Part of Energy Queensland

Overhead Assets Standard

Standard for Distribution Line Design Overhead

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Abstract: Design standards for overhead line design

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1. Overview

1.1 Purpose

This Standard for Distribution Line Design Overhead has been compiled in order to provide support for layout staff and asset managers in the application of Ergon Energy Corporation's Construction Standards.

It replaces the content in Blue Binder (Design Manual) overhead section currently in circulation. This section of the Blue Binder can be disposed of accordingly. All references to distribution line design overhead shall be carried in accordance with this document.

1.2 Scope

This standard contains design information and guidelines necessary to allow use of the Overhead Construction Standards structures in a manner consistent with optimum economic, reliability and safety objectives.

It is proposed that the standard will be expanded in conjunction with future issues of the Overhead Construction Manual.

The provisions of this standard are in accordance with relevant Australian Standards and / or recognised electricity design practice and have RPEQ sign off. Designs carried out in accordance with this standard can be considered to comply in this regard.

This standard is based on the current design philosophies of Limit State design which supersede the Working Load Approach.

A key element of this design standard is the provision of the design software, developed in Visual Basic, which support the standard range of conductor and structure types. Descriptions of these programs are detailed in Appendix A – Overhead Design Programs. Duties for structures in commonly used situations are also tabulated within the document.

This design software is proposed as a basic tool. Some of the functions of the design software have been incorporated into the CATAN design and layout package. The base data and assumptions underlying the design software are also provided.

Support for this design standard is available from the Line Standards staff as follows:

Overhead	Fabio Zaini, Melissa St John, Simon Lewis, Jegan Ramasubramanian, Craig Avenell, Paul Relf & Marcella Huismans
Underground & Public Lighting	MD Shihabul Islam, Boyd Brunsmann, Shaye Byrne, & Kim Slater
Materials	David Knox
Estimating & Compatible Units	Darren Sayers & Leon Burton
Drafting	Leon Burton & Tim Borg

2. References

2.1 Legislation, Regulations, Rules, and Codes

This document refers to the following:

Legislation, regulations, rules, and codes
Electrical Safety Act 2002
Electrical Safety Regulation 2002
Work Health and Safety Act 2011
Work Health and Safety Regulation 2011
Electricity Act 1994
Electricity Regulation 2006
ASCE No. 74 - Guidelines for Electrical Transmission Line Structural Loading - 3rd Ed.
Building Code of Australia (BCA) – National Construction Code 2012

2.2 Controlled Documents

Magnetic Field Calculator - 2914132

Standard for Electric and Magnetic Field Design - 3060782

2.3 Other Documents

Document number or location (if applicable)	Document name	Document type
AS/NZS 1163	Cold-formed structural steel hollow sections	Australian Standard
AS 1720.1	Timber structures - Design methods	Australian Standard
AS 1824.2-1985	AS 1824.2-1985: Insulation coordination (phase-to-earth and phase-to-phase, above 1 kV) - Application guide	Australian Standard
AS 2082-2007	Timber - Hardwood - Visually stress-graded for structural purposes	Australian Standard
AS 3891.1-2008	Air navigation - Cables and their supporting structures - Marking and safety requirements - Permanent marking of overhead cables and their supporting structures for other than planned low-level flying	Australian Standard
AS6947-2009	Crossing of Waterways by Electricity Infrastructure	Australian Standard

AS/NZS 7000:2016	Overhead line design - Detailed procedures	Australian Standard
C(b)1-1991 (Superseded by AS7000)	Electricity Supply Association of Australia (ESAA) – Guidelines for Design and Maintenance of Overhead distribution and Transmission Lines	ESAA Guidelines
Electrical Safety Regulation 2002	Electrical Safety Regulation 2002 (superseded)	Queensland Regulation
Water Act 2000	Water Act 2000	Legislation

2.4 Other Sources

IDAS Development Application Steps:

https://planning.statedevelopment.qld.gov.au/development-application

Riverine protection permit exemption requirements

https://www.business.qld.gov.au/industries/mining-energy-water/water/authorisations/riverine-protection

Coastal Management District Search Application Form

http://www.ehp.qld.gov.au/

Development Approvals Searches (Coastal) Application Form

http://www.ehp.qld.gov.au/

IDAS Application Forms

https://www.statedevelopment.qld.gov.au/economic-development-qld/forms-guidelines-practice-notes

IDAS Development Application Form 1

https://planning.statedevelopment.qld.gov.au/planning-framework/development-assessment/development-assessment-process/forms-and-templates

IDAS Assessment Checklist

https://planning.statedevelopment.qld.gov.au/planning-framework/state-assessment-and-referral-agency/state-development-assessment-provisions-sdap

Prescribed Tidal Work Information sheet

https://www.qld.gov.au/environment/coasts-waterways/plans/resources

Guideline: Local government assessment of Prescribed Tidal Works

https://www.business.qld.gov.au/running-business/environment/licences-permits/applying/assessment

Guideline: Making an application for prescribed tidal work

https://www.business.qld.gov.au/running-business/environment/licences-permits/applying/types

Operational Policy, Building and Engineering Standards for Tidal Works

http://www.ehp.qld.gov.au/coastal/development/pdf/building-engineering-standards-tidal-works.pdf

Guideline: Assessable coastal development https://www.qld.gov.au/environment/coasts-waterways/plans/development/about

Guideline: Owner's Consent for assessable coastal development

https://www.qld.gov.au/environment/coasts-waterways/plans/resources

3. Definitions and Abbreviations

3.1 Definitions

Where definitions are required, they have been included in the relevant sections of the document.

3.2 Abbreviations

AAC	All Aluminium Conductor
ABC	Aerial Bundled Conductor
ACSR	All Aluminium Conductor Steel Reinforcement
AAAC	All Aluminium Alloy Conductor
ACR	Automatic Circuit Recloser
CA	Capricornia (Central Queensland)
CCA	Copper Chrome Arsenate (Treated Timber)
CMEN	Common Multiple Earth Neutral
EDT	Every Day Tension
EMF	Electro-Magnetic Field
FN	Far North (Queensland)
HAT	Highest Astronomical Tide
HDC	Hard Drawn Copper
HV	High Voltage
kVA	Kilo Volt Amperes
kN	Kilo Newtons
LV	Low Voltage
MES	Mean Equivalent Span (also Ruling Span)
MHWS	Mean High Water Springs
MK	Mackay (Queensland)
MPa	Mega Pascal
MSQ	Maritime Safety Queensland
NQ	North Queensland
OH	Overhead
OHEW	Overhead Earth Wire
Pa	Pascal
RL	Relative Level

RMS	Root Mean Squared
RPEQ	Registered Professional Engineer of Queensland
SC	Steel Conductor
SCM	Standard Construction Manual
SW	South West (Queensland)
SWER	Single Wire Earth Return
V.P.I.	Vacuum / Pressure Impregnation (Treated Timber)
WB	Wide Bay (Queensland)
°C	Degrees Celsius (Temperature)
/AC	Aluminium Clad
/AZ	Alumoweld
/GZ	Galvanised

Note: Some Abbreviations for section 12 are defined in that section as they are only relevant to that section.

4. Design Summary

4.1 Limit State Design

Practice for the design of Overhead Line Structural Components is to use a Limit State design approach as set out in AS/NZS 7000 Overhead Line Design.

The Limit State design approach uses a reliability based (risk of failure) approach to match component strengths (modified by a factor to reflect strength variability) to the effect of loads calculated on the basis of an acceptably low probability of occurrence. This approach allows component strengths to be more readily matched and optimised by economic comparison.

The Limit State wind pressures of approximately 900Pa and 1200Pa correspond to the previously used working stress values of 500Pa and 660Pa respectively. These result in equivalent failure rates based on typical component strength factors and appropriate component reliability factors. Limit State wind load pressures are therefore greater than permissible stress loads by a factor of 1.8.

Conductor tension loads will increase in response to the higher design wind pressures by a factor depending on conductor everyday tension and conductor characteristics and are generally in the range 1.3 to 1.6.

Conductor weight loads will increase due to the effect of increased tension on structures with a height profile above the average of neighbouring structures, however in general this factor is fairly minimal in relatively flat terrain.

In general, allowable structure duties under this approach are not significantly different to the working stress approach.

Design Component stresses are based on the ultimate stress at failure modified by a strength factor which takes into account the material strength variability.

Design component stresses are listed in the relevant sections.

4.1.1 The Ultimate Strength Limit State Condition

$\phi R > \gamma W_n + 1.25G_c + 1.1G_s + \gamma_x F_t$

Where:

γW_n	=	Effect of transverse wind loads
G_c	=	Vertical dead loads resulting from conductors under limit state wind conditions
G_s	=	Vertical dead loads resulting from non conductor loads
F_t	=	Intact conductor tension loads under limit state wind conditions
ϕR	=	Component design stress for limit state condition
γ_x	=	Load factor applied to intact conductor loads taken as 1.25

4.1.2 The Maintenance Load Condition

$\phi R > 1.1G_s + 1.5\,G_c + 2.0Q + 1.5\,F_t$

Where:

G_c	=	Vertical dead loads resulting from conductors under everyday condition
G_s	=	Vertical dead loads resulting from non conductor loads
Q	=	Maintenance loads - applies to conductors under maintenance

F_t	=	Intact conductor tension loads under maintenance wind condition
ϕR	=	Component design stress for maintenance loads

4.1.3 The Sustained Load Condition

$\phi R > 1.25\ G_c + 1.1\ G_s + 1.1\ F_{te}$

Where:

G_c	=	Effect of vertical dead loads resulting from conductors under everyday conductor tension loads
G_s	=	Effect of vertical dead loads resulting from non conductor loads
F_{te}	=	Effect of intact conductor tension loads under every day (15°C no wind) conditions
ϕR	=	Component design stress for long duration loads

4.2 Design Wind Pressures

An assessment of design wind pressures is necessary to determine the wind loadings to be applied to distribution line components as follows:

- Wind load on the pole element
- Transverse wind load on conductors
- Increase in conductor tension due to the transverse load applied by the wind action
- Wind load on insulators, crossarms and other fittings

Wind pressures have been rationalised to two sets of figures to cater for areas of Queensland subject to the influence of tropical cyclones and other areas as follows:

- Areas subject to the influence of Tropical cyclones, defined as Region C are within 50km of the coast in locations above latitude 25° i.e., from Bundaberg north.
- Areas not likely to be subjected to tropical cyclones consist of the remainder of the state, defined as Regions A and B or Region AB.

Design wind pressures for the determination of conductor transverse wind loads and longitudinal tension loads are as follows:

- Region C – exposed to tropical cyclones 1200Pa @ 25°C
- Remainder of State (Regions A and B) 900Pa @ 25°C

Design wind pressures for the determination of wind on poles, elements, insulators and hardware are as follows:

- Region C – exposed to tropical cyclones 1700Pa @ 25°C
- Remainder of State (Regions A and B) 1300Pa @ 25°C

These wind pressures correspond to wind speeds of 184km/h and 160km/h respectively.

These wind pressures provide for a return period of better than 50 years in accordance with the provisions of AS/NZS 7000 and approximately relate to the superseded working wind figures by a factor of 1.8.

4.2.1 Special Situations

In situations of above average exposure, e.g., elevated and exposed coastal locations in a cyclone prone area, higher figures would be appropriate. Such a situation may be a structure located on an exposed coastal escarpment or hill and a design pressure increase of the order of 20% may be appropriate.

Conversely, for lines of a temporary nature in a protected environment, reduced figures may be appropriate.

Consideration should also be given to the importance of the load supplied.

4.2.2 Maintenance Wind Pressures

For determination of maintenance loadings, a nominal wind pressure of 100Pa @ 15°C is proposed. This corresponds to a wind speed of 44km/h.

4.2.3 Wind Pressures for Clearances

Wind pressures for calculation of clearances to structures etc. should be based on a design pressure of 500Pa @ 35°C in accordance with the recommendations of AS/NZS 7000. This corresponds to a wind speed of 100km/h.

5. Conductor Design

5.1 Standard Conductor Applications

5.1.1 Conductor Selection

Economically, conductors represent between 20 to 40% of the total cost of a line. Consequently, their selection is of prime importance. In earlier days of electrical power transmission, copper was mainly used as the material of overhead line conductors, however with the expansion of electricity networks, several factors, such as price, weight, availability and conductivity have virtually compelled Designers to concentrate on aluminium based conductors as listed below.

AAC = All Aluminium Conductor

ACSR = All Aluminium Conductor Steel Reinforcement

AAAC = All Aluminium Alloy Conductor

Steel conductors are still widely used as overhead earth wires and also as phase conductors on rural distribution lines as listed below.

SC/GZ = Galvanised Steel Conductor

SC/AC = Aluminium Clad Steel Conductor

Phase conductors fulfil an electromechanical function; hence both the electrical and mechanical aspects are to be considered.

The most important parameter affecting the choice of conductor is its resistance because it influences voltage regulation, power loss and current rating.

For AC lines, the diameter of a conductor affects the inductance and the capacities. Up to a voltage of 132kV, the above considerations are generally adequate, however at higher voltages, the above gradient on the conductor surface may require the selection of a conductor on the basis of its diameter, thus leading to the use of bundled conductor (i.e., 2, 3 or 4 phase).

As already indicated aluminium based conductors represent the highest proportion of conductor usage. The advantageous mechanical properties of aluminium alloys have also been recognised for a long time, but AAAC has always been more expensive than ACSR, for equivalent conductivities. However, there are cases where initial cost is not the governing factor. One of these is the corrosion performance, since being monometallic, the risk of bimetallic corrosion between the aluminium and the zinc on the steel core are non-existent. Consequently, AAAC conductors are used on lines in coastal areas.

5.1.2 Conductor Degradation

Table 6-1 provides an indication of the relative corrosion performance of various conductor types. The recommendations should be modified by local experience, for example, for salt spray pollution the relative distances from the source depend upon the prevailing winds and the terrain. Special circumstances such as crop dusting, which has been known to have severe effects, should also be taken into account.

Table 5-1 – Indication of relative corrosion performance of conductors

Conductor Type	Salt Spray Pollution		Industrial Pollution	
	Open Ocean	Bays Inlets Salt Lakes	Acidic	Alkaline
AAC	1	1	1	3
AAC/6201	1	1	2	3
AAAC/1120	1	1	1	3
ACSR/GZ	3	2	2	3
ACSR/AZ	2	1	2	3
ACSR/AC	1	1	2	3
SC/GZ	3	2	3	2
SC/AC	1	1	2	3
HDC	1	1	2	1

Note:

1 = Good performance

2 = Average performance

3 = Poor performance

5.1.3 Conductor Tensions

Stringing tensions for use as a standard for distribution use is listed in section 5.3. Applications for the bare conductors will generally be for HV with LV ABC used for LV applications; however, the bare conductor tensions are also suitable for use on LV as a non-preferred construction.

The applications described are defined briefly as follows:

- *Urban Slack* – Span lengths up to around 40m in locations where staying is difficult or not practical.
- *Urban Standard* – Span lengths typically in the range 40 – 60m in a typical urban environment.
- *Semi Urban* – Span lengths typically up to 80 or 100m in rural ranchette type subdivisions.
- *Rural* – Span lengths generally greater than 150m (with the exception of LV ABC). AAC conductors would generally be used for spans up to around 150m with higher strength conductors for longer spans as appropriate.

These tensions are a rationalisation of tensions already generally in use and are considered to be a reasonable compromise between layout economies and construction and maintenance practicalities. Use of reduced tensions in situations such as short slack off spans to avoid staying is permissible at the discretion of the designer, however tensions in 3/2.75 SCGZ or SCAC and 3/4 and 4/3 ACSR conductors should not be reduced below 10% in consideration of the performance of preformed fittings and the tendency of these conductors to retain a spiral set at low tension.

5.1.4 Conductor Layout Temperature

Proposed conductor temperatures for layout purposes (unless specified otherwise by planning) for bare conductors are 60°C for rural applications and 75°C for urban applications. The layout temperature for LV ABC conductors is 80°C.

5.1.5 Conductor Mid-Span Clearances

Limitations on allowable spans of the same circuit to mitigate mid-span conductor clashing are as per the provisions of AS/NZS 7000 Section 3. A program for calculation allowable spans is detailed in Appendix A – Overhead Design Programs.

5.1.6 Conductor Vibration Protection

Vibration dampers are used to damp aeolian vibration which occurs when laminar wind flows across a conductor causing vortices to be shed alternatively from top to bottom of the conductor. The resultant vibration can cause severe damage to conductors and fittings. Laminar flow winds are most prevalent in early morning in winter in exposed locations. The presence of trees, buildings or other obstructions will generally break up the laminar flow.

Vibration dampers are therefore only required at rural tensions for locations which are exposed or likely to become exposed due to future timber clearing. In general, vibration dampers should be fitted in open rural or exposed coastal areas with consideration being to the possibility of future clearing in the vicinity of the line. Fit 1 damper per conductor span, except in known bad vibration areas fit 2 dampers per conductor per span.

5.2 Conductor Sag and Tension

5.2.1 Parabola vs Catenary Assumptions

Conductor tension calculations for distribution are generally carried out using parabolic assumptions. A parabola is the shape that is formed by a cable supporting an evenly distributed horizontal weight where as a catenary is the shape that is formed by a hanging cable whose weight is a constant per unit of arc length. The word *catenary* comes from the Latin word *catena*, meaning chain.

Provided that the sag is less than 9% of the span length, there is less than 1% difference in their shapes. So, for most practical distribution applications the parabola will suffice. The mathematical formulae which are derived for the parabola are much simpler than the catenary formulae.

5.2.2 Sag

The following formula for the sag in a parabola can be used for level and non-level spans. A level span is a span where the conductor supports are at the same elevation.

$$S = \frac{wL^2}{8T}$$

Where:

S = mid-span sag (m)

w = conductor weight (N/m)

L = horizontal span length (m)

T = conductor tension (N)

The conductor tension T is the tension at the low point of the cable however the tension does increase with conductor elevation. The tension at the supports will be no greater than an additional 7% of the tension at the low point for a level span where the sag is less than 9% of the span length.

