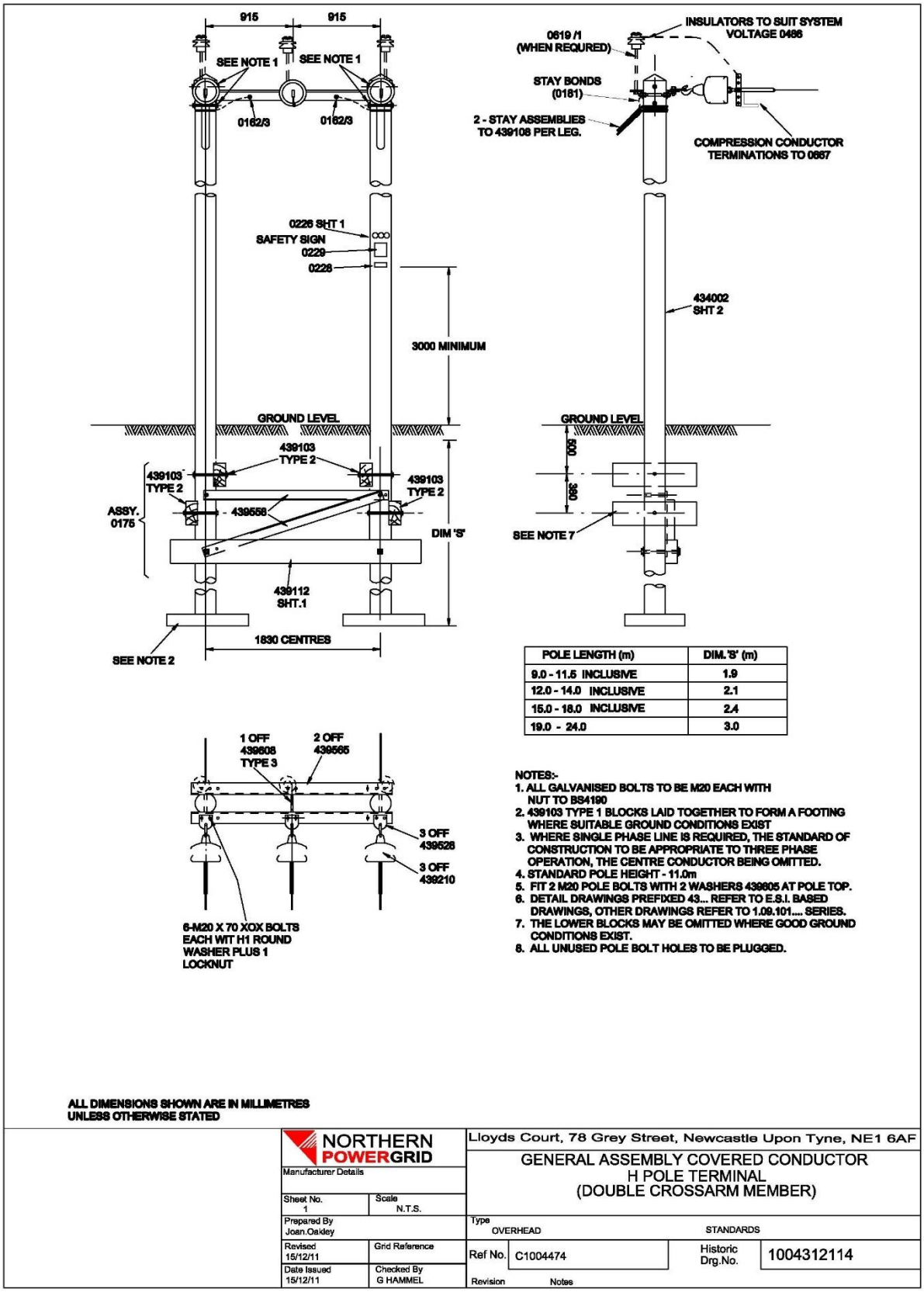
Drg No 1.00.431.2110 Sheet 1


605
605
SEE NOTE 2
3 OFF
M20x 60 BOLTS EACH
C/W WITH 1 ROUND
WASHER
1 OFF
0162 / 3
4 OFF
439526
0619 / 1 (WHEN
REQUIRED)
INSULATORS TO SUIT
SYSTEM VOLTAGE
200
STAY
BOND
500
SEE NOTE 3
STAY ASSEMBLY
TO 439108
0226 SHT 1
0229
0228
100
3000 APPROX
434010/2
GROUND LEVEL
500
380
439103
439605
0183 / 6
DIM 'S'
WHEN TWO STAYS ARE FITTED THESE MAY BE SPLAYED
OR IN TANDEM GIVING A SEPARATION OF 1.5 - 2.0m AT
GROUND LEVEL
2 OFF
439563
2 OFF
439608
TYPE 3
210
3 OFF
439528
6 M20 x 70 BOLTS
EACH C/W 1 ROUND
WASHER & LOCKNUT
3 OFF
439210
NOTES:
1. STANDARD POLE LENGTH 11.0m.
2. FIT 2 M20 POLE BOLTS WITH 2 WASHERS
439605 AT POLE TOP.
3. COMPRESSION TERMINATIONS TO 1.09.101.0867 SHT 1
4. ALL POLE BOLTS TO BE M20 EXCEPT WHERE
OTHERWISE STATED.
5. DETAIL DRAWINGS PREFIXED 43....
REFER TO E.S.I. DRGS. AND OTHER
DETAIL DRGS. REFER TO 1.09.101. SERIES
6. ALL UNUSED BOLT HOLES SHALL BE PLUGGED.
7. ALL INSULATOR BINDERS TO BE INSTALLED IN CONJUCTION
WITH SEMI - CONDUCTING TAPE
POLE LENGTH (m) | DIM. 'S' (m)
9.0 - 11.5 INCLUSIVE | 1.9
12.0 - 14.0 INCLUSIVE | 2.1
15.0 - 18.0 INCLUSIVE | 2.4
19.0 - 24.0 | 3.0
ALL DIMENSIONS SHOWN ARE IN MILLIMETRES
UNLESS OTHERWISE STATED
NORTHERN POWERGRID
Manufacturer Details
Lloyds Court, 78 Grey Street, Newcastle Upon Tyne, NE1 6AF
OVERHEAD LINES (11,20 & 33KV SYSTEMS)
GENERAL ASSEMBLY COVERED CONDUCTOR
SINGLE POLE TERMINAL
(DOUBLE CROSSARM MEMBER)
Sheet No. 1
Scale N.T.S.
Prepared By Joan.Oakley
Type OVERHEAD
STANDARDS
Revised 15/12/11
Grid Reference
Ref No. C1004443
Historic Drg.No. 1004312110
Date Issued 15/12/11
Checked By G HAMMEL
Revision
Notes