Normally the conductor weight is given in kg/km which must be converted into N/m to use in the above equation.

$$w = \frac{W_c \times 9.81}{1000}$$

Where:

W_c = conductor weight (kg/km)

5.2.3 Slack

The difference in distance between the straight line between the supports and the distance along the parabola arc (the stretched conductor length) is called the slack. For a level span the slack is given by:

$$K = \frac{8\,S^2}{3\,L}$$

Where:

K = slack (m)

S = mid-span sag (m)

L = span length (m

5.2.4 Factors that Affect Conductor Tension

Temperature

As the temperature increases, the unstretched conductor length will increase by an amount equal to:

$$\Delta L = \alpha TS$$

Where:

α = the coefficient of thermal expansion

T = the temperature increase in degrees Celsius

S = the span length in metres

This will result in a decrease in conductor tension and an increase in sag.

Wind

A wind load on the conductor will increase the apparent weight of the conductor resulting in an in increase in tension.

The increase in tension will increase the cable length due to elastic stretch by an amount given by:

$$\Delta L = (T_o - T) / EA$$

Where:

T_o = the initial tension in newtons

T = the final tension

E = the coefficient of elasticity

A = the cross section of the conductor in metres.

This increase in resultant load will result in an effective sag in an inclined direction with both horizontal and vertical components.

Ice

Ice build-up on the conductor will increase the apparent diameter and weight of the conductor. This is not an issue in Queensland however the same approach can be used for calculating loads and sags if bird diverters are installed along a span.

Age

Conductor sag over time may increase due to the effects of strand settling in and metallurgical creep. A higher tension may be used when the conductor is first erected to allow for “settling in of conductor strands and for subsequent metallurgical creep of the conductor material

Pole movement

Any movement of pole tops due to stay relaxation, etcetera will have the effect of introducing additional length into the span.

5.2.5 Ruling Span

The ruling span (or equivalent span) is defined as that span which behaves identically to the tension in every span of a series of suspension spans under the same loading condition. In general, the flexibility of a wood pole is sufficient to ensure that an intermediate pin structure can be considered as a suspension for the purposes of calculation of the ruling span provided that the ratio of adjacent span lengths is not too extreme (e.g., less than 1:2).

The ruling span can be calculated using:

$$L_r = \sqrt{\frac{\sum_{i=1}^{n} L_i^3}{\sum_{i=1}^{n} L_i}}$$

Where:

L_r = ruling span

L_i = horizontal span length of span I

n = number of spans between strain structures

This equation applies for lines in flat to undulating terrain. In very mountainous terrain with large differences in elevation between structures, use of Equation (S4) in Appendix S of AS/NZS 7000 Overhead Line Design – Detailed Procedures may be required.

5.2.6 Weight Span

The weight span at a structure is the length of span between the catenary low points on either side of the particular structure and determines the vertical load due to the weight of conductor at that structure.

5.2.7 Wind Span

The wind span at a particular structure is the length of span that determines the transverse load on the structure due to wind action on the conductor and is defined as:

L_w = one half the sum of the adjacent spans.

5.2.8 Conductor Tension Limitations

Conductor tension limitations are determined by the most onerous of the following conditions.

Serviceability Condition or everyday condition (relates to vibration, construction and anchoring practicalities) – as specified in the tables of section 6.3 Standard Conductor Applications at a temperature of 15°C.

Conductor Strength Limit State - Bare conductors – 72% of Conductor nominal breaking load at a temperature of 25°C.

Serviceability Condition – low temperature condition – 50% of conductor nominal breaking load. This relates to structural loadings at a temperature of 0°C. (This condition will generally never govern for the range of conditions proposed.)

Conductor Strength Limit State LV ABC conductors – 40% of Conductor nominal breaking load at a temperature of 25°C (Relates to insulation adhesion considerations).

In some cases, more than one condition may govern for different span lengths. The span at which the change occurs is called the transition span.

Conductor stringing charts from which conductor tensions can be determined for differing temperature and wind loading conditions are located in Appendix B – Stringing Charts

5.3 Standard Conductors

A set of standard conductors for distribution is contained in Tables 6-2 to 6-5. Conductors specified for new constructions should generally be chosen from the conductors in bold text. All other conductors are only intended for maintenance and special applications.

Table 6-2 – Standard Applications for AAC Conductors

AAC Conductors						
Conductor Applications						
Conductor Code	Conductor Type	Application	Urban Slack - spans up to 40m %CBL	Urban Standard - spans typically 40 - 60m %CBL	Semi Urban - spans typically 80-100m %CBL	Rural - spans around 150m %CBL
Libra	**7/3.00 AAC**	**Urban and close rural laterals**	**2.5%**	**6%**	**10%**	**20%**
Mars*	7/3.75 AAC	Maintenance, reconductoring and special applications	2.5%	6%	10%	20%
Moon*	7/4.75 AAC	Maintenance and special applications for urban and close rural backbone	2.5%	6%	10%	20%
Pluto	**19/3.75 AAC**	**Urban and close rural heavy backbone, and heavy LV open wire applications**	**2.5%**	**6%**	**10%**	**20%**
LV ABC	**4 x 95 sq mm**	**Standard LV reticulation cable**	**2.5%**	**6%**	**10%**	**N.A.**

Notes:

- Conductors in **bold** are standard conductors.
- *These conductors should only be used for maintenance and special applications.

Table 6-3 – Standard Applications for AAAC, ACSR, SC/GZ and SC/AC Conductors (Rural Only)

AAAC , ACSR , SC/GZ and SC/AC Conductors				
Conductor Applications - Rural only				
Conductor Code	Conductor Type	Application	% CBL	Typical Span
Chlorine*	7/2.5 AAAC	Maintenance, reconductoring and special applications	20%	250m
Fluorine	**7/3.00 AAAC**	**Rural lateral in coastal environment**	**20%**	**250m**
Helium*	7/3.75 AAAC	Maintenance, reconductoring and special applications	20%	250m
Iodine	**7/4.75 AAAC**	**Rural backbone**	**20%**	**250m**
Apple	**6/1/3.0 ACSR**	**Rural lateral in cyclonic or open rural area**	**22%**	**250m**
Banana*	6/1/3.75 ACSR	Maintenance, 7/104 Cu replacement and special applications	22%	250m
Raisin*	3/4/2.5 ACSR	SWER backbone for reconductoring	22%	320m
Sultana	**4/3/3.0 ACSR**	**SWER backbone**	**22%**	**320m**
3/2.75*	SC/GZ	Maintenance and SWER and light rural where work practices are not available for AC	25%	350m
3/2.75	**SC/AC**	**SWER and open rural 1 & 3 phase lateral**	**25%**	**350m**

Notes:

- Conductors in **bold** are standard conductors.
- *These conductors should only be used for maintenance and special applications.

Table 6-4 – Standard Conductors Electrical and Mechanical Properties

Conductor Code	Conductor Type	Area of Section (mm²)	Overall Diameter (mm)	Calculated Breaking Load (kN)	Unit Mass (kg/km)	Final Modulus of Elasticity (GPa)	Co-efficient of Linear Expansion (xE-6/°C)	DC Resistance (at 20°C) (ohms/km)	AC Resistance (at 75°C) (ohms/km)	Temperature Co-efficient of Resistance at 20°C (/°C)	Magnetic Effect Ratio
Libra	**7/3.00 AAC/1350**	**49.48**	**9**	**7.91**	**135**	**59**	**23**	**0.579**	**0.708**	**0.00403**	**1**
Mars*	7/3.75 AAC/1350	77.31	11.3	11.9	212	59	23	0.37	0.452	0.00403	1
Moon*	7/4.75 AAC/1350	124	14.3	18.8	340	59	23	0.232	0.284	0.00403	1
Pluto	**19/3.75 AAC/1350**	**209.8**	**18.8**	**32.3**	**578**	**56**	**23**	**0.137**	**0.168**	**0.00403**	**1**
Chlorine*	7/2.5 AAAC/1120	34.36	7.5	8.18	94	59	23	0.864	1.049	0.0039	1
Fluorine	**7/3.00 AAAC/1120**	**49.5**	**9**	**11.8**	**135**	**59**	**23**	**0.601**	**0.73**	**0.0039**	**1**
Helium*	7/3.75 AAAC/1120	77.31	11.3	17.6	211	59	23	0.383	0.465	0.0039	1
Iodine	**7/4.75 AAAC/1120**	**124**	**14.3**	**27.1**	**339**	**59**	**23**	**0.239**	**0.29**	**0.0039**	**1**
Apple	**6/1/3.0 ACSR/GZ**	**49.48**	**9**	**14.9**	**171**	**79**	**19.3**	**0.677**	**0.893**	**0.0042**	**1.1**
Banana*	6/1/3.75 ACSR/GZ	77.31	11.3	22.8	268	79	19.3	0.433	0.587	0.0042	1.1
Raisin*	3/4/2.5 ACSR/GZ	34.36	7.5	24.4	193	136	13.9	1.58	2.047	0.0042	1.06
Sultana	**4/3/3.0 ACSR/GZ**	**49.48**	**9**	**28.3**	**242**	**119**	**15.2**	**0.893**	**1.172**	**0.0042**	**1.1**
3/2.75*	SC/GZ	17.82	5.93	22.2	139	192	11.5	9.7	12.05	0.0044	1.1
3/2.75	**SC/AC**	**17.82**	**5.93**	**22.7**	**118**	**162**	**12.9**	**4.8**	**5.75**	**0.0036**	**1.1**

Conductor Code	Conductor Type	Area of Section (mm²)	Overall Diameter (mm)	Calculated Breaking Load (kN)	Unit Mass (kg/km)	Final Modulus of Elasticity (GPa)	Co-efficient of Linear Expansion (xE-6/°C)	DC Resistance (at 20°C) (ohms/km)	AC Resistance (at 80°C) (ohms/km)	Temperature Co-efficient of Resistance at 20°C (/°C)	Magnetic Effect Ratio
LV ABC	**4 x 95 mm²**	**380**	**38.4**	**53.2**	**1350**	**56**	**23**	**0.32**	**0.398**	**0.00403**	**1**
LV ABC	**4 x 50 mm²**	**200**	**28.7**	**28**	**700**	**59**	**23**	**0.641**	**0.796**	**0.00403**	**1**
LV ABC	**4 x 25 mm²**	**100**	**22.2**	**14**	**400**	**59**	**23**	**1.201**	**1.49**	**0.00403**	**1**
LV ABC	**3 x 25 mm²**	**75**	**19.8**	**10.5**	**300**	**59**	**23**	**1.201**	**1.49**	**0.00403**	**1**
LV ABC	**2 x 95 mm²**	**190**	**31.8**	**26.6**	**680**	**56**	**23**	**0.32**	**0.398**	**0.00403**	**1**
LV ABC	**2 x 50 mm²**	**100**	**23.8**	**14**	**350**	**59**	**23**	**0.641**	**0.796**	**0.00403**	**1**
LV ABC	**2 x 25 mm²**	**50**	**18.4**	**7**	**200**	**59**	**23**	**1.201**	**1.49**	**0.00403**	**1**

Notes:

- Conductors in **bold** are standard conductors.
- *These conductors should only be used for maintenance and special applications.

Table 6-5 – Superseded Conductors Electrical and Mechanical Properties

Conductor Code	Conductor Type		Area of Section (mm²)	Overall Diameter (mm)	Calculated Breaking Load (kN)	Unit Mass (kg/km)	Final Modulus of Elasticity (GPa)	Co-efficient of Linear Expansion (xE-6/°C)	DC Resistance (at 20°C) (ohms/km)	AC Resistance (at 75°C) (ohms/km)	Temperature Co-efficient of Resistance at 20°C (/°C)	Magnetic Effect Ratio
HDC Impl	7/0.064		14.57	4.87	5.97	130.55	118	17	1.242	1.502	0.00381	1
HDC Impl	7/0.080		22.7	6.1	9.45	203.4	118	17	0.797	0.964	0.00381	1
HDC Impl	7/0.104		38.36	7.92	15.76	343.9	118	17	0.472	0.571	0.00381	1
Cherry	6/4.75 7/1.6	ACSR/GZ	120.4	14.3	33.2	404	76	19.9	0.271	0.372	0.0042	1.13

Table 6-6 – Stringing Table for Services

SPAN LENGTH (m)	10	15	20	25	30	35	40	45	50
CABLE	**MINIMUM SAG @ 25°C (m)**								
2x25mm²	0.2	0.4	0.6	1.0	1.4	1.9	2.5	3.1	3.9
3x25mm²	0.2	0.4	0.70	1.1	1.5	2.1	2.7	3.4	4.2
4x25mm²	0.2	0.50	0.8	1.2	1.7	2.3	3.0	3.8	4.7
2x50mm²	0.2	0.2	0.3	0.4	0.7	0.9	1.2	1.6	1.9
4x50mm²	0.2	0.2	0.3	0.5	0.7	0.9	1.2	1.6	1.9
2x95mm²	0.2	0.20	0.30	0.5	0.7	0.9	1.2	1.5	1.9
4x95mm²	0.2	0.3	0.4	0.6	0.9	1.2	1.6	2.0	2.4

Notes:

1. Sag must be equal to or greater than that specified in the stringing table above.
2. Minimum vertical clearances to ground must be 300mm greater than the clearances listed in the section "Layout Clearances". The additional 300mm is to allow for extra sag due to heating of the cable.
3. These sags have been determined such that limit state loading restrictions on customers attachments do not result in the specific working loads of 1kN for 25mm² and 3.5kN for 50 mm² and 95mm² cables being exceeded under 1200Pa wind loading. Sags have been rounded up for practical applications.

6. Poles

6.1 Hardwood Pole Tip Loads

Pole strengths are currently specified in terms of the allowable working loads applied at the pole tip.

This nomenclature has wide acceptance and familiarity, and it is proposed that these designations remain. The equivalent limit state design stresses calculated in accordance with AS1720.1 1997 equate closely to 1.8 times these figures and the proposed limit state loadings for the current range of pole sizes is listed in tables following in this section.

The limit state stresses are equivalent to a strength factor of 0.72 which also equates to the strength factor derived from AS1720.1. Practice is to limit sustained loads on poles to 50% of the working loads as listed in the table. The resultant stresses are conservative in terms of the provisions of AS1720.1 by a factor of around 60% and make allowance for considerations of ground line deterioration and aesthetic considerations relating to pole deflection.

The equivalent pole timber design stresses which are to be used for calculation of allowable bending moments at intermediate locations on poles (e.g., stay attachment points) are as follows:

Strength Group S1:	Limit State Condition	75 MPa
	Sustained Load Condition	20 MPa
Strength Group S2:	Limit State Condition	60 MPa
	Sustained Load Condition	17 MPa
Strength Group S3:	Limit State Condition	48 MPa
	Sustained Load Condition	14 MPa

In general, Strength Group S2 poles are the most common and basing of designs on S2 stresses and diameters will be sufficiently accurate in the event that the actual pole installed is S1 or S3.

New hardwood pole strength is identifiable on the pole disc however some strength degradation occurs over time. Ergon Energy has an asset inspection program for hardwood poles. This program includes assessments that determine the extent of pole degradation and decides whether the pole remains serviceable, requires replacement or is reinforced. Part of the output of the inspection program is the calculated pole working strength (Ellipse Rating) and is based upon Working Stress Calculations. This value is recorded against the pole and used for future designs and augmentation of the line.

The calculated pole working strength needs to be converted to Limit State and the following conversions apply.

For new pole, the allowable pole strengths are based on the ultimate pole strength factored by 0.72 for Limit State, and 0.2 for sustained loads:

- Ultimate = Nominal (i.e., **Pole Disc Rating**) * 2.5
- Allowable pole strength, Limit State = Ultimate * 0.72
- Allowable pole strength, Sustained = Ultimate * 0.2

For existing pole with no change in tip load, the allowable pole strengths, for no change in the tip load, are based on the ultimate pole strength factored by 0.9 for Limit State, and 0.25 for sustained loads:

- Ultimate = **Ellipse Rating** * 2

- Allowable pole strength, Limit State = Ultimate * 0.9
- Allowable pole strength, Sustained = Ultimate * 0.25

For existing pole with a change in tip load, the allowable pole strengths, for a change in the tip load, are based on the ultimate pole strength factored by 0.72 for Limit State, and 0.2 for sustained loads

- Ultimate = **The Lesser Rating (between Pole Disc Rating and Ellipse Rating)** * 2
- Allowable pole strength, Limit State = Ultimate * 0.72
- Allowable pole strength, Sustained = Ultimate * 0.2

The information above also applies to nailed or reinstated hardwood poles and steel butted hardwood poles.

6.1.1 Foundation Loads

Consideration of foundation strength is critical if the full design capacity of the pole is to be achieved.

The recommended minimum pole setting depth (standard depth) in good soil is specified at 0.1 of pole height plus 0.6m. However, for application of Ergon Energy overhead constructions, a setting depth of 0.1 of pole height plus 0.75m is recommended as a minimum for general use.

Appendix C – Pole Characteristics and Net Allowable Pole Tip Loads list net allowable pole tip loads after allowance for wind on the pole. The shaded figures indicate that the allowable pole tip load is limited by the pole strength.

If the design relies on use of the full pole strength capability, in particular for the higher strength rated poles, and/or the foundation material is suspect then special attention must be given to the foundation design. This can be achieved by provision of additional depth and or use of stabilised backfill. In very poor soil situations, a tailored foundation design may be required. In expansive or "black soil" country, an additional 0.15 m depth is recommended.

The foundation loads listed in the tables are based on the approach used in C(b)1-1991 and formulae are listed in the program write up for the program "Allowable Pole Tip Loads" Appendix A – Overhead Design Programs.

6.1.2 Foundations in rock

Where rock is encountered in the pole foundation, the embedment depth may be able to be reduced depending on the soundness of the rock, depth that rock is encountered and the properties of the soil above the rock.

In general, the use of concrete or stabilised backfill will be necessary in order to achieve that required bearing strength to allow the design pole tip load to be achieved at a reduced embedment.

In order to facilitate pole ground line inspections, a minimum depth of 300 mm of natural backfill should be provided above the concrete.

Advice should be sought from designers when a reduction from the specified embedment depth to minimise excavation in rock is proposed.

6.1.3 Poles used for Transformer Structures

In general, the additional bending, column and wind load moments applied to a pole that result from the installation of a transformer or other pole mounted plant will be minor compared with conductor tension loads, however in view of the increased importance of these structures, an increase in specified pole strength is recommended.

The following pole sizes are recommended:

SWER transformers	8 kN
Rural transformers on the three phase system and other plant, e.g., isolators ACR's etc.	12 kN
Urban transformers 315 KVA and above	12 kN

6.1.4 Difficulties in Sourcing 12.5 and 14m 12kN Hardwood Poles

From time to time there are difficulties experienced in sourcing 12.5 and 14m 12kN hardwood poles. This section provides recommendations on the appropriate use for 12kN strength rated poles in order to minimise the demand for these poles.

There is some scope for designers to specify an 8kN pole in situations where:

- There is little likelihood of the transformer being upgraded
- There are no significant resultant loads resulting from unbalanced conductor loads
- The stay location is close to the load application point.

Use of 12kN poles would be appropriate for poles supporting high value and weight plant such as regulators or 500kVA transformers; however, for other pole mounted plant constructions, specification of an 8kN pole will generally be more than adequate.

In addition to these applications, there could be some situations where the necessity to avoid stays in urban situations requires the use of a 12kN pole for strain and angle poles. In some cases, it may be possible to modify the design parameters with regard to stringing tension and pole locations in order to avoid the need for 12kN strength rated poles.

In areas where there is an established CMEN system, it is recommended that concrete poles be used for transformer structures as a substitute for 12kN strength rated hardwood poles.

6.2 Economics of Pole Costs

Hardwood poles are significantly cheaper than other currently available alternatives for distribution applications. Except for applications involving high value plant or locations with aggressive termite activity, the whole of life costing will generally favour use of hardwood poles. This Standard considers applications where alternative pole types can offer best value as a substitute for hardwood poles and makes recommendations for their application. The benefits of deploying alternative pole types are:

- Use of alternatives will reduce requirements for hardwood poles and allow use of hardwood in situations where they are more cost effective. This typically may be for the replacement of in-service poles on a like for like basis.
- Development of alternative pole constructions will allow design and construction staff to become familiar with these alternatives and develop supply chain arrangements. This will facilitate a ramp up of the use of alternatives to hardwood should supply of hardwood become unexpectedly acute.

6.3 Step and Touch Potential Issues

The use of conducting poles such as concrete or steel poles in urban locations introduces step and touch potential issues under fault conditions. This can be addressed by adoption of a Common Multiple Earthed Neutral (CMEN) earthing system. Much of Ergon Energy's urban system is classed as separately earthed. In practice however, neutrals would already be routinely interconnected so conversion to a CMEN system could be readily achieved. Until systems are formally converted to CMEN, the use of conducting poles in urban locations in non-CMEN areas is constrained.

6.4 Alternative Pole Types

Alternative poles to hardwood are listed as follows and progress to date on developments as an alternative discussed. Also refer to Technical Instruction TSD0264 – Distribution Poles for further information.

6.4.1 Concrete Poles

Concrete poles have been used for some time within Ergon Energy for the construction of high voltage networks and other structures that require a high level of reliability. Due to the higher initial cost and considerations of step and touch potential, concrete poles have not been widely used for urban applications. The pole elements are required to have attachment holes and ferrules specified at the design stage and this tends to inhibit their use for small extensions and replacements.

There is however scope for distribution use of concrete poles for transformer structures and feeder backbone applications where the reduced maintenance and increased reliability can be justified on a whole of life basis. The economics of their use generally favour applications where longer pole lengths and higher strengths are required. These would typically be larger conductor feeder backbone or sub-transmission lines where Overhead Earth Wires (OHEW's) are required.

Standard constructions have been developed for rural 11kV, 22kV and 33kV applications which use the standard range of distribution conductors. These are included in the Concrete Pole section of the Overhead (OH) Construction Manual.

Standard constructions have also been developed for urban transformer installations, and these are included in the concrete transformer pole section of the OH Construction Manual.

6.4.2 Steel Poles

Standard constructions for rural applications using Bluescope steel pole elements have been developed and included in the OH Construction Manual. Design software is also available to facilitate the use of these designs. These constructions provide for pole sizes in 12m and 14m which are suitable for typical rural lines without OHEW for the range of standard distribution conductors.

In this size range, they are a cheaper alternative to concrete and their lightweight reduces transport costs in rural situations. They are also able to be drilled on site to facilitate tee-offs etc.

6.4.3 Softwood Poles

Queensland Forest Service installed an in-service trial of 175 treated slash pine power poles. The aim of this trial was to provide evidence to support the use of CCA treated slash pine as an alternative to the increasingly difficult to source Class 1 and 2 hardwoods.

In May 2001, after fifteen years of service, 130 of the original 175 treated slash pine power poles were assessed for a wide range of defects and the results compared with those obtained from a sample of Australian hardwood poles installed in a similar location and conditions. The results showed that the slash pine poles performed equally well in most aspects and significantly better in relation to soft rot, the main cause of early power pole failure. Vertical splitting is the only apparent factor where the slash pine poles performed worse than the hardwood. However, although the overall physical deterioration of the pine poles is marginally worse than the hardwood poles after 15 years of service, it does not seem to have led to premature failures. In summary, this trial indicates that in terms of durability, treated softwood poles should provide a satisfactory alternative to hardwood.

Small numbers of slash pine poles were purchased around 2006 and issues arose regarding the surface finish resulting from the debarking operation and brittle fracturing related to advanced decay prior to the treatment process. Any purchasing arrangements should address these quality issues.

Pine poles (Caribbean and Slash/Caribbean hybrids) are now available in the same strength/classes as hardwood poles. However, they require an increased diameter to achieve the same strength. There is no reason that they cannot be used interchangeably with the traditional hardwood poles to satisfy future demands in most cases. Refer to Technical Instruction TSD0264 – Distribution Poles for further information on Softwood poles

6.4.4 Steel Butted Hardwood Poles

Steel butted poles are a means of extending the length of hardwood poles, thus allowing small lengths of timber to be used for standard pole lengths. The additional manufacturing process increases the cost to place the poles in a similar cost category to steel or concrete pole alternatives. They are particularly suitable for use in termite prone locations. They could however be used as a direct substitute in Ergon Energy standard constructions for standard hardwood poles subject to suitable supply arrangements being put in place in the event of developing shortages of standard hardwood poles. A construction code to cover the use of steel butted poles is included in the Overhead Construction Manual.

6.4.5 Composite Fibre Poles

The use of manufactured composite fibre poles is an additional option that is currently under trial in EQL. These technologies are using reinforced epoxy, polyester or cementitious materials.

6.4.6 Options Currently Available

Sets of construction drawings using alternative pole types for distribution applications have been developed and included in the Overhead Construction Manual as follows:

- Rural Intermediate and Strain Concrete Pole Constructions – these are detailed in the Concrete Pole folder of the Overhead Construction Manual.
- Rural Intermediate and Strain Steel Pole Constructions – these are detailed in the Steel Pole folder of the Overhead Construction Manual.
- Urban Concrete Transformer Pole Constructions – these are detailed in the Concrete Transformer Pole folder of the Overhead Construction Manual.
- Codes for steel butted poles are available in the Overhead Construction Manual which allows a direct substitution for a standard hardwood pole.

In addition to these applications, steel and concrete poles have been developed as Special Constructions for such applications as:

- Steel poles used in urban locations in Mt Isa as an alternative to wood in order to avoid termite damage. This location is a designated CMEN area.
- Concrete used for Sub-Transmission applications requiring larger conductors and a requirement for Overhead Earth Wire.

Compatible units for Pine and Jointed Poles are not currently in the Overhead Construction Manual.

6.5 Criteria for Use

Alternative poles to standard hardwood poles are to be specified based on the criteria below. In general, cost benefit analysis may not favour the use of the alternative. This will depend upon reliability weighting and discount rates etc. but the use of alternatives will relieve supply pressures on hardwood poles and assist in developing familiarity by field staff and designers in the use of these alternative products which will facilitate their wide use in the event of critical shortages of hardwood poles. Refer to Technical Instruction TSD0264 – Distribution Poles for further information.

6.5.1 Concrete Poles

Use for transformer poles in CMEN areas. Multi Pole-top Construction (MPC) poles are also available in 12.5 and 14m sizes.

Use for larger conductor feeder backbone and sub-transmission applications where the increased height/strength range allows a more cost effective design. Standard constructions are available in the Overhead Construction Manual for the standard conductor range. If designs outside of this range are required, it may be possible to adapt designs from previous similar projects.

6.5.2 Steel Poles

Use in rural locations on projects that require delivery of significant number of poles to site. These light weight poles will reduce the transport cost of poles to site. These would generally be feeder backbone extensions or extensions of significant length.

Priority is to be given to termite prone areas or on feeders where pole failures are a significant contributor to unplanned outages. These are currently not available as a standard product.

Wood or fibre composite crossarms can be utilised on steel poles.

6.5.3 Softwood Poles

Softwood poles can now be used as a suitable alternative to hardwood poles. Noting that softwood poles are less resistant to fire than hardwood poles, as such a softwood pole should not be used in high bushfire risk areas as they are more likely to be damaged by a nearby fire. Softwood pole are approved for use with transformers up to 500kVA, and plant such as HV switches and reclosers, excluding Regulators.

6.5.4 Steel Butted Hardwood Poles

Steel butted poles are currently in stock and codes are available in the Overhead Construction Manual in order to facilitate their use as an alternative to standard hardwood poles. Due to the increased cost, their use should generally be restricted to termite prone locations and bushfire areas.

Steel Butted Wood Poles must not be used for:

- Installations within 3kms of the marine coast
- Installations in areas of known acid sulphate soils, such as low lying river/creek areas, wetlands and flood plains. (Under certain conditions sulphuric acid can form, degrading the steel)
- Installations in the wet tropics.

Steel Butted Wood Poles can be used for:

- Intermediate constructions
- Strain constructions
- Termination constructions that are stayed
- Angle constructions that are stayed
- Cable Termination constructions
- Gas Load Break Switch constructions
- S.W.E.R Recloser/Reactor constructions

6.5.5 Composite Fibre Poles

These are currently under trial and further information will be provided in future as they are rolled out.

6.6 Bushfire Mitigation

Pole wraps are now available, refer to TSD0264 – Distribution Poles.

6.7 V.P.I Wood Pole Specification and Fitting Details

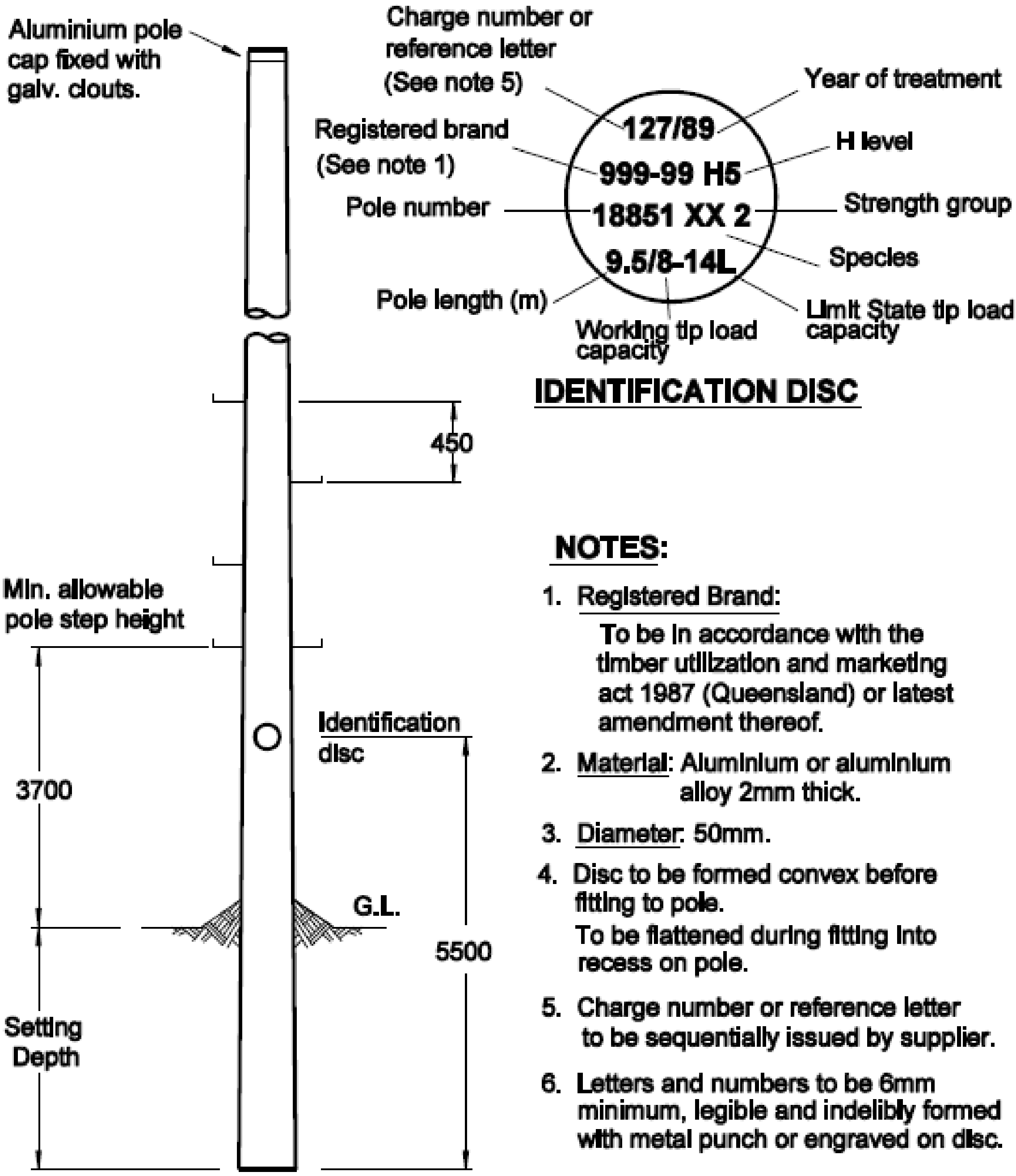


Figure 6.1 – Pole Identification Disk

Table 7-1 – Acceptable Species for Poles

Species Code	Standard Trade or Common Name	Botanical Name	Strength Group
BI	Broad-leaved red ironbark	E. fibrosa ssp. fibrosa	S1
J	Cooktown ironwood	Erythrophleum chlorostachys	S1
GG	Grey gum	E. punctata	S1
		E. propinqua	
GI	Grey ironbark	E. drepanophylla	S1
		E. paniculata	
HA	Hickory ash	E. flindersia ifflaiana	S1
BB	Blackbutt	E. piluaris	S2
CR	Crow's ash	Flindersia australis	S2
GM	Gympie messmate	E. cloeziana	S2
GB	Grey box	E. moluccana	S2
		E. woollsiana	
NI	Narrow-leaved red ironbark	E. crebra	S2
RI	Red ironbark	E. sideroxylon	S2
PW	Brown penda	Xanthostemon chrysanthus	S2
PD	Red penda	Xanthostemon whitei	S2
SG	Spotted gum	E. maculata	S2
		E. citriodora	
TW	Tallowwood	E. microcorys	S2
FR	Forest red gum	E. tereticornis	S3
NA	New England blackbutt	E. andrewsii	S3
TP	Turpentine	Syncarpia glomulifera	S3
WS	White stringybark	E. eugenioides	S3
PS	Slash Pine	Pinus elliottii	S5
PB (or CP)	Caribbean Pine Qld	Pinus caribaea	S5
SCH	Slash Caribbean Pine Hybrid Qld	Pinus elliottii/caribaea hybrid	S6

6.8 Poles Diameters and Masses

Table 7-2 – Concrete Poles Diameters and Masses

Pole Description			Pole Diameters and Masses		
Length (m)	Standard Setting Depth (m) (Note 1)	Strength Rating (kN) (Note 2)	Diameter at Butt (mm)	Diameter at Head (mm)	Maximum Mass (kg)
8.0	1.40	6	270	150	580
		10	345	225	820
		16	360	240	930
		24	390	270	1170
9.5	1.55	6	292	150	740
		10	367	225	1020
		16	382	240	1160
		24	412	270	1440
11.0	1.70	6	315	150	910
		10	390	225	1240
		16	405	240	1410
		24	435	270	1740
		32	480	315	2110
12.5	1.85	10	412	225	1480
		16	427	240	1680
		24	457	270	2060
		32	502	315	2490
14.0	2.00	10	435	225	1730
		16	450	240	1970
		24	480	270	2460
		32	525	315	2900
15.5	2.15	10	457	225	2000
		16	472	240	2270
		24	502	270	2830
		32	547	315	3330
17.0	2.30	16	495	240	2790
		24	525	270	3220
		32	570	315	3780
18.5	see Note 3	16	517	240	3160
		24	547	270	3630
		32	592	315	4300
20.0	see Note 3	16	540	240	3560
		24	570	270	4070
		32	615	315	4810
21.5	see Note 3	16	562	240	3970
		24	592	270	4520

Notes:

1. Concrete poles shall be set in the ground to a depth of not less than 0.6m plus one tenth of the pole height unless otherwise specified. In poor soil, additional stability shall be provided by sinking the pole deeper, or by the use of stabilised fill or stays.
2. The Strength Rating (kN) is the limit state tip load under maximum wind conditions.
3. The setting depth for these taller poles needs to reflect the soil type. Contact distribution support department for details.