COMPONENT	DRAWING No.	QUANTITY			CAT NO
Wood 'H' Pole	434002 Sht 2	1			As rqd
Wood Blocks +	439103 Type 2	4			235124
Wood Brace Block	439112 Sht 1	1			234668
Foundation Braces	439558	2			254657
Bolts, M20 x 530, Galvd (Stout)	-	8			372815
Washers, M20, Square, Flat Galvd	0183/6	5			368063
Washers, M20, Square, Curved, Galvd	439605	8			368078
Crossarm Members	439565	2			251478
Terminating Plate	439528	3			237596
Bolts, M20 x 60, Galvd, Earthing	0162/3	2			370504
Bolts, M20 x 70, Galvd	-	6			373911
Bolts, M20 x 300	-	6			378794
Tie Rods, M20 x 330, Galvd	439608/3	4			375828
Nuts, M20, Galvd	-	6			378915
Washers, M20, Round, Galvd	-	16			375616
Washers, M20, Square, Curved, Galvd	439605	8			368078
Tension Set Assemblies comprising:		11 kV	20 kV	33 kV	
70kV Composite Insulator (11 & 20kV)	0487/24	3	3	3	253706 or
90kV Composite Insulators (33kV	0487/23	3	3	3	216150
439210 Assy 1 or 2 comprising:					
Ball Ended Hook	0454	3			253071
Compression Termination	0667/1	3			As rqd
Jumper Lug	0102/8	3			As rqd
OR					
439210 Assy 3 comprising (33 kV only):					
Ball Ended Hook	0454	3			253086
Socket Tongue	0449	3			253071
Compression Termination *	0667/1	3			As rqd
Jumper Lug *	0102/8	3			As rqd
Notices (see Work Specs 04/055 & 04/056)	-	As spec'd			-
Safety Sign	-	1			363318
Fibre Washer 9/16 in dia x 1/4 thick		6			374581
Fibre Washer 9/16 in dia x 1/16 thick		6			374577
Screws 1 in x No 8 brass		6			375777
OR					
Screw Nails, Hardened					
B2P 2 in x 10 G		2			371738
Stays (see Work Specs 04/027 & 04/028)	-	As rqd			-
70kV Rating (All 11 and 20kV earthed & Unearthed Poles)	0486/13	3			253833 or
90kV rating Pin Insulator (33kV)	0486/4	3			253423 or
Semi conducting Tape					365328
Pilot Pin Ø	0619/1	3			261909
Distribution Ties (see Work Spec 04/043)	0660	3			As rqd
Wood Plugs 24 mm x 75 mm Long	0247/3	8			263073

11 kV, 20 kV AND 33 kV OVERHEAD LINES
'H' POLE TERMINAL

Drg No 1.00.431.2114 Sheet 1



POLE LENGTH (m)	DIM.'S' (m)
9.0 - 11.5 INCLUSIVE	1.9
12.0 - 14.0 INCLUSIVE	2.1
15.0 - 18.0 INCLUSIVE	2.4
19.0 - 24.0	3.0

NOTES:-
1. ALL GALVANISED BOLTS TO BE M20 EACH WITH NUT TO BS4190
2. 439103 TYPE 1 BLOCKS LAID TOGETHER TO FORM A FOOTING WHERE SUITABLE GROUND CONDITIONS EXIST
3. WHERE SINGLE PHASE LINE IS REQUIRED, THE STANDARD OF CONSTRUCTION TO BE APPROPRIATE TO THREE PHASE OPERATION, THE CENTRE CONDUCTOR BEING OMITTED.
4. STANDARD POLE HEIGHT - 11.0m
5. FIT 2 M20 POLE BOLTS WITH 2 WASHERS 439605 AT POLE TOP.
6. DETAIL DRAWINGS PREFIXED 43... REFER TO E.S.I. BASED DRAWINGS, OTHER DRAWINGS REFER TO 1.09.101.... SERIES.
7. THE LOWER BLOCKS MAY BE OMITTED WHERE GOOD GROUND CONDITIONS EXIST.
8. ALL UNUSED POLE BOLT HOLES TO BE PLUGGED.

ALL DIMENSIONS SHOWN ARE IN MILLIMETRES
UNLESS OTHERWISE STATED

NORTHERN POWERGRID
Manufacturer Details

Lloyds Court, 78 Grey Street, Newcastle Upon Tyne, NE1 6AF

GENERAL ASSEMBLY COVERED CONDUCTOR
H POLE TERMINAL
(DOUBLE CROSSARM MEMBER)

Sheet No. 1	Scale N.T.S.
Prepared By Joan.Oakley	
Revised 15/12/11	Grid Reference
Date Issued 15/12/11	Checked By G HAMMEL

Type OVERHEAD STANDARDS
Ref No. C1004474
Historic Drg.No. 1004312114
Revision Notes

Appendix 9 - 50mm XLPE Covered AAAC - Normal Altitude - 100m Basic

Conductor Code Name (if any)	50CC AL3
Covered Conductor Weight (kg/m)	0.21
Cross Sectional Area of Conductor (mm^2)	50
Diameter of Covered Conductor (mm)	13.4
Coefficient of Linear Expansion (/Degree C)	0.000023
Modulus of Elasticity (kg/mm^2)	6628.1554
Rated Breaking Strength of Conductor (kgf)	1509.18
Basic / Recommended Span (m)	100
Wind Pressure on Conductor (N/m^2)	380
Radial Ice Thickness (mm)	5
Ice Density (kg/m^3)	913
Absolute Maximum Working Tension (MWT) Limit (kgf)	603.7
Temperature at MWT Limit (Degrees C)	-5.6
Maximum "Everyday" Tension (EDT) Limit (kgf)	142.76027
Temperature at EDT Limit (Degrees C)	5

Maximum Conductor Tension (MCT) (kgf)	at	-5.6°C	500.9
Maximum Conductor Weight (MCW) (kg/m)			0.474
Maximum Conductor Pressure (MCP) (kg/m)			0.907
Freezing Point Tension (FPT) (kgf)	at	0°C	150.6

ORDINATES FOR PLOTTING UPLIFT AND GROUND CLEARANCE CURVES

Conductor: 50CC AL3

Temperature Shift (Deg. C) 0

Tension Reduction at 15°C (%) 5

2X Span (m)	Sag (m) for Cold Curve -5.6	Sag (m) for Range of Hot Curve Temperatures					
		50	55	60	65	70	75
40	0.26	0.43	0.44	0.45	0.47	0.48	0.49
80	1.05	1.73	1.77	1.82	1.86	1.91	1.95
120	2.35	3.88	3.99	4.09	4.19	4.29	4.39
160	4.18	6.90	7.09	7.27	7.45	7.63	7.80
200	6.54	10.78	11.08	11.36	11.65	11.92	12.19
240	9.41	15.53	15.95	16.36	16.77	17.17	17.56
280	12.81	21.13	21.71	22.27	22.83	23.37	23.90
320	16.73	27.60	28.35	29.09	29.81	30.52	31.22
360	21.17	34.93	35.88	36.82	37.73	38.63	39.51
400	26.14	43.13	44.30	45.45	46.58	47.69	48.78
440	31.63	52.18	53.61	55.00	56.37	57.71	59.02
480	37.64	62.10	63.80	65.45	67.08	68.67	70.24
520	44.18	72.88	74.87	76.82	78.73	80.60	82.43