Table 7-3 – V.P.I. Hardwood Poles Diameters and Maximum Masses

Pole Description			Minimum Pole Diameters and Maximum Masses											
Length (m)	Standard Setting Depth (m) (Note 1)	Strength Rating (kN) (Note 2)	Strength Group S1 (Note 3)				Strength Group S2 (Note 3)				Strength Group S3 (Note 3)			
			Diameter 2m from Butt (mm)	Diameter at Head (mm)	Maximum Mass (kg)	Girth 2m from Butt (mm)	Diameter 2m from Butt (mm)	Diameter at Head (mm)	Maximum Mass (kg)	Girth 2m from Butt (mm)	Diameter 2m from Butt (mm)	Diameter at Head (mm)	Maximum Mass (kg)	Girth 2m from Butt (mm)
8.0	1.40	3	165	105	290	518	175	115	330	550	185	125	350	581
		5	195	135	410	613	210	145	450	660	220	155	490	691
		8	230	165	545	723	245	175	590	770	260	190	630	817
		12	265	195	700	833	280	210	750	880	295	220	790	927
9.5	1.55	3	180	110	380	565	190	120	425	597	200	125	470	628
		5	210	135	545	660	225	150	595	707	240	160	640	754
		8	250	170	715	785	265	185	765	833	280	195	845	880
		12	285	200	905	895	300	215	960	942	320	230	1070	1005
11.0	1.70	3	190	110	485	597	200	120	535	628	215	130	585	675
		5	225	135	680	707	240	150	735	754	255	160	790	801
		8	265	170	875	833	280	175	965	880	295	195	1025	927
		12	300	200	1100	942	320	220	1230	1005	335	230	1290	1052
12.5	1.85	3	200	115	610	628	215	125	650	675	225	130	695	707
		5	235	140	815	738	250	150	890	785	265	160	950	833
		8	275	170	1055	864	295	185	1155	927	310	195	1250	974
		12	315	200	1350	990	335	215	1460	1052	355	235	1610	1115
14.0	2.00	3	210	120	780	660	220	130	870	691	235	140	875	738
		5	250	145	1025	785	265	165	1075	833	280	165	1170	880
		8	290	170	1305	911	305	185	1360	958	325	200	1470	1021
		12	330	205	1615	1037	350	215	1750	1100	370	235	1870	1162
15.5	2.15	5	260	155	1275	817	275	165	1385	864	290	175	1440	911
		8	300	180	1600	942	320	195	1720	1005	335	205	1830	1052
		12	345	210	2160	1084	365	230	2285	1147	385	245	2410	1210
		20	410	255	2830	1288	435	285	3105	1367	455	300	3245	1429
17.0	2.30	5	265	160	1445	833	285	170	1500	895	300	180	1625	942
		8	310	190	1810	974	330	200	1935	1037	350	215	2060	1100
		12	355	220	2430	1115	380	235	2650	1194	400	250	2865	1257
		20	420	265	3210	1319	450	285	3585	1414	475	305	3880	1492
18.5	2.45	5	275	165	1735	864	290	175	1870	911	310	185	1935	974
		8	320	195	2150	1005	340	210	2290	1068	360	220	2425	1131
		12	370	225	2855	1162	390	240	3085	1225	410	255	3230	1288
		20	435	270	3655	1367	465	290	4090	1461	490	310	4415	1539
20.0	2.60	5	285	170	2070	895	300	180	2220	942	320	190	2285	1005
		8	330	200	2540	1037	350	215	2780	1100	370	225	2930	1162
		12	380	230	3225	1194	400	250	3590	1257	425	265	3845	1335
		20	450	280	4450	1414	475	295	4510	1492	505	315	4890	1587
21.5	2.75	5	290	175	2450	911	310	185	2615	974	325	195	2775	1021
		8	340	205	3075	1068	360	220	3245	1131	380	235	3410	1194
		12	390	240	3975	1225	415	255	4265	1304	435	270	4540	1367
		20	460	285	4995	1445	490	305	5420	1539	515	325	5835	1618

Notes:

1. In accordance with the C(b)1-1999, a pole shall be set in the ground to a depth of not less than 0.6m plus one tenth of the pole length. In poor soil, additional stability shall be provided by sinking the pole deeper, or by the use of stabilised fill or stays.
2. The Strength Rating (kN) is the allowable pole top load under maximum wind conditions.
3. Strength groups are as defined in AS2878 "Timbers – Classification into Strength Groups".

Table 7-4 – V.P.I. Softwood Poles Diameters and Maximum Masses

Pole Description			**Minimum Pole Diameters (mm)**				**Pole Weight**
Length (m)	Strength Rating (kN)		Strength Group S5		Strength Group S6		S5 Strength Approx. kg
	Max Working	Limit State	2m from butt	At head	2m from butt	At head	
9.5	5	9	280	190	295	205	560
	8	14	330	240	345	255	645
	12	22	380	290	395	305	900
11.0	5	9	300	192	315	207	585
	8	14	345	237	365	257	800
	12	22	400	292	415	307	1065
12.5	5	9	315	189	330	204	780
	8	14	365	239	380	254	1060
	12	22	415	289	435	309	1390
14.0	5	9	330	186	354	201	930
	8	14	380	236	400	256	1270
	12	22	435	291	455	311	1660

Table 7-5 – Steel Poles Diameters and Masses

Pole Description			Pole Diameters and Masses	
Length (m)	Standard Setting Depth (m) (Note 1)	Strength Rating (kN) (Note 2)	Diameter (mm)	Maximum Mass (kg)
9.5	1.55	13.5	273	317
12.5	1.85	10.8	273	420
		14.4	323	478
14.0	2.00	12.15	273	547
		14.4	323	651

Notes:

1. Steel poles shall be set in the ground to a depth of not less than 0.6m plus one tenth of the pole height unless otherwise specified. In poor soil, additional stability shall be provided by sinking the pole deeper, or by the use of stabilised fill or stays.
2. The Strength Rating (kN) is the limit state tip load under maximum wind conditions.
3. The setting depth for these taller poles needs to reflect the soil type. Contact distribution support department for details.

7. Crossarms

7.1 Hardwood Crossarm

The Queensland Electricity Supply Industry Hardwood Crossarms specifies that timber shall generally be visually stress graded in accordance with AS 2082. The minimum stress grade for timber supplied to the specification is F17 except that only Structural Grade No 1 or 2 shall be accepted.

The F17 stress grade may be achieved by a number of combinations of strength group and structural grades. The minimum strength group allowable is S3, however the majority of crossarms supplied generally come into the strength group S2 and the additional specification requirement that the top surface be without visual defects effectively means that the actual F grade is generally somewhat better than F17. Timber stresses are to be based generally in accordance with AS 1720.1 1997 using a limit state approach.

Crossarms are specified with dimensional tolerance of ± 3mm and are supplied generally in an unseasoned state. Design stresses are therefore based on values for unseasoned timber and used in conjunction with the minimum under-tolerance value.

Crossarm duties are to comply with the most onerous of the following conditions:

Maximum Wind load case – using a limit state design wind pressure on conductors of 1200Pa in defined cyclone prone areas and 900Pa elsewhere.

Permanent or Long Duration load case – based on standard conductor tensions at 15°C under no wind conditions.

Maintenance load case – to account for loads generated during construction or maintenance activities – based on 100Pa wind loads at 15°C.

For Intermediate crossarms, it is assumed that there is a nominal longitudinal tension of 5% of the conductor tension.

Design of bolted connections is in accordance with AS1720.1 Section 4.4 using joint group JD2. In general, this will not be a limitation for the expected structure duties.

Timber stresses and load factors to be used for these load cases are as follows:

7.1.1 Maximum Wind Load

Design timber stress in Bending	37.8 MPa
Design timber stress in tension	22.4 MPa

Load factors are as follows:

- Allowance for wind loads shall be provided based on limit state wind pressure appropriate to the location.
- Vertical dead loads from non conductor loads
  (insulator and crossarm self weight) 1.1
- Vertical conductor loads 1.25
- Longitudinal conductor loads – based on limit state
  design wind pressure applied to appropriate MES (Mean Equivalent Span). 1.25

7.1.2 Permanent or Long Duration Load

Design timber stress in Bending	18 MPa
Design timber stress in tension	11 MPa

Load factors are as follows:

- No allowance to be provided for wind load
- Vertical dead loads from non conductor loads (insulator and crossarm self weight) — 1.1
- Vertical conductor loads — 1.25
- Longitudinal conductor loads – based on conductor EDT (Every Day Tension) at 15°C — 1.1

7.1.3 Maintenance Load Case

Design timber stress in Bending	30.6 MPa
Design timber stress in tension	18.3 MPa

Load factors are as follows:

- Allowance for wind loads based on nominal wind pressure of 100Pa
- Vertical dead loads from non conductor loads — 1.1
- Vertical conductor loads — 1.5
- Longitudinal conductor loads based on 100Pa wind pressure applied to appropriate MES — 1.5
- Weight of men and equipment — 2.0
- Allowance to be provided for pole top rescue loads assuming weight of man at 1.0kN with mechanical advantage 2.0 on lowering line (i.e., load multiplication factor 1.5) applied 800mm from the pole.

Standard crossarm sizes for general application are as follows:

7.1.4 Sizes -Intermediate pin structure – both Flat and Delta

11kV	2400x100x100
	2400x100x125
22/33kV	2700x100x100
	2700x100x125

7.1.5 Sizes - Strain / Termination

11kV	2400x150x100 – single or double
	2400x175x125 – single or double
22/33kV	2700x150x100 – single or double
	2700x175x125 – single or double

7.1.6 Sizes – Intermediate/Fuse Crossarms

11kV Delta Pin/Intermediate	2400x100x100
	2400x100x125
11kV Flat Pin/Intermediate	2700x100x100
	2700x125x125
22/33kV Delta Pin/Intermediate	2700x100x100
	2700x100x125
22/33kV Flat Intermediate	3000x100x100
	3000x100x125

Required crossarm sizes for a range of typical applications are listed in the Section 11 - Pole Structures and can also be determined by using the program “Crossarm Design” which will give the allowable weight span for a specified application.

7.2 Composite Crossarm

Ergon Energy has traditionally used hardwood crossarms for distribution applications. Hardwood as a crossarm material has good electrical and structural properties and is relatively cheap however there are issues with manual handling, degradation in service and long-term supply availability. In order to address these issues, Ergon Energy has been investigating alternative materials and constructions.

Composite fibre extruded sections are now available for use as a crossarm material. This product uses thermosetting resin binders including epoxies, vinyl esters, polyurethane or phenolic compounds combined with glass fibre reinforcement applied by a pultruded or filament winding process. This product has significant promise with regard to longevity, electrical performance and light weight.

7.2.1 Electrical Properties

Composite materials have very good insulation properties, to the extent that they could function as primary insulation, however there are other properties that must be considered with regard to their long term performance in power line applications. These relate to the arc quenching properties and resistance to surface erosion due to tracking from leakage currents.

Timber has properties that inhibit the establishment of power follow current following a lightning induced flashover. This has the effect of preventing a protection operation and subsequent momentary outage. Composite materials do not have such properties, however provided that the voltage gradient is reasonably low, the momentary outage performance are acceptable.

With hardwood crossarms, electrical leakage generated by pollution layers on the primary insulation has the potential to initiate pole top fires at bolt locations. Measures to prevent this by increasing the contact areas have generally proven to be successful. Electrical testing on composite crossarms and field experience have also indicated suitable long term performance under service conditions.

7.2.2 Structural Properties

Timber crossarms must meet structural requirements with regard to bending moments under short term wind load, maintenance loadings and sustained load conditions and bearing loads at attachment bolts as referred in previous section. These loads are defined by AS/NZS 1170. There is no equivalent Australian Standard relating to composite fibre crossarms and the provisions of the

EUROCOMP Design Code "Structural Design of Polymer Composites" have been used as a reference for this purpose.

Composite Crossarms manufactured by Wagners consist of 100x100 mm and 125x125 mm square hollow sections with square insert on bolt holes for structural integrity. Structural design and test data has been supplied and discussed with Wagner staff in order to equate loading capacities of the Composite crossarms to Ergon Energy's design criteria.

Crossarms manufactured by PUPI consist of 100x100 mm and 125 x 125 mm square sections with foam in-fill, with circular insert on bolt holes for structural integrity. . Similar design and test data to equate loading capacities to timber has been carried for the PUPI crossarm.

A comparison of cross-section short-term ultimate strength properties is tabulated in Table 8-1. Other section properties can be acquired from the OH Line Standards Team.

Table 8-1 Comparison of Timber and Composite Cross-section

Hardwood Timber Section (mm x mm)	**Equivalent Composite Section** (mm x mm)
100 x 100	100 x 100
100 x 125	100 x 100
100 x 150	125 x 125

7.2.3 UV Performance

The Wagner's second generation crossarm design provides for a membrane of thermoplastic polymer alloy heat bonded to the fibre composite substrate. The crossarm coating was tested in a QUV accelerated weather meter in compliance with ASTM G 154-02 for a minimum of 5000 hours. To date the coating samples have endured over 400 cycles with the following results:

- No significant colour change
- No visual cracking, peeling, or coating disruption to adhered sample
- Some loss of gloss is apparent

Although this testing cannot be directly correlated to a number of years in service, indications are that the composite crossarms should have a service life of the same order or better than hardwood crossarms.

The PUPI crossarms have a similar UV protection that is also thermally bonded to the surface that has gone under rigorous testing. There is also a UV resistance polyester veil and inhibitor within the internal layers of the crossarms.

7.2.4 Weight Component

The main advantage of the composite crossarm is its weight over hardwood equivalents. The 100 x 100 section weighs approximately at 5.5kg/m and the 125 x 125 section at 8kg/m. As a result of this field staff have taken a liking to using the crossarms and the inherent consequence of eliminating soft tissue damage such as jammed fingers, back injuries, and other manual handling issues.

7.2.5 Criteria for Use

There are several constructions available in the OH Construction Manual for the use of the composite crossarms. Currently they fall under the following criteria:

- Wagners Composite Crossarms:
    - **For use in both HV and LV constructions**
    - For use in new constructions as per the OH Construction Manual
    - For use in maintenance construction under the “like for like” methodology approved by the Distribution Network Standards Team and Maintenance Standards Team
    - Design and constructions checked and approved by the Line Design Team
- PUPI Composite Crossarms:
    - **For use in both HV and LV constructions**
    - For use in new constructions as per the OH Construction Manual
    - For use in maintenance construction under the “like for like” methodology approved by the Distribution Network Standards Team and Maintenance Standards Team
    - Design and constructions checked and approved by the Line Design Team

8. Stays

8.1 Stay Design

Designers are to use the Distribution Pole Stay and Equipment design tool to design stay arrangements once rolled out. The following information is for background purposes.

The limit state strength of a particular stay type is determined by the least value of the strength of the:

- Eyebolt
- Staywire
- Stay Insulator
- Foundation

Component strengths for each of these components are tabulated for the range of components used in the OH constructions as follows:

Table 9-1 – Eyebolt Strength

Bolt Diameter	Tensile Stress Area (MPa)	Ultimate Strength (kN)	Strength Factor	Limit State Strength (kN)
M24	350	143.5	0.8	114.8

The allowable bearing strength on the pole timber limits the loading that can be applied at the interface with the eyebolt when 19/2.75 staywire is used and hence a Cast 2 Bolt Stay Bracket connection to the pole is used with this staywire.

Table 9-2 – Staywire Strength

Staywire	Min. Breaking Load (kN)	Strength Factor	Limit State Strength (kN)
7/2.75 SC/GZ	49.0	0.8	39.20
19/2.00 SC/GZ	70.5	0.8	56.4
19/2.75 SC/GZ	133.0	0.8	106.4

The stay insulator strengths are as follows:

Table 9-3 – Stay Insulator

Stay Insulator	Min. Failing Load (kN)	Strength Factor	Limit State Strength (kN)
GY2	71	0.8	56.8
GY3	222	0.8	177.6
GY4	222	0.8	177.6

8.2 Foundations

Available foundation types are screw anchor, concrete bedlog, a poured concrete and rock anchor. A strength factor of 0.7 has been applied to these foundations.

Screw anchors are to be installed to the installation hydraulic pressure specified in the OH Construction Manual to obtain capacity to match the stay type.

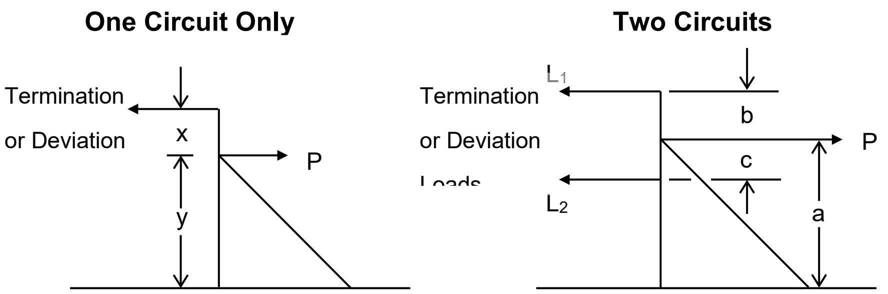
Concrete bedlogs are to be installed to a depth determined by the stay rod length. For 2700mm rods, the depth will be 1.9m for 45° stays and 2.3m for 60° stays.

Allowable loads for bedlogs are based on soil weight using a frustum angle of 30° for good to medium soils and 20° for well compacted sand or waterlogged clay soils. Bedlogs are not suitable for installation in loose sandy soils or swampy soils.

8.3 Stay Attachment Location

In general, the stay should be located as close as possible to the load centre. Select the appropriate stay whose allowable horizontal load capacity from the Table 9-4 – Allowable Limit State Loads (in kN) is greater than the horizontal load due to the conductor termination or deviation loads.

Where the stay attachment is not close to the load centre, calculate the equivalent horizontal load on the stay, P, due to the conductor termination or deviation loads as follows:



$P = L_1 (1+3x/2y)$ $P = L_1 (1+3b/2a) + L_2 (1-3c/2a)$

Figure 8.1 – Calculation for Horizontal Load on a Stay

8.4 Pole Load at Stay Attachment

Where the Stay attachment is not located close to the load centre, the pole must be designed to resist the long duration and short duration bending moments which will occur in the pole at the stay attachment.

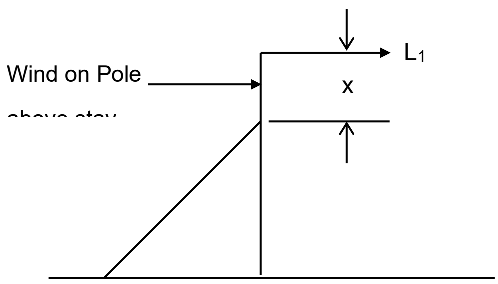


Figure 8.2 – Calculation Variables for Stay Attachments Not Close to Load Centre

i.e. $\sigma Z \Rightarrow$ $L_1 x$ + Wind moment on pole

Where:

L_1	=	horizontal load due to conductors
x	=	distance from load centre to stay attachment
Z	=	modulus of pole at stay attachment point
	=	$\pi D^3/32$ (mm^3)
D	=	diameter of pole at stay attachment
σ	=	maximum allowable bending stress in pole as listed in the section “Poles”

The wind moment on the pole can be calculated by taking the area of the pole above the stay multiplied by the design wind pressure and by x / 2.

Loads under both the limit state and sustained load condition should be checked. The majority of pole species fall into the strength group 2 and a check carried out using strength group 2 stresses and diameters will generally be satisfactory for the other strength group stress / diameter cases.

8.5 Stay Applications

Component make up and strengths for the range of applicable stay types are listed in the Stay Components in Table 9-4 and their application is described briefly as follows.

8.5.1 Ground Stay Types GS1, GS2 and GS3

These are stays for general application and are installed with a stay insulator except in situations where the stay is used on a bollard.

The preferred angle to the horizontal is 45° however they can be used at 60° in restricted locations with the capacity reduced accordingly.

8.5.2 Aerial Stays AS1, AS2 and AS3

These are installed to a bollard at an angle to the horizontal that should not exceed 30°.

A ground stay on the bollard may or may not be installed depending on the design load requirement.

If an unstayed bollard is used, the allowable horizontal load can be determined from the tables in Section 7 Poles for the appropriate bollard size and cyclonic / non-cyclonic wind pressure area. Attention to the foundation design will be necessary to ensure that the necessary load capacity is available.

8.5.3 Sidewalk Stays

These stays are for use in restricted urban locations only and then only for low tension and short span applications. The purpose of this stay type is to maintain the staywire at an angle close to vertical in order to minimise hindrance to pedestrian traffic.

The stay would normally be installed at a location from 2.4 to 3m from the pole. Increasing the spacing to 3m or more will result in significantly reduced loadings on the stay components.

This stay design results in high loadings in the stay components and attention should be given to the foundation design and installation.

The design also places high bending moments in the pole and use of an 8kN pole is therefore required for the SS3 application.

8.5.4 Stay Orientation

The selections of stay orientation for bisect angles will be influenced by site constraints and construction practicalities however in general, the following guidelines should be followed:

- For a bisect angle on pin insulators, use a single bisect stay. In general, this angle will be limited by the restriction to maintain everyday deviation loads on pin insulators to 0.5kN.
- For line deviation angles up to 45° using strain crossarms, use either a bisect stay or two termination stays – if termination stays are used, they should be offset 1.5m away from the angle.
- For line deviation angles above 45°, use termination stays in both directions with a 1.5m offset.

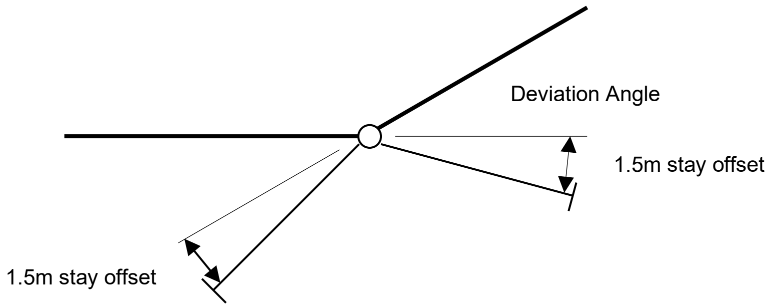


Figure 8.3 – 1.5m Stay Offsets for Line Deviations above 45°

Table 9-4 – Allowable Limit State Loads (in kN)

STAY COMPONENTS	STAY TYPE										
	GS1		GS2		GS3		SS2	SS3	AS1	AS2	AS3
	45°	60°	45°	60°	45°	60°					
Eyebolt /Stayrod											
M24	115.8		115.8		115.8		115.8		115.8	115.8	115.8
Staywire											
7/2.75	41								41		
19/2.00			59				59			59	
19/2.75					112			112			112
Stay Insulator											
GY2 LV	56.8								56.8		
GY3 11/22kV	177.6		177.6		177.6		177.6	177.6	177.6	177.6	177.6
GY4 33kV	177.6		177.6		177.6		177.6	177.6	177.6	177.6	177.6
Screw Anchor foundation											
Screw Anchor to appropriate installation torque	42		60		114		60	114			
Bedlog Foundation - Medium Soil											
1.5x0.19 D 1.9	105		105		105						
1.5x0.19 D 2.3		133		133		133					
Allowable limit state tension in stay	41	41	59	59	105	112	59	112	41	59	112
Horizontal component at pole for screw anchors or bedlogs in good to medium soil	**28**	**20**	**41**	**29**	**74**	**56**	**9**	**14**	**35**	**51**	**96**
Horizontal component at pole for bedlogs in sandy soil or waterlogged clay	**23**	**20**	**41**	**29**	**46**	**39**					

9. Insulators

9.1 Insulator Loads and Applications

9.1.1 Insulator and Hardware

Design loads for insulators, stay fittings and miscellaneous hardware (with the exception of insulator pins) under the ultimate strength limit state case are to be based on the appropriate failing load factored by the Component strength factor as listed in table 6.2 of AS/NZS 7000 as follows:

Fittings – forged and fabricated	0.8
Fittings – cast	0.7
Porcelain and Glass insulators	0.8
Synthetic of composite strain insulators (one minute mechanical strength)	0.7
Synthetic of composite strain insulators (long term mechanical strength)	0.4

9.1.2 Insulator Pin Loadings

Insulator pins are rated at 7 and 11kN failing load for 11 and 22kV insulator applications and a strength factor of 0.8 would be applied in accordance with the provisions of C(b)1 to determine limit state design loads.

However, in order to facilitate construction and maintenance operations, limit angular deflections of the pins and avoid conductor birdcaging, sustained transverse loads on pin insulators should be limited to 0.5kN under everyday tension conditions or a maximum angle of 20°. The resulting deviation angles on single pin insulators are listed on the tables later in this section.

9.1.3 Insulator Selection with Regard to Pollution.

Selection of insulators in pollution prone environments is generally based on the surface creepage length per kV rms line to ground voltage.

Australian Standard 1824.2 – Insulation coordination grades the severity of pollution at a site as follows:

Table 10-1 – Surface Creepage Length with regards to Pollution

Severity of pollution at site	Location	Recommended surface creepage – mm per kV of line to ground voltage
Light	Sites beyond 10 km from the coast and without local pollution sources.	25 to 35
Moderate	Sites 3 to 10 km from the coast or 0.3 to 1km from salt lakes or bays. Sites near inland power stations or sources of conductive dust.	30 to 40
Heavy	Sites 1 to 3 km from the coast or within 0.3 km of salt lakes or bays. Sites near large chemical works or exposed to severe dust deposits.	35 to 50
Extreme	Sites within 1 km of the sea, close to heavy industry or intense sources of high conductivity dust.	>50

The surface creepage length per kV is only an indicator of insulator pollution performance and other factors such as frequency of heavy rain and insulator shed profile will influence the pollution performance of insulators. Insulators with an open or aerodynamic profile may perform best in areas subject to regular rainfall while insulators with generous protected creepage distance may be a better solution in areas subject to long dry spells.

The approach specified in the Insulator selection guide Figures 10-1 to Figures 10-3 is to provide for a higher voltage class insulator to be used as the favoured option for pollution prone areas.

In general, the insulators provided for ERGON SCM constructions for “standard” pollution areas will have creepage lengths in the range covered by the Light to moderate ranges in the above table. Insulators specified as “pollution” by the selection guide will in general be sufficient to cater for sites classed as “heavy”.

In general, sites along the Queensland coast even though within 1 km of the ocean could be classified as “heavy” rather than “extreme” due to the probability of rainfall at reasonable regular intervals. Exception may be situations exposed to high levels of wind borne salt spray, e.g., on a rocky headland or adjacent to a surf beach.

Any sites which could be considered to come in the “extreme” category because of the nature of the site or based on a past history of pollution outages should be referred to the standards group for further advice.

Table 10-2 – Pin Insulators Deviation Angle Limits

AAC Conductors					
Conductor Code	Conductor Type	2.5% EDT	6% EDT	10% EDT	20% EDT
Libra	7/3.00 AAC	20°	20°	20°	18°
Mars	7/3.75 AAC	20°	20°	20°	12°
Moon	7/4.75 AAC	20°	20°	15°	7°
Pluto	19/3.75 AAC	20°	14°	8°	4°
Saturn	37/3.00 AAC	20°	11°	6°	3°
LV ABC (Suspension Clamps)	4 x 95 sq mm	15°	15°	15°	N.A.
LV ABC (Angle Clamps)	4 x 95 sq mm	30°	30°	30°	N.A.
Apple	6/1/3.0 ACSR	20°	20°	19°	9°
Cherry	6/4.75 + 7/1.60 ACSR	20°	14°	8°	4°

AAAC , ACSR , SC/GZ and SC/AC Conductors			
Conductor Code	Conductor Type	% EDT	Deviation Angle Limit
Chlorine	7/2.5 AAAC	20%	17°
Fluorine	7/3.00 AAAC	20%	12°
Helium	7/3.75 AAAC	20%	8°
Iodine	7/4.75 AAAC	20%	5°
Apple	6/1/3.0 ACSR	22%	8°
Banana	6/1/3.75 ACSR	22%	5°
Raisin	3/4/2.5 ACSR	22%	5°
Sultana	4/3/3.0 ACSR	22%	4°
3/2.75	SC/GZ	25%	5°
3/2.75	SC/AC	25%	5°
Cherry	6/4.75 + 7/1.60 ACSR	22%	3°

Note:

For Trident constructions, the same limitations as for pin insulators should be applied.

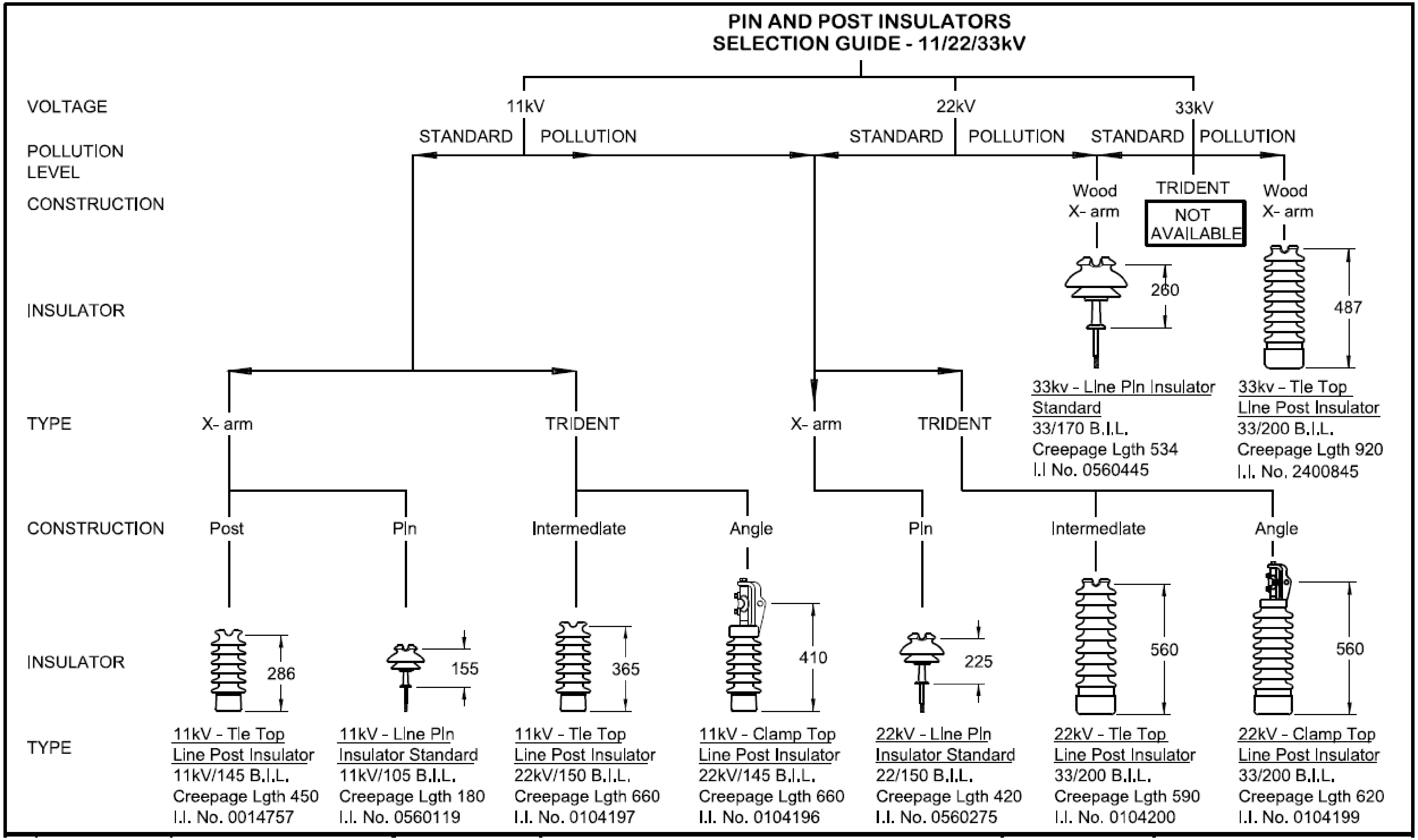
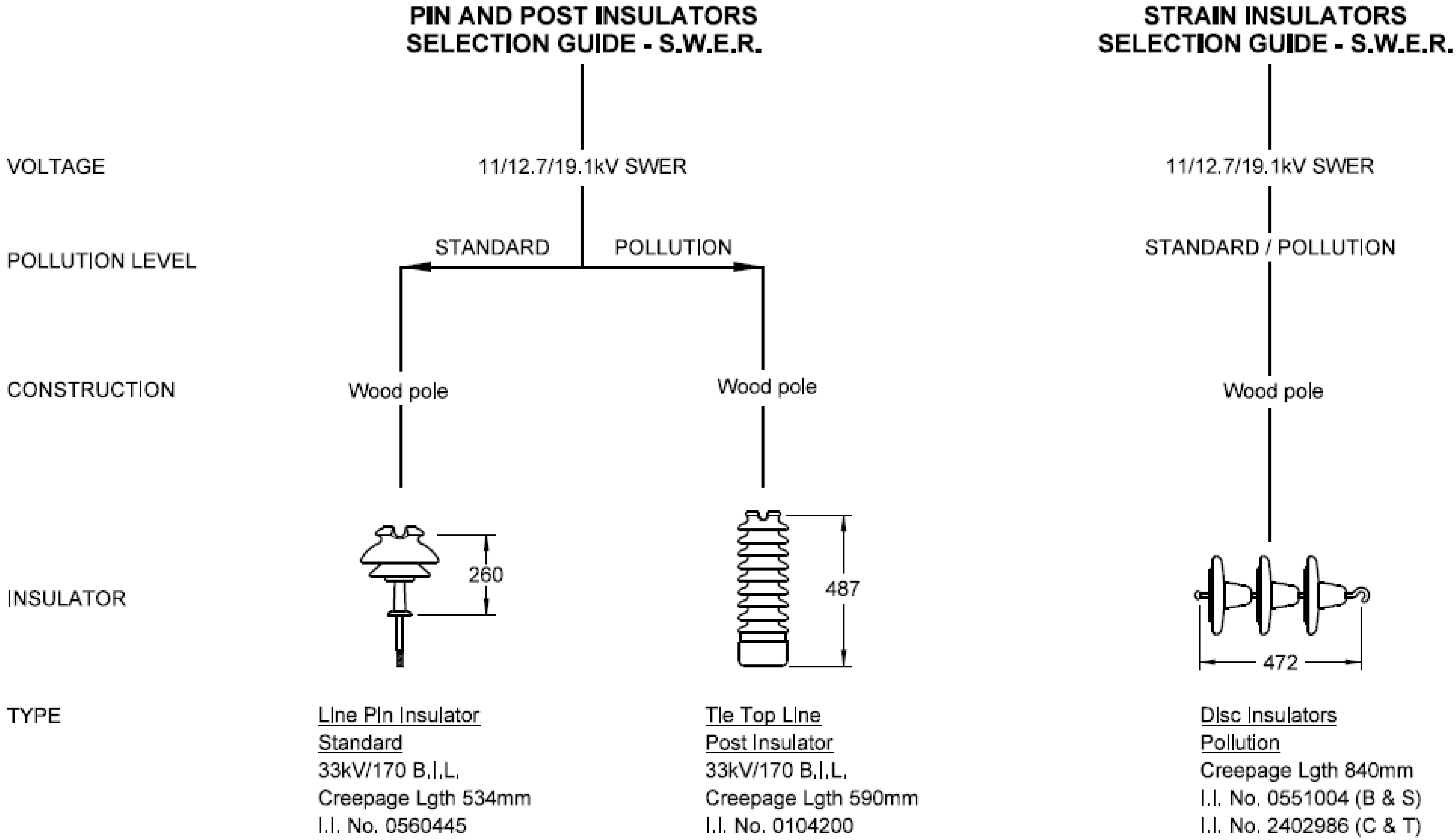


Figure 9.1 – Pin and Post Insulators Selection Guide (11/22/33kV)

Figure 9.2 – Pin, Post and Strain Insulators Selection Guide (S.W.E.R.)