Appendix 9a - 50mm XLPE Covered AAAC - Normal Altitude - 100m Basic

Conductor Code Name		50CC AL3	
Basic / Recommended Span	(m)	100	
Temperature Shift for Creep	(Deg. C)	0	Insert minus sign as necessary
Equivalent Percentage Increase in Tension (%)		0.0	at 15°C
Required Percentage Increase in Tension (%)		0	at 15°C

Temp. (Deg. C)	Tension (kgf)	DESIGN TABLE Sag (m) for Span Length (m) 60	70	80	90	100	110	120	130	140
-5.6	160.7	0.59	0.80	1.05	1.32	1.63	1.98	2.35	2.76	3.20
0	150.6	0.63	0.85	1.12	1.41	1.74	2.11	2.51	2.95	3.42
5	142.8	0.66	0.90	1.18	1.49	1.84	2.22	2.65	3.11	3.60
10	135.8	0.70	0.95	1.24	1.57	1.93	2.34	2.78	3.27	3.79
15	129.7	0.73	0.99	1.30	1.64	2.02	2.45	2.91	3.42	3.97
20	124.2	0.76	1.04	1.35	1.71	2.11	2.56	3.04	3.57	4.14
25	119.3	0.79	1.08	1.41	1.78	2.20	2.66	3.17	3.72	4.31
30	114.9	0.82	1.12	1.46	1.85	2.29	2.76	3.29	3.86	4.48
35	110.9	0.85	1.16	1.52	1.92	2.37	2.87	3.41	4.00	4.64
40	107.2	0.88	1.20	1.57	1.98	2.45	2.96	3.53	4.14	4.80
45	103.8	0.91	1.24	1.62	2.05	2.53	3.06	3.64	4.27	4.95
50	100.8	0.94	1.28	1.67	2.11	2.61	3.15	3.75	4.40	5.11
55	97.9	0.97	1.31	1.72	2.17	2.68	3.24	3.86	4.53	5.25
60	95.3	0.99	1.35	1.76	2.23	2.75	3.33	3.97	4.66	5.40
65	92.9	1.02	1.39	1.81	2.29	2.83	3.42	4.07	4.78	5.54
70	90.6	1.04	1.42	1.85	2.35	2.90	3.51	4.17	4.90	5.68
75	88.5	1.07	1.45	1.90	2.40	2.97	3.59	4.27	5.01	5.82
80	86.5	1.09	1.49	1.94	2.46	3.04	3.67	4.37	5.13	5.95

Conductor Code Name		50CC AL3	
Basic / Recommended Span	(m)	100	
Temperature Shift for Creep	(Deg. C)	-10	Insert minus sign as necessary
Equivalent Percentage Increase in Tension (%)		10.1	at 15°C
Required Percentage Increase in Tension (%)		0	at 15°C

Temp. (Deg. C)	Tension (kgf)	ERECTION TABLE Sag (m) for Span Length (m) 60	70	80	90	100	110	120	130	140
-5.6	182.9	0.52	0.70	0.92	1.16	1.43	1.74	2.07	2.42	2.81
0	169.7	0.56	0.76	0.99	1.25	1.55	1.87	2.23	2.61	3.03
5	159.5	0.59	0.81	1.05	1.33	1.65	1.99	2.37	2.78	3.23
10	150.6	0.63	0.85	1.12	1.41	1.74	2.11	2.51	2.95	3.42
15	142.8	0.66	0.90	1.18	1.49	1.84	2.22	2.65	3.11	3.60
20	135.8	0.70	0.95	1.24	1.57	1.93	2.34	2.78	3.27	3.79
25	129.7	0.73	0.99	1.30	1.64	2.02	2.45	2.91	3.42	3.97
30	124.2	0.76	1.04	1.35	1.71	2.11	2.56	3.04	3.57	4.14
35	119.3	0.79	1.08	1.41	1.78	2.20	2.66	3.17	3.72	4.31
40	114.9	0.82	1.12	1.46	1.85	2.29	2.76	3.29	3.86	4.48
45	110.9	0.85	1.16	1.52	1.92	2.37	2.87	3.41	4.00	4.64
50	107.2	0.88	1.20	1.57	1.98	2.45	2.96	3.53	4.14	4.80
55	103.8	0.91	1.24	1.62	2.05	2.53	3.06	3.64	4.27	4.95
60	100.8	0.94	1.28	1.67	2.11	2.61	3.15	3.75	4.40	5.11
65	97.9	0.97	1.31	1.72	2.17	2.68	3.24	3.86	4.53	5.25
70	95.3	0.99	1.35	1.76	2.23	2.75	3.33	3.97	4.66	5.40
75	92.9	1.02	1.39	1.81	2.29	2.83	3.42	4.07	4.78	5.54
80	90.6	1.04	1.42	1.85	2.35	2.90	3.51	4.17	4.90	5.68

Appendix 10 - 120mm XLPE Covered AAAC - Normal Altitude - 100m Basic

Conductor Code Name (if any)	120CC AL3
Covered Conductor Weight (kg/m)	0.43
Cross Sectional Area of Conductor (mm²)	120
Diameter of Covered Conductor (mm)	18.4
Coefficient of Linear Expansion (/Degree C)	0.000023
Modulus of Elasticity (kg/mm²)	6424.2121
Rated Breaking Strength of Conductor (kgf)	3609.7954
Basic / Recommended Span (m)	100
Wind Pressure on Conductor (N/m²)	380
Radial Ice Thickness (mm)	9.5
Ice Density (kg/m³)	913
Absolute Maximum Working Tension (MWT) Limit (kgf)	1804.9
Temperature at MWT Limit (Degrees C)	-5.6
Maximum "Everyday" Tension (EDT) Limit (kgf)	428.28081
Temperature at EDT Limit (Degrees C)	5

Maximum Conductor Tension (MCT) (kgf)	at	-5.6°C	1148.6
Maximum Conductor Weight (MCW) (kg/m)			1.190
Maximum Conductor Pressure (MCP) (kg/m)			1.449
Freezing Point Tension (FPT) (kgf)	at	0°C	466.3

ORDINATES FOR PLOTTING UPLIFT AND GROUND CLEARANCE CURVES

Conductor: 120CC AL3

Temperature Shift (Deg. C) 0
Tension Reduction at 15°C (%) 10

2X Span (m)	Sag (m) for Cold Curve -5.6	Sag (m) for Range of Hot Curve Temperatures					
		50	55	60	65	70	75
40	0.17	0.36	0.38	0.39	0.40	0.42	0.43
80	0.67	1.46	1.51	1.57	1.62	1.67	1.72
120	1.50	3.28	3.40	3.52	3.64	3.75	3.86
160	2.67	5.84	6.05	6.26	6.47	6.67	6.86
200	4.17	9.12	9.46	9.79	10.11	10.42	10.72
240	6.00	13.14	13.62	14.09	14.55	15.00	15.44
280	8.17	17.88	18.54	19.18	19.81	20.42	21.02
320	10.67	23.35	24.21	25.05	25.87	26.67	27.45
360	13.51	29.55	30.64	31.71	32.74	33.75	34.74
400	16.68	36.49	37.83	39.14	40.42	41.67	42.89
440	20.18	44.15	45.78	47.36	48.91	50.42	51.90
480	24.01	52.54	54.48	56.37	58.21	60.01	61.76
520	28.18	61.66	63.94	66.15	68.31	70.42	72.48