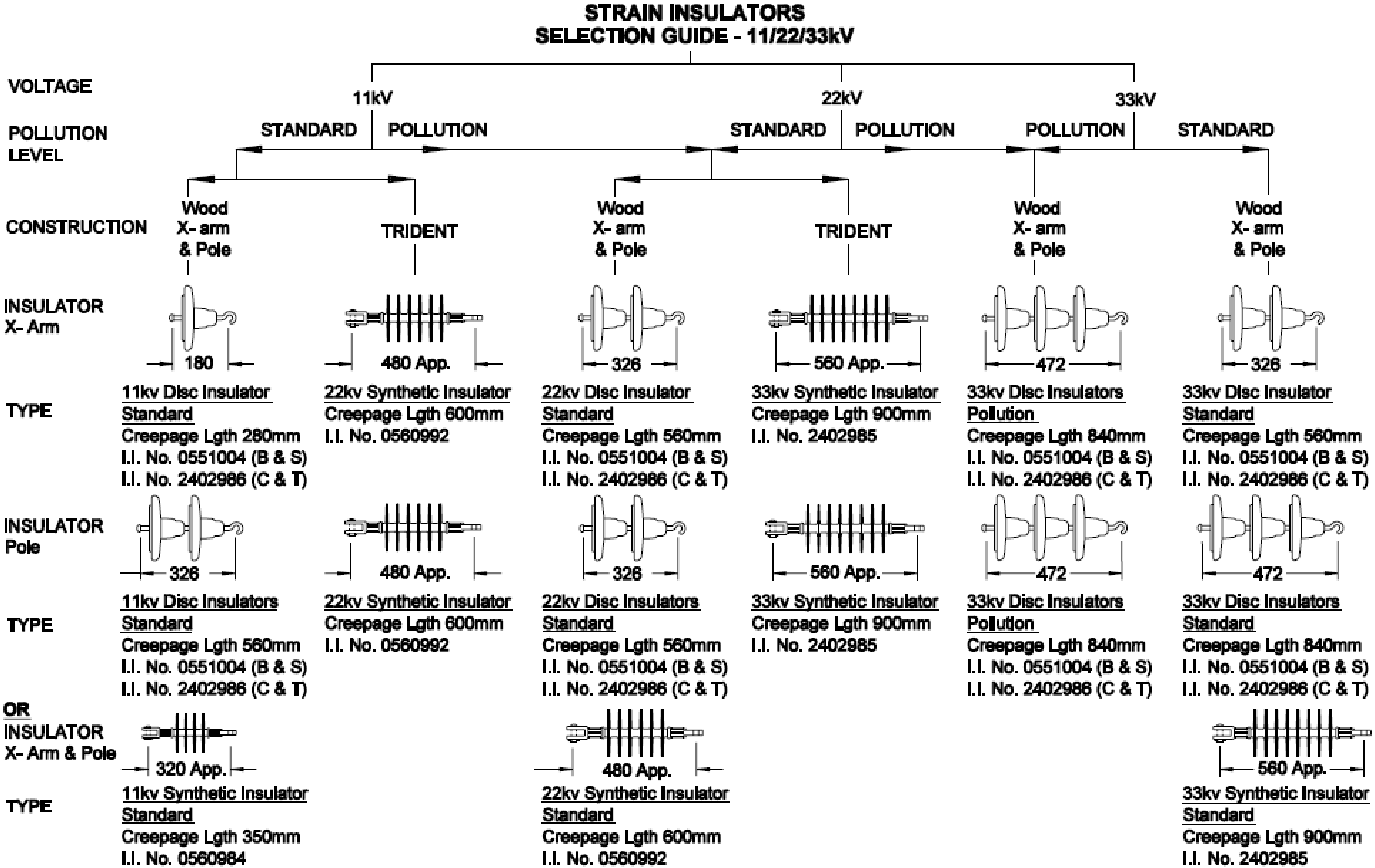


Figure 9.3 – Strain Insulators Selection Guide (11/22/33kV)

10. Pole Structures

10.1 Structure Applications

This section lists the structure designs and duty limitations that would be applicable for general application.

A suite of design software is provided as detailed in the section “Overhead Design Programs” which allow calculation of allowable duties for other situations.

Alternatively, calculations could be carried out from first principles using conductor loads derived from stringing charts or tension change calculations.

10.1.1 Urban Applications

The preferred available design for 11 and 22kV HV urban use is the trident and is applied using AAC conductors at tensions of 2.5%, 6% or 10%. For 33kV, the standard construction is the delta. This construction is used with preformed ties without armour rods or vibration dampers.

The spanning limitation of the trident intermediate structure with respect to mid span conductor clearance, ground clearance and wind span loading are listed in the following tables for a range of pole sizes and strengths that would be applicable for general applications.

These allowable structure duties are based on the assumption that the poles are also fitted with 4x 95mm² LVABC conductors installed at the same % CBL as HV conductors and provision for a single service take off at right angles to the line is included. A tension of 1.8kN limit state load is assumed for the service.

Staying requirements for termination and strain trident structures for the range of urban tensions are listed in the section “Urban Strain / Termination” which lists staying options for termination structures and

maximum deviation angles for unstayed poles and poles with bisect stays.

HV flat construction is provided for situations requiring tee offs, crosscheck arms or subsidiary circuits. Requirements for crossarm sizes in these situations can be determined using the program “Crossarm Design”.

10.1.2 Rural Applications

The preferred available design for 11 and 22 and 33kV HV rural use is the delta and is applied using the range of conductor types and tensions listed in the section “Standard Conductor Applications”. This construction is used with preformed ties and armour rods. In general, vibration dampers should be applied at these tensions except in situations where the line passes through timbered areas with tree heights that project up to or above the conductor height and are not likely to be cleared in the future.

The spanning limitation of the delta intermediate structure with respect to mid span conductor clearance, ground clearance and wind span loading are listed in the following tables for a range of pole sizes and strengths that would be applicable for common applications.

These allowable structure duties are based on the assumption that the poles are not fitted with any subsidiary conductors.

Staying requirements for termination and strain structures for the range of rural tensions are listed in the section “Rural Strain / Termination” which lists staying options for termination structures and maximum deviation angles for unstayed poles and poles with bisect stays.

HV flat construction is provided for situations requiring tee off or subsidiary circuits. Requirements for crossarm sizes in these situations can be determined using the program “Crossarm Design”.

10.2 Intermediate Urban 11kV TRIDENT Constructions – Duties for common applications

For a 3 Phase Construction with subsidiary LV ABC 4x95mm² and allowance for 1.5kN Service Load

Foundations standard depth plus 150mm

Layout temperature 75°C for HV and 80°C for LV

Maximum Span for ground clearance limitation based on 5.8m clearance for LV on level ground

Table 11-1 – Specifications for Urban Intermediate Wood Pole (11kV)

						Non-Cyclonic Area			Cyclonic Area		
Conductor Type	Stringing Condition	Assumed Ruling Span	Maximum Span - mid span clearance limitation (m)	Standard Pole Ht (m)	Maximum Span - ground clearance limitation (m)	Pole Strength Tip Rating (kN)	Allowable Wind Span with 0° deviation (m)	Maximum Deviation Angle on unstayed pole for wind span equal to assumed ruling span (°)	Pole Strength Tip Rating (kN)	Allowable Wind Span with 0° deviation (m)	Maximum Deviation Angle on unstayed pole for wind span equal to assumed ruling span (°)
Libra 7/3.00 AAC	2.5% CBL	40 m	64	12.5	41	5	128	20	5	90	20
Mars 7/3.75 AAC	2.5% CBL	40 m	63	12.5	41	5	114	20	5	80	19
Moon 7/4.75 AAC	2.5% CBL	40 m	63	12.5	41	5	100	20	5	70	14
Pluto 19/3.75 AAC	2.5% CBL	40 m	63	12.5	41	5	84	19	5	59	8
Libra 7/3.00 AAC	6% CBL	60 m	94	12.5	60	5	128	14	5	90	6
Mars 7/3.75 AAC	6% CBL	60 m	92	12.5	60	5	114	11	5	80	4
Moon 7/4.75 AAC	6% CBL	60 m	92	12.5	60	5	100	8	5	70	2
Pluto 19/3.75 AAC	6% CBL	60 m	92	12.5	60	5	84	4	5	59	-
Libra 7/3.00 AAC	10% CBL	100 m	121	14	97	5	120	2	5	83	-
Mars 7/3.75 AAC	10% CBL	100 m	120	14	97	5	107	-	8	140	5
Moon 7/4.75 AAC	10% CBL	100 m	119	14	97	5	94	-	8	123	3
Pluto 19/3.75 AAC	10% CBL	100 m	120	14	97	8	145	5	8	104	-

Notes:

1. Shading indicates that the Maximum Deviation Angle is limited by the deviation angle limit of the insulator.
2. Where there is subsidiary LV ABC on the pole, the Maximum Deviation Angle may be limited further depending on whether suspension clamps or angle clamps are used.
3. Refer to Table 10-2 “Pin Insulators Deviation Angle Limits” in the “Insulators” Section 10 of this standard for these limitations.

10.3 Intermediate Urban 22kV TRIDENT Constructions – Duties for common applications

For a 3 Phase Construction with subsidiary LV ABC 4x95mm² and allowance for 1.5kN Service Load

Foundations standard depth plus 150mm

Layout temperature 75°C for HV and 80°C for LV

Maximum Span for ground clearance limitation based on 5.8m clearance on level ground

Table 11-2 – Specifications for Urban Intermediate Wood Pole (22kV)

						Non-Cyclonic Area			Cyclonic Area		
Conductor Type	Stringing Condition	Assumed Ruling Span	Maximum Span - mid span clearance limitation (m)	Standard Pole Ht (m)	Maximum Span - ground clearance limitation (m)	Pole Strength Tip Rating (kN)	Allowable Wind Span with 0° deviation (m)	Maximum Deviation Angle on unstayed pole for wind span equal to assumed ruling span (°)	Pole Strength Tip Rating (kN)	Allowable Wind Span with 0° deviation (m)	Maximum Deviation Angle on unstayed pole for wind span equal to assumed ruling span (°)
Libra 7/3.00 AAC	2.5% CBL	40 m	72	12.5	41	5	128	20	5	90	20
Mars 7/3.75 AAC	2.5% CBL	40 m	71	12.5	41	5	114	20	5	80	19
Moon 7/4.75 AAC	2.5% CBL	40 m	70	12.5	41	5	99	20	5	70	14
Pluto 19/3.75 AAC	2.5% CBL	40 m	71	12.5	41	5	84	19	5	59	8
Libra 7/3.00 AAC	6% CBL	60 m	104	12.5	60	5	128	14	5	90	6
Mars 7/3.75 AAC	6% CBL	60 m	103	12.5	60	5	114	11	5	80	4
Moon 7/4.75 AAC	6% CBL	60 m	103	12.5	60	5	99	8	5	70	2
Pluto 19/3.75 AAC	6% CBL	60 m	103	12.5	60	5	84	4	5	59	-
Libra 7/3.00 AAC	10% CBL	100 m	135	14	97	5	120	2	5	83	-
Mars 7/3.75 AAC	10% CBL	100 m	133	14	97	5	107	-	8	140	5
Moon 7/4.75 AAC	10% CBL	100 m	133	14	97	5	93	-	8	122	3
Pluto 19/3.75 AAC	10% CBL	100 m	133	14	97	8	145	5	8	103	-

Notes:

1. Shading indicates that the Maximum Deviation Angle is limited by the deviation angle limit of the insulator.
2. Where there is subsidiary LV ABC on the pole, the Maximum Deviation Angle may be limited further depending on whether suspension clamps or angle clamps are used.
3. Refer to Table 10-2 “Pin Insulators Deviation Angle Limits” in the “Insulators” Section 10 of this standard for these limitations.

10.4 Intermediate Urban 33kV DELTA Constructions – Duties for common applications

For a 3 Phase Construction with subsidiary LV ABC 4x95mm² and allowance for 1.5kN Service Load

Foundations standard depth plus 150mm

Delta is of standard height unless otherwise stated

Layout temperature 75oC for HV and 80oC for LV

Crossarm size 2700x100x100 satisfactory for all applications below for weight spans up to ruling span plus 10%

Maximum Span for ground clearance limitation based on 5.8m clearance for LV on level ground

Table 11-3 – Specifications for Urban Intermediate Wood Pole (33kV)

						Non-Cyclonic Area			Cyclonic Area		
Conductor Type	Stringing Condition	Assumed Ruling Span	Maximum Span - mid span clearance limitation (m)	Standard Pole Ht (m)	Maximum Span - ground clearance limitation (m)	Pole Strength Tip Rating (kN)	Allowable Wind Span with 0° deviation (m)	Maximum Deviation Angle on unstayed pole for wind span equal to assumed ruling span (°)	Pole Strength Tip Rating (kN)	Allowable Wind Span with 0° deviation (m)	Maximum Deviation Angle on unstayed pole for wind span equal to assumed ruling span (°)
Libra 7/3.00 AAC	2.5% CBL	40 m	86	12.5	41	5	128	20	5	90	20
Mars 7/3.75 AAC	2.5% CBL	40 m	84	12.5	41	5	114	20	5	80	19
Moon 7/4.75 AAC	2.5% CBL	40 m	84	12.5	41	5	100	20	5	70	14
Pluto 19/3.75 AAC	2.5% CBL	40 m	84	12.5	41	5	84	19	5	59	8
Libra 7/3.00 AAC	6% CBL	60 m	125	12.5	60	5	128	14	5	90	6
Mars 7/3.75 AAC	6% CBL	60 m	123	12.5	60	5	114	11	5	80	4
Moon 7/4.75 AAC	6% CBL	60 m	122	12.5	60	5	100	8	5	70	2
Pluto 19/3.75 AAC	6% CBL	60 m	123	12.5	60	5	84	4	5	59	-
Libra 7/3.00 AAC	10% CBL	100 m	161	14	97	5	120	2	5	83	-
Mars 7/3.75 AAC	10% CBL	100 m	159	14	97	5	107	-	8	140	5
Moon 7/4.75 AAC	10% CBL	100 m	158	14	97	5	94	-	8	123	3
Pluto 19/3.75 AAC	10% CBL	100 m	159	14	97	8	145	5	8	104	-

Notes:

1. Shading indicates that the Maximum Deviation Angle is limited by the deviation angle limit of the insulator.
2. Where there is subsidiary LV ABC on the pole, the Maximum Deviation Angle may be limited further depending on whether suspension clamps or angle clamps are used.
3. Refer to Table 10-2 “Pin Insulators Deviation Angle Limits” in the “Insulators” Section 10 of this standard for these limitations.

10.5 Intermediate Rural 11kV DELTA Constructions – Duties for common applications

For a 3 Phase Construction with no LV on Pole

Foundations standard depth plus 150mm

Delta is of standard height unless otherwise stated

Layout temperature 60°C

Crossarm size 2400x100x100 satisfactory for all applications below for weight spans up to the ruling span plus 10% with the exception of Pluto which requires a 2400x100x125 Crossarm

Maximum Span for ground clearance limitation based on 6.0m clearance on level ground

Table 11-4 – Specifications for Rural Intermediate Wood Pole (11kV)

				Non-Cyclonic Area					Cyclonic Area				
Conductor Type	Stringing Condition	Assumed Ruling Span	Standard Pole Ht (m)	Maximum Span - mid span clearance limitation (m) (Note 1)	Maximum Span - ground clearance limitation (m) (Note 1)	Pole Strength Tip Rating (kN)	Allowable Wind Span with 0° deviation (m)	Maximum Deviation Angle on unstayed pole for wind span equal to assumed ruling span (°) (Note 2)	Maximum Span - mid span clearance limitation (m) (Note 1)	Maximum Span - ground clearance limitation (m) (Note 1)	Pole Strength Tip Rating (kN)	Allowable Wind Span with 0° deviation (m)	Maximum Deviation Angle on unstayed pole for wind span equal to assumed ruling span (°) (Note 2)
Libra 7/3.00 AAC	20% CBL	150 m	12.5	223	164	5	318	14	186	139	5	227	7
			14		188	5	307	13		159	5	216	6
Mars 7/3.75 AAC	20% CBL	150 m	12.5	222	163	5	253	8	206	153	5	180	2
			14		187	5	244	7		175	5	172	1
Moon 7/4.75 AAC	20% CBL	150 m	12.5	221	163	5	200	3	221	163	5	142	-
			14		186	5	193	3		186	8	235	6
Pluto 19/3.75 AAC	20% CBL	150 m	12.5	222	163	5	152	-	222	163	8	183	2
			14		187	5	147	-		187	8	179	2
Chlorine 7/3.75 AAAC	20% CBL	250 m	12.5	256	191	5	382	8	209	158	5	272	1
			14		218	5	368	7		181	5	259	-
			15.5		243	5	359	6		201	5	249	-
Helium 7/3.75 AAAC	20% CBL	250 m	12.5	279	207	5	253	-	265	197	8	305	3
			14		236	5	244	-		226	8	298	2
			15.5		263	5	238	-		251	8	288	2
Iodine 7/4.75 AAAC	20% CBL	250 m	12.5	275	204	8	333	4	275	204	8	241	-
			14		233	8	327	3		233	8	235	-
			15.5		259	8	320	3		259	8	228	-
Apple 6/1/3.0 ACSR	22% CBL	250 m	12.5	299	221	5	318	3	283	210	8	383	7
			14		253	5	307	2		241	8	374	7
			15.5		281	5	299	2		268	8	362	6
Banana 6/1/3.75 ACSR	22% CBL	250 m	12.5	296	219	5	253	-	296	219	8	305	2
			14		251	5	244	-		251	8	298	2
			15.5		279	5	238	-		279	8	288	2
Raisin 3/4/2.5 ACSR	22% CBL	320 m	12.5	371	276	5	382	2	371	276	8	459	5
			14		316	5	368	1		316	8	449	5
			15.5		351	5	359	1		251	8	435	4
Sultana 4/3/3.0 ACSR	22% CBL	320 m	12.5	356	265	5	318	-	356	265	8	383	2
			14		303	5	307	-		303	8	374	2
			15.5		337	8	509	4		337	8	362	1
3/2.75 SC/GZ	25% CBL	350 m	12.5	450	335	5	483	4	450	335	5	344	-
			14		383	5	466	3		383	5	327	-
3/2.75 SC/AC	25% CBL	350 m	12.5	490	364	5	483	4	490	364	5	344	-
			14		416	5	466	3		416	5	327	-

Notes:

1. Shading indicates that the Maximum Span is limited by the Transition Span of the conductor.
2. Shading indicates that the Maximum Deviation Angle is limited by the deviation angle limit of the insulator.