Appendix 10a - 120mm XLPE Covered AAAC - Normal Altitude - 100m Basic

Conductor Code Name		120CC AL3	
Basic / Recommended Span	(m)	100	
Temperature Shift for Creep	(Deg. C)	0	Insert minus sign as necessary
Equivalent Percentage Increase in Tension (%)		0.0	at 15°C
Required Percentage Increase in Tension (%)		0	at 15°C

Temp. (Deg. C)	Tension (kgf)	DESIGN TABLE Sag (m) for Span Length (m) 60	70	80	90	100	110	120	130	140
-5.6	515.7	0.38	0.51	0.67	0.84	1.04	1.26	1.50	1.76	2.04
0	466.3	0.41	0.56	0.74	0.93	1.15	1.39	1.66	1.95	2.26
5	428.3	0.45	0.61	0.80	1.02	1.26	1.52	1.81	2.12	2.46
10	395.5	0.49	0.67	0.87	1.10	1.36	1.64	1.96	2.30	2.66
15	367.3	0.53	0.72	0.94	1.19	1.46	1.77	2.11	2.47	2.87
20	343.1	0.56	0.77	1.00	1.27	1.57	1.90	2.26	2.65	3.07
25	322.2	0.60	0.82	1.07	1.35	1.67	2.02	2.40	2.82	3.27
30	304.0	0.64	0.87	1.13	1.43	1.77	2.14	2.55	2.99	3.47
35	288.1	0.67	0.91	1.19	1.51	1.87	2.26	2.69	3.15	3.66
40	274.1	0.71	0.96	1.25	1.59	1.96	2.37	2.82	3.31	3.84
45	261.8	0.74	1.01	1.31	1.66	2.05	2.48	2.96	3.47	4.02
50	250.8	0.77	1.05	1.37	1.74	2.14	2.59	3.09	3.62	4.20
55	240.9	0.80	1.09	1.43	1.81	2.23	2.70	3.21	3.77	4.37
60	232.1	0.83	1.13	1.48	1.88	2.32	2.80	3.34	3.91	4.54
65	224.0	0.86	1.18	1.54	1.94	2.40	2.90	3.45	4.05	4.70
70	216.7	0.89	1.22	1.59	2.01	2.48	3.00	3.57	4.19	4.86
75	210.0	0.92	1.25	1.64	2.07	2.56	3.10	3.69	4.33	5.02
80	203.9	0.95	1.29	1.69	2.14	2.64	3.19	3.80	4.46	5.17

Conductor Code Name		120CC AL3	
Basic / Recommended Span	(m)	100	
Temperature Shift for Creep	(Deg. C)	-15	Insert minus sign as necessary
Equivalent Percentage Increase in Tension (%)		26.9	at 15°C
Required Percentage Increase in Tension (%)		0	at 15°C

Temp. (Deg. C)	Tension (kgf)	ERECTION TABLE Sag (m) for Span Length (m) 60	70	80	90	100	110	120	130	140
-5.6	685.0	0.28	0.38	0.50	0.64	0.78	0.95	1.13	1.33	1.54
0	615.7	0.31	0.43	0.56	0.71	0.87	1.06	1.26	1.48	1.71
5	559.9	0.35	0.47	0.61	0.78	0.96	1.16	1.38	1.62	1.88
10	510.1	0.38	0.52	0.67	0.85	1.05	1.28	1.52	1.78	2.07
15	466.3	0.41	0.56	0.74	0.93	1.15	1.39	1.66	1.95	2.26
20	428.3	0.45	0.61	0.80	1.02	1.26	1.52	1.81	2.12	2.46
25	395.5	0.49	0.67	0.87	1.10	1.36	1.64	1.96	2.30	2.66
30	367.3	0.53	0.72	0.94	1.19	1.46	1.77	2.11	2.47	2.87
35	343.1	0.56	0.77	1.00	1.27	1.57	1.90	2.26	2.65	3.07
40	322.2	0.60	0.82	1.07	1.35	1.67	2.02	2.40	2.82	3.27
45	304.0	0.64	0.87	1.13	1.43	1.77	2.14	2.55	2.99	3.47
50	288.1	0.67	0.91	1.19	1.51	1.87	2.26	2.69	3.15	3.66
55	274.1	0.71	0.96	1.25	1.59	1.96	2.37	2.82	3.31	3.84
60	261.8	0.74	1.01	1.31	1.66	2.05	2.48	2.96	3.47	4.02
65	250.8	0.77	1.05	1.37	1.74	2.14	2.59	3.09	3.62	4.20
70	240.9	0.80	1.09	1.43	1.81	2.23	2.70	3.21	3.77	4.37
75	232.1	0.83	1.13	1.48	1.88	2.32	2.80	3.34	3.91	4.54
80	224.0	0.86	1.18	1.54	1.94	2.40	2.90	3.45	4.05	4.70

Appendix 11 - 185mm XLPE Covered AAAC - Normal Altitude - 100m Basic

Conductor Code Name (if any)	185CC AL3
Covered Conductor Weight (kg/m)	0.625
Cross Sectional Area of Conductor (mm²)	185
Diameter of Covered Conductor (mm)	21.8
Coefficient of Linear Expansion (/Degree C)	0.000023
Modulus of Elasticity (kg/mm²)	6424.2121
Rated Breaking Strength of Conductor (kgf)	5567.6505
Basic / Recommended Span (m)	100
Wind Pressure on Conductor (N/m²)	380
Radial Ice Thickness (mm)	9.5
Ice Density (kg/m³)	913
Absolute Maximum Working Tension (MWT) Limit (kgf)	1814.0
Temperature at MWT Limit (Degrees C)	-5.6
Maximum "Everyday" Tension (EDT) Limit (kgf)	660.26625
Temperature at EDT Limit (Degrees C)	5

Maximum Conductor Tension (MCT) (kgf)	at	-5.6°C	1515.8
Maximum Conductor Weight (MCW) (kg/m)			1.478
Maximum Conductor Pressure (MCP) (kg/m)			1.581
Freezing Point Tension (FPT) (kgf)	at	0°C	723.1

ORDINATES FOR PLOTTING UPLIFT AND GROUND CLEARANCE CURVES

Conductor: 185CC AL3

Temperature Shift (Deg. C) 0
Tension Reduction at 15°C (%) 10

2X Span (m)	Sag (m) for Cold Curve -5.6	Sag (m) for Range of Hot Curve Temperatures					
		50	55	60	65	70	75
40	0.16	0.36	0.37	0.38	0.40	0.41	0.42
80	0.62	1.42	1.48	1.53	1.58	1.63	1.68
120	1.40	3.20	3.32	3.45	3.56	3.68	3.79
160	2.48	5.69	5.91	6.12	6.33	6.54	6.74
200	3.88	8.89	9.23	9.57	9.90	10.21	10.53
240	5.59	12.80	13.30	13.78	14.25	14.71	15.16
280	7.61	17.43	18.10	18.76	19.40	20.02	20.63
320	9.94	22.76	23.64	24.50	25.33	26.15	26.95
360	12.58	28.81	29.92	31.01	32.06	33.10	34.10
400	15.53	35.56	36.94	38.28	39.59	40.86	42.10
440	18.79	43.03	44.70	46.32	47.90	49.44	50.94
480	22.36	51.21	53.19	55.12	57.00	58.84	60.63
520	26.25	60.10	62.43	64.69	66.90	69.05	71.15

Appendix 11a - 185mm XLPE Covered AAAC - Normal Altitude - 100m Basic

Conductor Code Name		185CC AL3	
Basic / Recommended Span	(m)	100	
Temperature Shift for Creep	(Deg. C)	0	Insert minus sign as necessary
Equivalent Percentage Increase in Tension (%)		0.0	at 15°C
Required Percentage Increase in Tension (%)		0	at 15°C

Temp. (Deg. C)	Tension (kgf)	DESIGN TABLE Sag (m) for Span Length (m) 60	70	80	90	100	110	120	130	140
-5.6	804.9	0.35	0.48	0.62	0.79	0.97	1.17	1.40	1.64	1.90
0	723.1	0.39	0.53	0.69	0.88	1.08	1.31	1.56	1.83	2.12
5	660.3	0.43	0.58	0.76	0.96	1.18	1.43	1.70	2.00	2.32
10	606.2	0.46	0.63	0.82	1.04	1.29	1.56	1.86	2.18	2.53
15	560.0	0.50	0.68	0.89	1.13	1.40	1.69	2.01	2.36	2.73
20	520.5	0.54	0.74	0.96	1.22	1.50	1.82	2.16	2.54	2.94
25	486.6	0.58	0.79	1.03	1.30	1.61	1.94	2.31	2.71	3.15
30	457.5	0.61	0.84	1.09	1.38	1.71	2.07	2.46	2.89	3.35
35	432.2	0.65	0.89	1.16	1.46	1.81	2.19	2.60	3.06	3.54
40	410.1	0.69	0.93	1.22	1.54	1.91	2.31	2.74	3.22	3.73
45	390.7	0.72	0.98	1.28	1.62	2.00	2.42	2.88	3.38	3.92
50	373.5	0.75	1.03	1.34	1.69	2.09	2.53	3.01	3.54	4.10
55	358.1	0.79	1.07	1.40	1.77	2.18	2.64	3.14	3.69	4.28
60	344.4	0.82	1.11	1.45	1.84	2.27	2.75	3.27	3.83	4.45
65	331.9	0.85	1.15	1.51	1.91	2.35	2.85	3.39	3.98	4.61
70	320.7	0.88	1.19	1.56	1.97	2.44	2.95	3.51	4.12	4.77
75	310.4	0.91	1.23	1.61	2.04	2.52	3.05	3.62	4.25	4.93
80	301.0	0.93	1.27	1.66	2.10	2.60	3.14	3.74	4.39	5.09

Conductor Code Name		185CC AL3	
Basic / Recommended Span	(m)	100	
Temperature Shift for Creep	(Deg. C)	-15	Insert minus sign as necessary
Equivalent Percentage Increase in Tension (%)		29.1	at 15°C
Required Percentage Increase in Tension (%)		0	at 15°C

Temp. (Deg. C)	Tension (kgf)	ERECTION TABLE Sag (m) for Span Length (m) 60	70	80	90	100	110	120	130	140
-5.6	1081.7	0.26	0.35	0.46	0.59	0.72	0.87	1.04	1.22	1.42
0	969.2	0.29	0.39	0.52	0.65	0.81	0.98	1.16	1.36	1.58
5	877.7	0.32	0.44	0.57	0.72	0.89	1.08	1.28	1.50	1.74
10	795.5	0.35	0.48	0.63	0.80	0.98	1.19	1.41	1.66	1.92
15	723.1	0.39	0.53	0.69	0.88	1.08	1.31	1.56	1.83	2.12
20	660.3	0.43	0.58	0.76	0.96	1.18	1.43	1.70	2.00	2.32
25	606.2	0.46	0.63	0.82	1.04	1.29	1.56	1.86	2.18	2.53
30	560.0	0.50	0.68	0.89	1.13	1.40	1.69	2.01	2.36	2.73
35	520.5	0.54	0.74	0.96	1.22	1.50	1.82	2.16	2.54	2.94
40	486.6	0.58	0.79	1.03	1.30	1.61	1.94	2.31	2.71	3.15
45	457.5	0.61	0.84	1.09	1.38	1.71	2.07	2.46	2.89	3.35
50	432.2	0.65	0.89	1.16	1.46	1.81	2.19	2.60	3.06	3.54
55	410.1	0.69	0.93	1.22	1.54	1.91	2.31	2.74	3.22	3.73
60	390.7	0.72	0.98	1.28	1.62	2.00	2.42	2.88	3.38	3.92
65	373.5	0.75	1.03	1.34	1.69	2.09	2.53	3.01	3.54	4.10
70	358.1	0.79	1.07	1.40	1.77	2.18	2.64	3.14	3.69	4.28
75	344.4	0.82	1.11	1.45	1.84	2.27	2.75	3.27	3.83	4.45
80	331.9	0.85	1.15	1.51	1.91	2.35	2.85	3.39	3.98	4.61

Appendix 12 - 50mm XLPE Covered AAAC - High Altitude - 90m Basic

Conductor Code Name (if any)	50CC AL3
Covered Conductor Weight (kg/m)	0.21
Cross Sectional Area of Conductor (mm²)	50
Diameter of Covered Conductor (mm)	13.4
Coefficient of Linear Expansion (/Degree C)	0.000023
Modulus of Elasticity (kg/mm²)	6628.1554
Rated Breaking Strength of Conductor (kgf)	1509.18
Basic / Recommended Span (m)	90
Wind Pressure on Conductor (N/m²)	380
Radial Ice Thickness (mm)	5
Ice Density (kg/m³)	913
Absolute Maximum Working Tension (MWT) Limit (kgf)	603.7
Temperature at MWT Limit (Degrees C)	-5.6
Maximum "Everyday" Tension (EDT) Limit (kgf)	142.76027
Temperature at EDT Limit (Degrees C)	5

Maximum Conductor Tension (MCT) (kgf)	at	-5.6°C	483.1
Maximum Conductor Weight (MCW) (kg/m)			0.474
Maximum Conductor Pressure (MCP) (kg/m)			0.907
Freezing Point Tension (FPT) (kgf)	at	0°C	152.1