10.6 Intermediate Rural 22kV DELTA Constructions – Duties for common applications

For a 3 Phase Construction with no LV on Pole

Foundations standard depth plus 150mm

Delta is of standard height unless otherwise stated

Layout temperature 60°C

Crossarm size 2700x100x100 satisfactory for all applications below for weight spans up to ruling span plus 10% with the exception of Pluto, Iodine and Sultana which require 2700x100x125 Crossarm

Maximum Span for ground clearance limitation based on 6.0m clearance on level ground

Table 11-5 – Specifications for Rural Intermediate Wood Pole (22kV)

				Non-Cyclonic Area					Cyclonic Area				
Conductor Type	Stringing Condition	Assumed Ruling Span	Standard Pole Ht (m)	Maximum Span - mid span clearance limitation (m) (Note 1)	Maximum Span - ground clearance limitation (m) (Note 1)	Pole Strength Tip Rating (kN)	Allowable Wind Span with 0° deviation (m)	Maximum Deviation Angle on unstayed pole for wind span equal to assumed ruling span (°) (Note 2)	Maximum Span - mid span clearance limitation (m) (Note 1)	Maximum Span - ground clearance limitation (m) (Note 1)	Pole Strength Tip Rating (kN)	Allowable Wind Span with 0° deviation (m)	Maximum Deviation Angle on unstayed pole for wind span equal to assumed ruling span (°) (Note 2)
Libra 7/3.00 AAC	20% CBL	150 m	12.5	229	166	5	317	13	191	140	5	225	6
			14		189	5	306	13		160	5	215	5
Mars 7/3.75 AAC	20% CBL	150 m	12.5	228	165	5	252	8	212	154	5	179	2
			14		188	5	243	7		176	5	171	1
Moon 7/4.75 AAC	20% CBL	150 m	12.5	227	164	5	199	3	227	164	5	142	-
			14		187	5	192	3		187	8	234	6
Pluto 19/3.75 AAC	20% CBL	150 m	12.4	228	165	5	151	-	228	165	8	182	2
			14		188	5	146	-		188	8	178	2
Chlorine 7/3.75 AAAC	20% CBL	250 m	12.5	263	192	5	380	8	215	159	5	271	1
			14		220	5	367	7		182	5	258	-
			15.5		244	5	357	6		202	5	248	-
Helium 7/3.75 AAAC	20% CBL	250 m	12.5	287	208	5	252	-	273	199	8	303	3
			14		238	5	243	-		227	8	296	2
			15.5		264	5	237	-		252	8	287	2
Iodine 7/4.75 AAAC	20% CBL	250 m	12.5	282	206	8	331	4	282	206	8	239	-
			14		235	8	326	3		235	8	234	-
			15.5		261	8	319	3		261	8	227	-
Apple 6/1/3.0 ACSR	22% CBL	250 m	12.5	307	223	5	317	3	291	212	8	381	7
			14		255	5	306	2		242	8	372	6
			15.5		283	5	298	2		269	8	361	6
Banana 6/1/3.75 ACSR	22% CBL	250 m	12.5	304	221	5	252	-	304	221	8	303	2
			14		253	5	243	-		253	8	296	2
			15.5		281	5	237	-		281	8	287	1
Raisin 3/4/2.5 ACSR	22% CBL	320 m	12.5	381	278	5	380	2	381	278	8	457	5
			14		318	5	367	1		318	8	447	5
			15.5		353	5	357	1		353	8	433	4
Sultana 4/3/3.0ACSR	22% CBL	320 m	12.5	366	267	5	317	-	366	267	8	381	2
			14		305	5	306	-		305	8	372	2
			15.5		339	8	507	4		339	8	361	1
3/2.75 SC/GZ	25% CBL	350 m	12.5	463	338	5	481	4	463	338	5	342	-
			14		386	5	464	3		386	5	326	-
3/2.75 SC/AC	25% CBL	350 m	12.5	504	367	5	481	4	504	367	5	342	-
			14		419	5	464	3		419	5	326	-

Notes:

1. Shading indicates that the Maximum Span is limited by the Transition Span of the conductor.
2. Shading indicates that the Maximum Deviation Angle is limited by the deviation angle limit of the insulator.

10.7 Intermediate Rural 33kV DELTA Constructions – Duties for common applications

For a 3 Phase Construction with no LV on Pole

Foundations standard depth plus 150mm

Delta is of standard height unless otherwise stated

Layout temperature 60°C

Crossarm size 2700x100x100 satisfactory for all applications below for weight spans up to ruling span plus 10% with the exception of Pluto, Iodine and Sultana which require 2700x100x125 Crossarm

Maximum Span for ground clearance limitation based on 6.0m clearance on level ground

Table 11-6 – Specifications for Rural Intermediate Wood Pole (33kV)

				Non-Cyclonic Area					Cyclonic Area				
Conductor Type	Stringing Condition	Assumed Ruling Span	Standard Pole Ht (m)	Maximum Span - mid span clearance limitation (m) (Note 1)	Maximum Span - ground clearance limitation (m) (Note 1)	Pole Strength Tip Rating (kN)	Allowable Wind Span with 0° deviation (m)	Maximum Deviation Angle on unstayed pole for wind span equal to assumed ruling span (°) (Note 2)	Maximum Span - mid span clearance limitation (m) (Note 1)	Maximum Span - ground clearance limitation (m) (Note 1)	Pole Strength Tip Rating (kN)	Allowable Wind Span with 0° deviation (m)	Maximum Deviation Angle on unstayed pole for wind span equal to assumed ruling span (°) (Note 2)
Libra 7/3.00 AAC	20% CBL	150 m	12.5	214	166	5	316	13	178	140	5	225	6
			14		189	5	305	12		160	5	214	5
Mars 7/3.75 AAC	20% CBL	150 m	12.5	213	165	5	252	8	198	154	5	179	2
			14		188	5	243	7		176	5	171	1
Moon 7/4.75 AAC	20% CBL	150 m	12.5	212	164	5	199	3	212	164	5	142	-
			14		188	5	192	3		188	8	234	6
Pluto 19/3.75 AAC	20% CBL	150 m	12.4	213	165	5	151	-	213	165	8	182	2
			14		188	5	146	-		188	8	178	2
Chlorine 7/3.75 AAAC	20% CBL	250 m	12.5	245	193	5	380	8	201	159	5	270	1
			14		220	5	366	7		182	5	257	-
			15.5		244	5	357	6		202	5	248	-
Helium 7/3.75 AAAC	20% CBL	250 m	12.5	268	209	5	252	-	255	199	8	303	3
			14		238	5	243	-		228	8	296	2
			15.5		265	5	237	-		253	8	287	2
Iodine 7/4.75 AAAC	20% CBL	250 m	12.5	264	206	8	331	4	264	206	8	239	-
			14		235	8	326	3		235	8	234	-
			15.5		261	8	318	3		261	8	227	-
Apple 6/1/3.0 ACSR	22% CBL	250 m	12.5	287	223	5	316	3	272	212	8	380	7
			14		255	5	305	2		242	8	372	6
			15.5		283	5	297	2		269	8	360	6
Banana 6/1/3.75 ACSR	22% CBL	250 m	12.5	284	221	5	252	-	284	221	8	303	2
			14		253	5	243	-		253	8	296	2
			15.5		281	5	237	-		281	8	287	1
Raisin 3/4/2.5 ACSR	22% CBL	320 m	12.5	356	279	5	380	2	356	279	8	456	5
			14		318	5	366	1		318	8	446	5
			15.5		353	5	357	1		353	8	433	4
Sultana 4/3/3.0ACSR	22% CBL	320 m	12.5	342	267	5	316	-	342	267	8	380	2
			14		305	5	305	-		305	8	372	2
			15.5		339	8	506	4		339	8	360	1
3/2.75 SC/GZ	25% CBL	350 m	12.5	432	338	5	480	4	432	338	5	342	-
			14		386	5	464	3		386	5	326	-
3/2.75 SC/AC	25% CBL	350 m	12.5	471	368	5	480	4	471	368	5	342	-
			14		420	5	464	3		420	5	326	-

Notes:

1. Shading indicates that the Maximum Span is limited by the Transition Span of the conductor.
2. Shading indicates that the Maximum Deviation Angle is limited by the deviation angle limit of the insulator.

10.8 Strain / Termination Urban TRIDENT 11/22kV Poles – Stay requirements for common applications

Cyclonic Area

For a 3 Phase Construction with subsidiary LV ABC and no allowance for Service Load

Foundations standard depth plus 150mm

Table 11-7 – Stay Requirements for Urban Strain/Termination Wood Pole (11/22kV, Cyclonic Area)

Conductor Type	Stringing Condition	Assumed Ruling Span	Standard Pole Ht (m)	Pole Strength Tip Rating (kN)	Limit State Conductor Termination Load (kN)	Required stay for termination Preferred/Alternative	Aerial Stay	Maximum deviation angle unstayed	Maximum deviation angle bisect stay
Libra 7/3.00 AAC	2.5% CBL	40 m	12.5	5	8.0	GS1/45 or GS1/60 or SS3	AS1	44°	45°+ GS1/45
Mars 7/3.75 AAC	2.5% CBL	40 m	12.5	5	9.0	GS1/45 or GS1/60 or SS3	AS1	38°	45°+ GS1/45
Moon 7/4.75 AAC	2.5% CBL	40 m	12.5	5	10.5	GS1/45 or GS1/60	AS1	31°	45°+ GS1/45
Pluto 19/3.75 AAC	2.5% CBL	40 m	12.5	8	12.9	GS1/45	AS1	47°	45°+ GS1/45
Libra 7/3.00 AAC	6% CBL	60 m	12.5	8	16.8	GS1/45	AS1	36°	45°+ GS1/45
Mars 7/3.75 AAC	6% CBL	60 m	12.5	8	19.2	GS2/45	AS2	30°	45°+ GS2/45
Moon 7/4.75 AAC	6% CBL	60 m	12.5	8	22.6	GS2/45	AS2	25°	45°+ GS2/45
Pluto 19/3.75 AAC	6% CBL	60 m	12.5	8	28.1	GS3/45 or GS3/60	AS3	19°	45°+ GS3/45
Libra 7/3.00 AAC	10% CBL	100 m	14	8	26.7	GS2/45	AS2	18°	45°+ GS2/45
Mars 7/3.75 AAC	10% CBL	100 m	14	8	30.6	GS3/45	AS3	15°	45°+ GS3/45
Moon 7/4.75 AAC	10% CBL	100 m	14	8	36.2	GS3/45	AS3	12°	45°+ GS3/45
Pluto 19/3.75 AAC	10% CBL	80 m	14	8	42.5	GS3/45	AS3	10°	45°+ GS3/45

Note: The Limit State Conductor Termination Load listed is relative to the pole tip.

10.9 Strain / Termination Urban TRIDENT 11/22kV Poles – Stay requirements for common applications

Non-Cyclonic Area

For a 3 Phase Construction with subsidiary LV ABC and no allowance for Service Load

Foundations standard depth plus 150mm

Table 11-8 – Stay Requirements for Urban Strain/Termination Wood Pole (11/22kV, Non-cyclonic Area)

Conductor Type	Stringing Condition	Assumed Ruling Span	Standard Pole Ht (m)	Pole Strength Tip Rating (kN)	Limit State Conductor Termination Load (kN)	Required stay for termination Preferred/Alternative	Aerial Stay	Maximum deviation angle unstayed	Maximum deviation angle bisect stay
Libra 7/3.00 AAC	2.5% CBL	40 m	12.5	5	6.2	GS1/45 or GS1/60 or SS3	AS1	66°	45°+ GS1/45
Mars 7/3.75 AAC	2.5% CBL	40 m	12.5	5	6.9	GS1/45 or GS1/60 or SS3	AS1	57°	45°+ GS1/45
Moon 7/4.75 AAC	2.5% CBL	40 m	12.5	5	8.1	GS1/45 or GS1/60 or SS3	AS1	47°	45°+ GS1/45
Pluto 19/3.75 AAC	2.5% CBL	40 m	12.5	8	10.0	GS1/45 or GS1/60	AS1	69°	45°+ GS1/45
Libra 7/3.00 AAC	6% CBL	60 m	12.5	8	13.3	GS1/45	AS1	50°	45°+ GS1/45
Mars 7/3.75 AAC	6% CBL	60 m	12.5	8	15.2	GS1/45	AS1	43°	45°+ GS1/45
Moon 7/4.75 AAC	6% CBL	60 m	12.5	8	17.9	GS1/45	AS1	35°	45°+ GS1/45
Pluto 19/3.75 AAC	6% CBL	60 m	12.5	8	22.3	GS2/45	AS2	27°	45°+ GS2/45
Libra 7/3.00 AAC	10% CBL	100 m	14	8	21.4	GS2/45	AS2	27°	45°+ GS2/45
Mars 7/3.75 AAC	10% CBL	100 m	14	8	24.5	GS2/45	AS2	23°	45°+ GS2/45
Moon 7/4.75 AAC	10% CBL	100 m	14	8	28.9	GS3/45 or GS3/60	AS2	18°	45°+ GS3/45
Pluto 19/3.75 AAC	10% CBL	80 m	14	8	34.4	GS3/45	AS3	16°	45°+ GS3/45

Note: The Limit State Conductor Termination Load listed is relative to the pole tip.

10.10 Strain / Termination Urban 33kV Poles – Stay requirements for common applications

Cyclonic Area

For a 3 Phase Construction with subsidiary LV ABC and no allowance for Service Load

Foundations standard depth plus 150mm

Crossarm size based on weight span of 70% of ruling span for termination and 110% of ruling span for strain

Table 11-9 – Stay Requirements for Urban Strain/Termination Wood Pole (33kV, Cyclonic Area)

Conductor Type	Stringing Condition	Assumed Ruling Span	Required crossarm for termination	Required crossarm for strain 0° deviation	Standard Pole Ht (m)	Pole Strength Tip Rating (kN)	Limit State Conductor Termination Load (kN)	Required stay for termination Preferred / Alternative	Aerial Stay	Maximum deviation angle unstayed	Maximum deviation angle bisect stay
Libra 7/3.00 AAC	2.5% CBL	40 m	S - 2700x150x100	S - 2700x150x100	12.5	5	8.1	GS1/45 or GS1/60 or SS3	AS1	44°	45°+ GS1/45
Mars 7/3.75 AAC	2.5% CBL	40 m	S - 2700x150x100	S - 2700x150x100	12.5	5	9.1	GS1/45 or GS1/60 or SS3	AS1	37°	45°+ GS1/45
Moon 7/4.75 AAC	2.5% CBL	40 m	S - 2700x150x100	S - 2700x150x100	12.5	5	10.6	GS1/45 or GS1/60	AS1	31°	45°+ GS1/45
Pluto 19/3.75 AAC	2.5% CBL	40 m	S - 2700x150x100	S - 2700x150x100	12.5	8	13.0	GS1/45	AS1	47°	45°+ GS1/45
Libra 7/3.00 AAC	6% CBL	60 m	S - 2700x150x100	S - 2700x150x100	12.5	8	16.9	GS1/45	AS1	35°	45°+ GS1/45
Mars 7/3.75 AAC	6% CBL	60 m	S - 2700x150x100	S - 2700x150x100	12.5	8	19.4	GS2/45	AS2	30°	45°+ GS2/45
Moon 7/4.75 AAC	6% CBL	60 m	S - 2700x150x100	S - 2700x150x100	12.5	8	22.8	GS2/45	AS2	25°	45°+ GS2/45
Pluto 19/3.75 AAC	6% CBL	60 m	S - 2700x150x100	S - 2700x150x100	12.5	8	28.3	GS3/45 or GS3/60	AS3	19°	45°+ GS3/45
Libra 7/3.00 AAC	10% CBL	100 m	S - 2700x150x100	S - 2700x150x100	14	8	27.0	GS2/45	AS2	18°	45°+ GS2/45
Mars 7/3.75 AAC	10% CBL	100 m	S - 2700x150x100	S - 2700x150x100	14	8	30.9	GS3/45	AS3	15°	45°+ GS3/45
Moon 7/4.75 AAC	10% CBL	100 m	S - 2700x175x125	S - 2700x150x100	14	8	36.4	GS3/45	AS3	12°	45°+ GS3/45
Pluto 19/3.75 AAC	10% CBL	80 m	S - 2700x175x125	S - 2700x175x125	14	8	42.8	GS3/45	AS3	10°	45°+ GS3/45

Note: The Limit State Conductor Termination Load listed is relative to the pole tip.

10.11 Strain / Termination Urban 33kV Poles – Stay requirements for common applications

Non-Cyclonic Area

For a 3 Phase Construction with subsidiary LV ABC and no allowance for Service Load

Foundations standard depth plus 150mm

Crossarm size based on weight span of 70% of ruling span for termination and 110% of ruling span for strain

Table 11-10 – Stay Requirements for Urban Strain/Termination Wood Pole (33kV, Non-Cyclonic Area)

Conductor Type	Stringing Condition	Assumed Ruling Span	Required crossarm for termination	Required crossarm for strain 0° deviation	Standard Pole Ht (m)	Pole Strength Tip Rating (kN)	Limit State Conductor Termination Load (kN)	Required stay for termination Preferred / Alternative	Aerial Stay	Maximum deviation angle unstayed	Maximum deviation angle bisect stay
Libra 7/3.00 AAC	2.5% CBL	40 m	S - 2700x150x100	S - 2700x150x100	12.5	5	6.2	GS1/45 or GS1/60 or SS3	AS1	65°	45°+ GS1/45
Mars 7/3.75 AAC	2.5% CBL	40 m	S - 2700x150x100	S - 2700x150x100	12.5	5	7.0	GS1/45 or GS1/60 or SS3	AS1	56°	45°+ GS1/45
Moon 7/4.75 AAC	2.5% CBL	40 m	S - 2700x150x100	S - 2700x150x100	12.5	5	8.1	GS1/45 or GS1/60 or SS3	AS1	47°	45°+ GS1/45
Pluto 19/3.75 AAC	2.5% CBL	40 m	S - 2700x150x100	S - 2700x150x100	12.5	8	10.1	GS1/45 or GS1/60	AS1	69°	45°+ GS1/45
Libra 7/3.00 AAC	6% CBL	60 m	S - 2700x150x100	S - 2700x150x100	12.5	8	13.4	GS1/45	AS1	50°	45°+ GS1/45
Mars 7/3.75 AAC	6% CBL	60 m	S - 2700x150x100	S - 2700x150x100	12.5	8	15.3	GS1/45	AS1	43°	45°+ GS1/45
Moon 7/4.75 AAC	6% CBL	60 m	S - 2700x150x100	S - 2700x150x100	12.5	8	18.0	GS1/45	AS1	35°	45°+ GS1/45
Pluto 19/3.75 AAC	6% CBL	60 m	S - 2700x150x100	S - 2700x150x100	12.5	8	22.5	GS2/45	AS2	27°	45°+ GS2/45
Libra 7/3.00 AAC	10% CBL	100 m	S - 2700x150x100	S - 2700x150x100	14	8	21.5	GS2/45	AS2	27°	45°+ GS2/45
Mars 7/3.75 AAC	10% CBL	100 m	S - 2700x150x100	S - 2700x150x100	14	8	24.7	GS2/45	AS2	23°	45°+ GS2/45
Moon 7/4.75 AAC	10% CBL	100 m	S - 2700x150x100	S - 2700x150x100	14	8	29.1	GS3/45 or GS3/60	AS2	18°	45°+ GS3/45
Pluto 19/3.75 AAC	10% CBL	80 m	S - 2700x175x125	S - 2700x175x125	14	8	34.7	GS3/45	AS3	15°	45°+ GS3/45

Note: The Limit State Conductor Termination Load listed is relative to the pole tip.