ORDINATES FOR PLOTTING UPLIFT AND GROUND CLEARANCE CURVES

Conductor: 50CC AL3

Temperature Shift (Deg. C) 0

Tension Reduction at 15°C (%) 5

2X Span (m)	Sag (m) for Cold Curve -5.6	Sag (m) for Range of Hot Curve Temperatures					
		50	55	60	65	70	75
40	0.26	0.45	0.47	0.48	0.49	0.51	0.52
80	1.02	1.81	1.87	1.92	1.97	2.03	2.08
120	2.30	4.08	4.20	4.32	4.44	4.56	4.67
160	4.09	7.25	7.47	7.68	7.90	8.10	8.30
200	6.39	11.33	11.67	12.01	12.34	12.66	12.97
240	9.20	16.31	16.81	17.29	17.76	18.23	18.68
280	12.53	22.20	22.88	23.53	24.18	24.81	25.43
320	16.36	29.00	29.88	30.74	31.58	32.40	33.21
360	20.71	36.70	37.82	38.90	39.97	41.01	42.03
400	25.57	45.31	46.69	48.03	49.34	50.63	51.89
440	30.93	54.83	56.49	58.12	59.71	61.26	62.79
480	36.81	65.25	67.23	69.16	71.06	72.91	74.72
520	43.20	76.57	78.90	81.17	83.39	85.56	87.69

Appendix 12a - 50mm XLPE Covered AAAC - High Altitude - 90m Basic

Conductor Code Name		50CC AL3	
Basic / Recommended Span	(m)	90	
Temperature Shift for Creep	(Deg. C)	0	Insert minus sign as necessary
Equivalent Percentage Increase in Tension (%)		0.0	at 15°C
Required Percentage Increase in Tension (%)		0	at 15°C

Temp. (Deg. C)	Tension (kgf)	DESIGN TABLE Sag (m) for Span Length (m) 60	70	80	90	100	110	120	130	140
-5.6	164.3	0.58	0.78	1.02	1.29	1.60	1.93	2.30	2.70	3.13
0	152.1	0.62	0.85	1.10	1.40	1.73	2.09	2.49	2.92	3.38
5	142.8	0.66	0.90	1.18	1.49	1.84	2.22	2.65	3.11	3.60
10	134.7	0.70	0.96	1.25	1.58	1.95	2.36	2.81	3.29	3.82
15	127.6	0.74	1.01	1.32	1.67	2.06	2.49	2.96	3.48	4.03
20	121.4	0.78	1.06	1.38	1.75	2.16	2.62	3.11	3.66	4.24
25	115.8	0.82	1.11	1.45	1.84	2.27	2.74	3.26	3.83	4.44
30	110.9	0.85	1.16	1.51	1.92	2.37	2.86	3.41	4.00	4.64
35	106.5	0.89	1.21	1.58	2.00	2.46	2.98	3.55	4.16	4.83
40	102.6	0.92	1.25	1.64	2.07	2.56	3.10	3.68	4.32	5.01
45	99.0	0.95	1.30	1.70	2.15	2.65	3.21	3.82	4.48	5.20
50	95.7	0.99	1.34	1.75	2.22	2.74	3.32	3.95	4.63	5.37
55	92.8	1.02	1.39	1.81	2.29	2.83	3.42	4.07	4.78	5.55
60	90.0	1.05	1.43	1.87	2.36	2.92	3.53	4.20	4.93	5.71
65	87.5	1.08	1.47	1.92	2.43	3.00	3.63	4.32	5.07	5.88
70	85.2	1.11	1.51	1.97	2.50	3.08	3.73	4.44	5.21	6.04
75	83.0	1.14	1.55	2.02	2.56	3.16	3.83	4.55	5.34	6.20
80	81.0	1.17	1.59	2.07	2.63	3.24	3.92	4.67	5.48	6.35

Conductor Code Name		50CC AL3	
Basic / Recommended Span	(m)	90	
Temperature Shift for Creep	(Deg. C)	-10	Insert minus sign as necessary
Equivalent Percentage Increase in Tension (%)		11.9	at 15°C
Required Percentage Increase in Tension (%)		0	at 15°C

Temp. (Deg. C)	Tension (kgf)	ERECTION TABLE Sag (m) for Span Length (m) 60	70	80	90	100	110	120	130	140
-5.6	191.8	0.49	0.67	0.88	1.11	1.37	1.66	1.97	2.31	2.68
0	175.4	0.54	0.73	0.96	1.21	1.50	1.81	2.16	2.53	2.93
5	162.9	0.58	0.79	1.03	1.31	1.61	1.95	2.32	2.72	3.16
10	152.1	0.62	0.85	1.10	1.40	1.73	2.09	2.49	2.92	3.38
15	142.8	0.66	0.90	1.18	1.49	1.84	2.22	2.65	3.11	3.60
20	134.7	0.70	0.96	1.25	1.58	1.95	2.36	2.81	3.29	3.82
25	127.6	0.74	1.01	1.32	1.67	2.06	2.49	2.96	3.48	4.03
30	121.4	0.78	1.06	1.38	1.75	2.16	2.62	3.11	3.66	4.24
35	115.8	0.82	1.11	1.45	1.84	2.27	2.74	3.26	3.83	4.44
40	110.9	0.85	1.16	1.51	1.92	2.37	2.86	3.41	4.00	4.64
45	106.5	0.89	1.21	1.58	2.00	2.46	2.98	3.55	4.16	4.83
50	102.6	0.92	1.25	1.64	2.07	2.56	3.10	3.68	4.32	5.01
55	99.0	0.95	1.30	1.70	2.15	2.65	3.21	3.82	4.48	5.20
60	95.7	0.99	1.34	1.75	2.22	2.74	3.32	3.95	4.63	5.37
65	92.8	1.02	1.39	1.81	2.29	2.83	3.42	4.07	4.78	5.55
70	90.0	1.05	1.43	1.87	2.36	2.92	3.53	4.20	4.93	5.71
75	87.5	1.08	1.47	1.92	2.43	3.00	3.63	4.32	5.07	5.88
80	85.2	1.11	1.51	1.97	2.50	3.08	3.73	4.44	5.21	6.04

Appendix 13 - 120mm XLPE Covered AAAC - High Altitude - 90m Basic

Conductor Code Name (if any)	120CC AL3
Covered Conductor Weight (kg/m)	0.43
Cross Sectional Area of Conductor (mm²)	120
Diameter of Covered Conductor (mm)	18.4
Coefficient of Linear Expansion (/Degree C)	0.000023
Modulus of Elasticity (kg/mm²)	6424.2121
Rated Breaking Strength of Conductor (kgf)	3609.7954
Basic / Recommended Span (m)	80
Wind Pressure on Conductor (N/m²)	570
Radial Ice Thickness (mm)	12.5
Ice Density (kg/m³)	913
Absolute Maximum Working Tension (MWT) Limit (kgf)	1804.9
Temperature at MWT Limit (Degrees C)	-5.6
Maximum "Everyday" Tension (EDT) Limit (kgf)	428.28081
Temperature at EDT Limit (Degrees C)	5

Maximum Conductor Tension (MCT) (kgf)	at	-5.6°C	1367.9
Maximum Conductor Weight (MCW) (kg/m)			1.538
Maximum Conductor Pressure (MCP) (kg/m)			2.523
Freezing Point Tension (FPT) (kgf)	at	0°C	476.9

ORDINATES FOR PLOTTING UPLIFT AND GROUND CLEARANCE CURVES

Conductor: 120CC AL3

Temperature Shift (Deg. C) 0

Tension Reduction at 15°C (%) 10

2X Span (m)	Sag (m) for Cold Curve -5.6	Sag (m) for Range of Hot Curve Temperatures					
		50	55	60	65	70	75
40	0.16	0.42	0.43	0.45	0.47	0.49	0.50
80	0.64	1.67	1.74	1.81	1.88	1.95	2.01
120	1.43	3.75	3.91	4.07	4.23	4.38	4.52
160	2.55	6.66	6.95	7.24	7.51	7.78	8.04
200	3.98	10.41	10.86	11.31	11.74	12.16	12.57
240	5.74	14.99	15.65	16.28	16.90	17.51	18.10
280	7.81	20.40	21.30	22.16	23.01	23.83	24.63
320	10.20	26.64	27.81	28.95	30.05	31.13	32.17
360	12.91	33.72	35.20	36.64	38.04	39.39	40.72
400	15.94	41.63	43.46	45.23	46.96	48.63	50.27
440	19.29	50.37	52.59	54.73	56.82	58.85	60.82
480	22.95	59.95	62.58	65.14	67.62	70.03	72.38
520	26.94	70.36	73.45	76.45	79.36	82.19	84.95

Appendix 13a - 120mm XLPE Covered AAAC - High Altitude - 90m Basic

Conductor Code Name		120CC AL3	
Basic / Recommended Span	(m)	80	
Temperature Shift for Creep	(Deg. C)	0	Insert minus sign as necessary
Equivalent Percentage Increase in Tension (%)		0.0	at 15°C
Required Percentage Increase in Tension (%)		0	at 15°C

Temp. (Deg. C)	Tension (kgf)	DESIGN TABLE Sag (m) for Span Length (m) 60	70	80	90	100	110	120	130	140
-5.6	539.6	0.36	0.49	0.64	0.81	1.00	1.21	1.43	1.68	1.95
0	476.9	0.41	0.55	0.72	0.91	1.13	1.36	1.62	1.90	2.21
5	428.3	0.45	0.61	0.80	1.02	1.26	1.52	1.81	2.12	2.46
10	386.7	0.50	0.68	0.89	1.13	1.39	1.68	2.00	2.35	2.72
15	351.5	0.55	0.75	0.98	1.24	1.53	1.85	2.20	2.58	3.00
20	321.9	0.60	0.82	1.07	1.35	1.67	2.02	2.40	2.82	3.27
25	297.1	0.65	0.89	1.16	1.47	1.81	2.19	2.61	3.06	3.55
30	276.2	0.70	0.95	1.25	1.58	1.95	2.36	2.80	3.29	3.81
35	258.4	0.75	1.02	1.33	1.68	2.08	2.52	3.00	3.52	4.08
40	243.2	0.80	1.08	1.41	1.79	2.21	2.67	3.18	3.74	4.33
45	230.0	0.84	1.14	1.50	1.89	2.34	2.83	3.36	3.95	4.58
50	218.6	0.89	1.20	1.57	1.99	2.46	2.98	3.54	4.16	4.82
55	208.5	0.93	1.26	1.65	2.09	2.58	3.12	3.71	4.36	5.05
60	199.6	0.97	1.32	1.72	2.18	2.69	3.26	3.88	4.55	5.28
65	191.7	1.01	1.37	1.79	2.27	2.80	3.39	4.04	4.74	5.50
70	184.6	1.05	1.43	1.86	2.36	2.91	3.52	4.19	4.92	5.71
75	178.1	1.09	1.48	1.93	2.44	3.02	3.65	4.35	5.10	5.91
80	172.3	1.12	1.53	2.00	2.53	3.12	3.78	4.49	5.27	6.12

Conductor Code Name		120CC AL3	
Basic / Recommended Span	(m)	80	
Temperature Shift for Creep	(Deg. C)	-15	Insert minus sign as necessary
Equivalent Percentage Increase in Tension (%)		35.7	at 15°C
Required Percentage Increase in Tension (%)		0	at 15°C

Temp. (Deg. C)	Tension (kgf)	ERECTION TABLE Sag (m) for Span Length (m) 60	70	80	90	100	110	120	130	140
-5.6	743.7	0.26	0.35	0.46	0.59	0.72	0.87	1.04	1.22	1.42
0	662.3	0.29	0.40	0.52	0.66	0.81	0.98	1.17	1.37	1.59
5	594.5	0.33	0.44	0.58	0.73	0.90	1.09	1.30	1.53	1.77
10	532.4	0.36	0.49	0.65	0.82	1.01	1.22	1.45	1.71	1.98
15	476.9	0.41	0.55	0.72	0.91	1.13	1.36	1.62	1.90	2.21
20	428.3	0.45	0.61	0.80	1.02	1.26	1.52	1.81	2.12	2.46
25	386.7	0.50	0.68	0.89	1.13	1.39	1.68	2.00	2.35	2.72
30	351.5	0.55	0.75	0.98	1.24	1.53	1.85	2.20	2.58	3.00
35	321.9	0.60	0.82	1.07	1.35	1.67	2.02	2.40	2.82	3.27
40	297.1	0.65	0.89	1.16	1.47	1.81	2.19	2.61	3.06	3.55
45	276.2	0.70	0.95	1.25	1.58	1.95	2.36	2.80	3.29	3.81
50	258.4	0.75	1.02	1.33	1.68	2.08	2.52	3.00	3.52	4.08
55	243.2	0.80	1.08	1.41	1.79	2.21	2.67	3.18	3.74	4.33
60	230.0	0.84	1.14	1.50	1.89	2.34	2.83	3.36	3.95	4.58
65	218.6	0.89	1.20	1.57	1.99	2.46	2.98	3.54	4.16	4.82
70	208.5	0.93	1.26	1.65	2.09	2.58	3.12	3.71	4.36	5.05
75	199.6	0.97	1.32	1.72	2.18	2.69	3.26	3.88	4.55	5.28
80	191.7	1.01	1.37	1.79	2.27	2.80	3.39	4.04	4.74	5.50

Appendix 14 - 185mm XLPE Covered AAAC - High Altitude - 90m Basic

Conductor Code Name (if any)	185CC AL3
Covered Conductor Weight (kg/m)	0.625
Cross Sectional Area of Conductor (mm²)	185
Diameter of Covered Conductor (mm)	21.8
Coefficient of Linear Expansion (/Degree C)	0.000023
Modulus of Elasticity (kg/mm²)	6424.2121
Rated Breaking Strength of Conductor (kgf)	5567.6505
Basic / Recommended Span (m)	90
Wind Pressure on Conductor (N/m²)	570
Radial Ice Thickness (mm)	12.5
Ice Density (kg/m³)	913
Absolute Maximum Working Tension (MWT) Limit (kgf)	1814.0
Temperature at MWT Limit (Degrees C)	-5.6
Maximum "Everyday" Tension (EDT) Limit (kgf)	660.26625
Temperature at EDT Limit (Degrees C)	5

Maximum Conductor Tension (MCT) (kgf)	at	-5.6°C	1814.0
Maximum Conductor Weight (MCW) (kg/m)			1.855
Maximum Conductor Pressure (MCP) (kg/m)			2.720
Freezing Point Tension (FPT) (kgf)	at	0°C	679.2

ORDINATES FOR PLOTTING UPLIFT AND GROUND CLEARANCE CURVES

Conductor: 185CC AL3

Temperature Shift (Deg. C) 0
Tension Reduction at 15°C (%) 10

2X Span (m)	Sag (m) for Cold Curve -5.6	Sag (m) for Range of Hot Curve Temperatures					
		50	55	60	65	70	75
40	0.16	0.39	0.41	0.42	0.44	0.45	0.47
80	0.66	1.57	1.63	1.69	1.75	1.80	1.86
120	1.48	3.52	3.66	3.80	3.93	4.06	4.19
160	2.62	6.26	6.51	6.75	6.99	7.22	7.44
200	4.10	9.78	10.17	10.55	10.92	11.28	11.63
240	5.90	14.09	14.65	15.19	15.72	16.24	16.74
280	8.03	19.18	19.94	20.68	21.40	22.10	22.79
320	10.49	25.05	26.04	27.01	27.95	28.87	29.76
360	13.28	31.70	32.96	34.18	35.38	36.54	37.67
400	16.40	39.14	40.69	42.20	43.67	45.11	46.50
440	19.84	47.35	49.24	51.07	52.85	54.58	56.27
480	23.61	56.36	58.60	60.77	62.89	64.95	66.97
520	27.71	66.14	68.77	71.32	73.81	76.23	78.59

Appendix 14a - 185mm XLPE Covered AAAC - High Altitude - 90m Basic

Conductor Code Name		185CC AL3	
Basic / Recommended Span	(m)	90	
Temperature Shift for Creep	(Deg. C)	0	Insert minus sign as necessary
Equivalent Percentage Increase in Tension (%)		0.0	at 15°C
Required Percentage Increase in Tension (%)		0	at 15°C

Temp. (Deg. C)	Tension (kgf)	DESIGN TABLE Sag (m) for Span Length (m) 60	70	80	90	100	110	120	130	140
-5.6	762.3	0.37	0.50	0.66	0.83	1.02	1.24	1.48	1.73	2.01
0	679.2	0.41	0.56	0.74	0.93	1.15	1.39	1.66	1.94	2.25
5	615.9	0.46	0.62	0.81	1.03	1.27	1.53	1.83	2.14	2.49
10	562.1	0.50	0.68	0.89	1.13	1.39	1.68	2.00	2.35	2.72
15	516.6	0.54	0.74	0.97	1.22	1.51	1.83	2.18	2.56	2.96
20	478.2	0.59	0.80	1.05	1.32	1.63	1.98	2.35	2.76	3.20
25	445.5	0.63	0.86	1.12	1.42	1.75	2.12	2.53	2.96	3.44
30	417.7	0.67	0.92	1.20	1.52	1.87	2.26	2.69	3.16	3.67
35	393.7	0.71	0.97	1.27	1.61	1.98	2.40	2.86	3.35	3.89
40	372.9	0.75	1.03	1.34	1.70	2.09	2.53	3.02	3.54	4.11
45	354.7	0.79	1.08	1.41	1.78	2.20	2.66	3.17	3.72	4.32
50	338.7	0.83	1.13	1.48	1.87	2.31	2.79	3.32	3.90	4.52
55	324.5	0.87	1.18	1.54	1.95	2.41	2.91	3.47	4.07	4.72
60	311.7	0.90	1.23	1.60	2.03	2.51	3.03	3.61	4.24	4.91
65	300.3	0.94	1.27	1.67	2.11	2.60	3.15	3.75	4.40	5.10
70	289.9	0.97	1.32	1.72	2.18	2.69	3.26	3.88	4.55	5.28
75	280.5	1.00	1.36	1.78	2.26	2.78	3.37	4.01	4.71	5.46
80	271.9	1.03	1.41	1.84	2.33	2.87	3.48	4.14	4.86	5.63

Conductor Code Name		185CC AL3	
Basic / Recommended Span	(m)	90	
Temperature Shift for Creep	(Deg. C)	-15	Insert minus sign as necessary
Equivalent Percentage Increase in Tension (%)		31.5	at 15°C
Required Percentage Increase in Tension (%)		0	at 15°C

Temp. (Deg. C)	Tension (kgf)	ERECTION TABLE Sag (m) for Span Length (m) 60	70	80	90	100	110	120	130	140
-5.6	1045.9	0.27	0.37	0.48	0.61	0.75	0.90	1.08	1.26	1.46
0	930.6	0.30	0.41	0.54	0.68	0.84	1.02	1.21	1.42	1.65
5	836.7	0.34	0.46	0.60	0.76	0.93	1.13	1.34	1.58	1.83
10	752.8	0.37	0.51	0.66	0.84	1.04	1.26	1.49	1.75	2.03
15	679.2	0.41	0.56	0.74	0.93	1.15	1.39	1.66	1.94	2.25
20	615.9	0.46	0.62	0.81	1.03	1.27	1.53	1.83	2.14	2.49
25	562.1	0.50	0.68	0.89	1.13	1.39	1.68	2.00	2.35	2.72
30	516.6	0.54	0.74	0.97	1.22	1.51	1.83	2.18	2.56	2.96
35	478.2	0.59	0.80	1.05	1.32	1.63	1.98	2.35	2.76	3.20
40	445.5	0.63	0.86	1.12	1.42	1.75	2.12	2.53	2.96	3.44
45	417.7	0.67	0.92	1.20	1.52	1.87	2.26	2.69	3.16	3.67
50	393.7	0.71	0.97	1.27	1.61	1.98	2.40	2.86	3.35	3.89
55	372.9	0.75	1.03	1.34	1.70	2.09	2.53	3.02	3.54	4.11
60	354.7	0.79	1.08	1.41	1.78	2.20	2.66	3.17	3.72	4.32
65	338.7	0.83	1.13	1.48	1.87	2.31	2.79	3.32	3.90	4.52
70	324.5	0.87	1.18	1.54	1.95	2.41	2.91	3.47	4.07	4.72
75	311.7	0.90	1.23	1.60	2.03	2.51	3.03	3.61	4.24	4.91
80	300.3	0.94	1.27	1.67	2.11	2.60	3.15	3.75	4.40	5.10