10.12 Strain / Termination Rural 11kV Poles – Stay requirements for common applications

Cyclonic Area

For a 3 Phase Construction with no LV Conductor on Pole

Foundations standard depth plus 150mm

Crossarm size based on weight span of 70% of ruling span for termination and 110% of ruling span for strain

Table 11-11 – Stay Requirements for Rural Strain/Termination Wood Pole (11kV, Cyclonic Area)

Conductor Type	Stringing Condition	Assumed Ruling Span	Required crossarm for termination	Required crossarm for strain 0° deviation	Standard Pole Ht (m)	Pole Strength Tip Rating (kN)	Limit State Conductor Termination Load (kN)	Required stay for termination Preferred/alternative	Aerial stay	Maximum deviation angle - with bisect stay (°)
Libra 7/3.00 AAC	20% CBL	150 m	S - 2400x150x100	S - 2400x150x100	12.5 14	5 5	16.1 16.1	GS1/45 GS1/45	AS1	64 63
Mars 7/3.75 AAC	20% CBL	150 m	S - 2400x150x100	S - 2400x150x100	12.5 14	5 5	24.2 24.3	GS2/45 GS2/45	AS1	68 67
Moon 7/4.75 AAC	20% CBL	150 m	S - 2400x175x125	S - 2400x175x125	12.5 14	5 8	35.6 35.8	GS3/45 or GS3/60 GS3/45 or GS3/60	AS2	79 78
Pluto 19/3.75 AAC	20% CBL	150 m	D - 2400x175x125	D - 2400x150x100	12.5 14	8 8	50.7 50.9	GS3/45 GS3/45	AS3	49 49
Chlorine 7/2.5 AAAC	20% CBL	250 m	S - 2400x150x100	S - 2400x150x100	12.5 14 15.5	5 5 5	16.6 16.7 16.7	GS1/45 GS1/45 GS1/45	AS1	54 53 53
Helium 7/3.75 AAAC	20% CBL	250 m	S - 2400x175x125	S - 2400x175x125	12.5 14 15.5	8 8 8	35.8 35.9 36.0	GS3/45 or GS3/60 GS3/45 or GS3/60 GS3/45 or GS3/60	AS2	73 73 72
Iodine 7/4.75 AAAC	20% CBL	250 m	D - 2400x175x125	S - 2400x175x125	12.5 14 15.5	8 8 8	50.6 50.7 50.9	GS3/45 GS3/45 GS3/45	AS3	46 46 46
Apple 6/1/3.0 ACSR	22% CBL	250 m	S - 2400x175x125	S - 2400x175x125	12.5 14 15.5	8 8 8	30.3 30.4 30.5	GS2/45 GS2/45 GS2/45	AS2	48 48 47
Banana 6/1/3.75 ACSR	22% CBL	250 m	S - 2400x175x125	S - 2400x175x125	12.5 14 15.5	8 8 8	42.6 42.9 42.9	GS3/45 GS3/45 GS3/45	AS3	59 59 59
Raisin 3/4/2.5 ACSR	22% CBL	320 m	S - 2400x175x125	S - 2400x175x125	12.5 14 15.5	8 8 8	37.4 37.6 37.7	GS3/45 GS3/45 GS3/45	AS2	72 72 71
Sultana 4/3/3.0ACSR	22% CBL	320 m	S - 2400x175x125	S - 2400x175x125	12.5 14 15.5	8 8 8	44.5 44.7 44.8	GS3/45 GS3/45 GS3/45	AS3	56 56 56
3/2.75 SC/GZ	25% CBL	350 m	S - 2400x175x125	S - 2400x175x125	12.5 14	5 5	33.3 33.4	GS3/45 or GS3/60 GS3/45 or GS3/60	AS2	86 86
3/2.75 SC/AC	25% CBL	350 m	S - 2400x175x125	S - 2400x175x125	12.5 14	5 5	32.5 32.6	GS2/45 GS3/45 or GS3/60	AS2	46 88

Note: The Limit State Conductor Termination Load listed is relative to the pole tip.

10.13 Strain / Termination Rural 11kV Poles – Stay requirements for common applications

Non-Cyclonic Area

For a 3 Phase Construction with no LV Conductor on Pole

Foundations standard depth plus 150mm

Crossarm size based on weight span of 70% of ruling span for termination and 110% of ruling span for strain

Table 11-12 – Stay Requirements for Rural Strain/Termination Wood Pole (11kV, Non-Cyclonic Area)

Conductor Type	Stringing Condition	Assumed Ruling Span	Required crossarm for termination	Required crossarm for strain 0° deviation	Standard Pole Ht (m)	Pole Strength Tip Rating (kN)	Limit State Conductor Termination Load (kN)	Required stay for termination Preferred/alternative	Aerial stay	Maximum deviation angle - with bisect stay (°)
Libra 7/3.00 AAC	20% CBL	150 m	S - 2400x150x100	S - 2400x150x100	12.5	5	16.1	GS1/45	AS1	71
					14	5	16.1	GS1/45		70
Mars 7/3.75 AAC	20% CBL	150 m	S - 2400x150x100	S - 2400x150x100	12.5	5	21.6	GS1/45	AS1	48
					14	5	21.7	GS1/45		48
Moon 7/4.75 AAC	20% CBL	150 m	S - 2400x175x125	S - 2400x175x125	12.5	5	29.4	GS2/45	AS1	56
					14	5	29.6	GS2/45		56
Pluto 19/3.75 AAC	20% CBL	150 m	S - 2400x175x125	D - 2400x150x100	12.5	5	42.2	GS3/45	AS2	65
					14	5	42.4	GS3/45		65
Chlorine 7/2.5 AAAC	20% CBL	250 m	S - 2400x150x100	S - 2400x150x100	12.5	5	16.6	GS1/45	AS1	62
					14	5	16.7	GS1/45		62
					15.5	5	16.7	GS1/45		61
Helium 7/3.75 AAAC	20% CBL	250 m	S - 2400x175x125	S - 2400x175x125	12.5	5	31.0	GS2/45	AS2	49
					14	5	31.1	GS2/45		49
					15.5	5	31.2	GS2/45		49
Iodine 7/4.75 AAAC	20% CBL	250 m	S - 2400x175x125	S - 2400x175x125	12.5	8	41.9	GS3/45	AS2	62
					14	8	42.0	GS3/45		62
					15.5	8	42.2	GS3/45		62
Apple 6/1/3.0 ACSR	22% CBL	250 m	S - 2400x175x125	S - 2400x175x125	12.5	5	26.3	GS2/45	AS1	63
					14	5	26.4	GS2/45		62
					15.5	5	26.5	Gs2/45		62
Banana 6/1/3.75 ACSR	22% CBL	250 m	S - 2400x175x125	S - 2400x175x125	12.5	5	35.6	GS3/45 or GS3/60	AS2	79
					14	5	35.8	GS3/45 or GS3/60		79
					15.5	5	35.9	GS3/45 or GS3/60		79
Raisin 3/4/2.5 ACSR	22% CBL	320 m	S - 2400x175x125	S - 2400x175x125	12.5	5	31.8	GS2/45	AS2	50
					14	5	31.9	GS2/45		50
					15.5	5	32.0	GS2/45		50
Sultana 4/3/3.0 ACSR	22% CBL	320 m	S - 2400x175x125	S - 2400x175x125	12.5	5	37.6	GS3/45	AS2	74
					14	5	37.8	GS3/45		74
					15.5	8	37.9	GS3/45		73
3/2.75 SC/GZ	25% CBL	350 m	S - 2400x175x125	S - 2400x175x125	12.5	5	28.7	GS2/45	AS1	58
					14	5	28.9	GS2/45		58
3/2.75 SC/AC	25% CBL	350 m	S - 2400x175x125	S - 2400x175x125	12.5	5	28.2	GS2/45	AS1	59
					14	5	28.3	GS2/45		59

Note: The Limit State Conductor Termination Load listed is relative to the pole tip.

10.14 Strain / Termination Rural 22kV Poles – Stay requirements for common applications

Cyclonic Area

For a 3 Phase Construction with no LV Conductor on Pole

Foundations standard depth plus 150mm

Crossarm size based on weight span of 70% of ruling span for termination and 110% of ruling span for strain

Table 11-13 – Stay Requirements for Rural Strain/Termination Wood Pole (22kV, Cyclonic Area)

Conductor Type	Stringing Condition	Assumed Ruling Span	Required crossarm for termination	Required crossarm for strain 0° deviation	Standard Pole Ht (m)	Pole Strength Tip Rating (kN)	Limit State Conductor Termination Load (kN)	Required stay for termination Preferred/alternative	Aerial stay	Maximum deviation angle - with bisect stay
Libra 7/3.00 AAC	20% CBL	150 m	S - 2700x150x100	S - 2700x150x100	12.5 14	5 5	16.1 16.1	GS1/45 GS1/45	AS1	64 63
Mars 7/3.75 AAC	20% CBL	150 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 5	24.2 24.3	GS2/45 GS2/45	AS1	68 67
Moon 7/4.75 AAC	20% CBL	150 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 8	35.6 35.8	GS3/45 or GS3/60 GS3/45 or GS3/60	AS2	79 78
Pluto 19/3.75 AAC	20% CBL	150 m	D - 2700x175x125	D - 2700x175x125	12.5 14	8 8	50.7 50.9	GS3/45 GS3/45	AS3	49 49
Chlorine 7/2.5 AAAC	20% CBL	250 m	S - 2700x150x100	S - 2700x150x100	12.5 14 15.5	5 5 5	16.6 16.7 16.7	GS1/45 GS1/45 GS1/45	AS1	54 53 53
Helium 7/3.75 AAAC	20% CBL	250 m	S - 2700x175x125	S - 2700x175x125	12.5 14 15.5	8 8 8	35.8 35.9 36.0	GS3/45 or GS3/60 GS3/45 or GS3/60 GS3/45 or GS3/60	AS2	73 73 72
Iodine 7/4.75 AAAC	20% CBL	250 m	D - 2700x175x125	D - 2700x150x100	12.5 14 15.5	8 8 8	50.6 50.7 50.9	GS3/45 GS3/45 GS3/45	AS3	46 46 46
Apple 6/1/3.0 ACSR	22% CBL	250 m	S - 2700x175x125	S - 2700x175x125	12.5 14 15.5	8 8 8	30.3 30.4 30.5	GS2/45 GS2/45 GS2/45	AS2	48 48 47
Banana 6/1/3.75 ACSR	22% CBL	250 m	D - 2700x175x125	S - 2700x175x125	12.5 14 15.5	8 8 8	42.6 42.9 42.9	GS3/45 GS3/45 GS3/45	AS3	59 59 59
Raisin 3/4/2.5 ACSR	22% CBL	320 m	S - 2700x175x125	S - 2700x175x125	12.5 14 15.5	8 8 8	37.4 37.6 37.7	GS3/45 GS3/45 GS3/45	AS2	72 72 71
Sultana 4/3/3.0ACSR	22% CBL	320 m	D - 2700x175x125	D - 2700x175x125	12.5 14 15.5	8 8 8	44.5 44.7 44.8	GS3/45 GS3/45 GS3/45	AS3	56 56 56
3/2.75 SC/GZ	25% CBL	350 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 5	33.3 33.4	GS3/45 or GS3/60 GS3/45 or GS3/60	AS2	86 86
3/2.75 SC/AC	25% CBL	350 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 5	32.5 32.6	GS2/45 GS3/45 or GS3/60	AS2	46 88

Note: The Limit State Conductor Termination Load listed is relative to the pole tip.

10.15 Strain / Termination Rural 22kV Poles – Stay requirements for common applications

Non-Cyclonic Area

For a 3 Phase Construction with no LV Conductor on Pole

Foundations standard depth plus 150mm

Crossarm size based on weight span of 70% of ruling span for termination and 110% of ruling span for strain

Table 11-14 – Stay Requirements for Rural Strain/Termination Wood Pole (22kV, Non-Cyclonic Area)

Conductor Type	Stringing Condition	Assumed Ruling Span	Required crossarm for termination	Required crossarm for strain 0° deviation	Standard Pole Ht (m)	Pole Strength Tip Rating (kN)	Limit State Conductor Termination Load (kN)	Required stay for termination Preferred/alternative	Aerial stay	Maximum deviation angle - with bisect stay
Libra 7/3.00 AAC	20% CBL	150 m	S - 2700x150x100	S - 2700x150x100	12.5 14	5 5	16.1 16.1	GS1/45 GS1/45	AS1	71 70
Mars 7/3.75 AAC	20% CBL	150 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 5	21.6 21.7	GS1/45 GS1/45	AS1	48 48
Moon 7/4.75 AAC	20% CBL	150 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 5	29.4 29.6	GS2/45 GS2/45	AS1	56 56
Pluto 19/3.75 AAC	20% CBL	150 m	D - 2700x175x125	D - 2700x175x125	12.5 14	5 5	42.2 42.4	GS3/45 GS3/45	AS2	65 65
Chlorine 7/2.5 AAAC	20% CBL	250 m	S - 2700x150x100	S - 2700x150x100	12.5 14 15.5	5 5 5	16.6 16.7 16.7	GS1/45 GS1/45 GS1/45	AS1	62 62 61
Helium 7/3.75 AAAC	20% CBL	250 m	S - 2700x175x125	S - 2700x175x125	12.5 14 15.5	5 5 5	31.0 31.1 31.2	GS2/45 GS2/45 GS2/45	AS2	49 49 49
Iodine 7/4.75 AAAC	20% CBL	250 m	D - 2700x175x125	D - 2700x150x100	12.5 14 15.5	8 8 8	41.9 42.0 42.2	GS3/45 GS3/45 GS3/45	AS2	62 62 62
Apple 6/1/3.0 ACSR	22% CBL	250 m	S - 2700x175x125	S - 2700x175x125	12.5 14 15.5	5 5 5	26.3 26.4 26.5	GS2/45 GS2/45 Gs2/45	AS1	63 62 62
Banana 6/1/3.75 ACSR	22% CBL	250 m	S - 2700x175x125	S - 2700x175x125	12.5 14 15.5	5 5 5	35.6 35.8 35.9	GS3/45 or GS3/60 GS3/45 or GS3/60 GS3/45 or GS3/60	AS2	79 79 79
Raisin 3/4/2.5 ACSR	22% CBL	320 m	S - 2700x175x125	S - 2700x175x125	12.5 14 15.5	5 5 5	31.8 31.9 32.0	GS2/45 GS2/45 GS2/45	AS2	50 50 50
Sultana 4/3/3.0 ACSR	22% CBL	320 m	D - 2700x175x125	D - 2700x175x125	12.5 14 15.5	5 5 8	37.6 37.8 37.9	GS3/45 GS3/45 GS3/45	AS2	74 74 73
3/2.75 SC/GZ	25% CBL	350 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 5	28.7 28.9	GS2/45 GS2/45	AS1	58 58
3/2.75 SC/AC	25% CBL	350 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 5	28.2 28.3	GS2/45 GS2/45	AS1	59 59

Note: The Limit State Conductor Termination Load listed is relative to the pole tip.

10.16 Strain / Termination Rural 33kV Poles – Stay requirements for common applications

Cyclonic Area

For a 3 Phase Construction with no LV Conductor on Pole

Foundations standard depth plus 150mm

Crossarm size based on weight span of 70% of ruling span for termination and 110% of ruling span for strain

Table 11-15 – Stay Requirements for Rural Strain/Termination Wood Pole (33kV, Cyclonic Area)

Conductor Type	Stringing Condition	Assumed Ruling Span	Required crossarm for termination	Required crossarm for strain 0° deviation	Standard Pole Ht (m)	Pole Strength Tip Rating (kN)	Limit State Conductor Termination Load (kN)	Required stay for termination Preferred/alternative	Aerial stay	Maximum deviation angle - with bisect stay
Libra 7/3.00 AAC	20% CBL	150 m	S - 2700x150x100	S - 2700x150x100	12.5 14	5 5	16.1 16.1	GS1/45 GS1/45	AS1	64 63
Mars 7/3.75 AAC	20% CBL	150 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 5	24.2 24.3	GS2/45 GS2/45	AS1	68 67
Moon 7/4.75 AAC	20% CBL	150 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 8	35.6 35.8	GS3/45 or GS3/60 GS3/45 or GS3/60	AS2	79 78
Pluto 19/3.75 AAC	20% CBL	150 m	D - 2700x175x125	D - 2700x175x125	12.5 14	8 8	50.7 50.9	GS3/45 GS3/45	AS3	49 49
Chlorine 7/2.5 AAAC	20% CBL	250 m	S - 2700x150x100	S - 2700x150x100	12.5 14 15.5	5 5 5	16.6 16.7 16.7	GS1/45 GS1/45 GS1/45	AS1	54 53 53
Helium 7/3.75 AAAC	20% CBL	250 m	S - 2700x175x125	S - 2700x175x125	12.5 14 15.5	8 8 8	35.8 35.9 36.0	GS3/45 or GS3/60 GS3/45 or GS3/60 GS3/45 or GS3/60	AS2	73 73 72
Iodine 7/4.75 AAAC	20% CBL	250 m	D - 2700x175x125	D - 2700x150x100	12.5 14 15.5	8 8 8	50.6 50.7 50.9	GS3/45 GS3/45 GS3/45	AS3	46 46 46
Apple 6/1/3.0 ACSR	22% CBL	250 m	S - 2700x175x125	S - 2700x175x125	12.5 14 15.5	8 8 8	30.3 30.4 30.5	GS2/45 GS2/45 GS2/45	AS2	48 48 47
Banana 6/1/3.75 ACSR	22% CBL	250 m	D - 2700x175x125	S - 2700x175x125	12.5 14 15.5	8 8 8	42.6 42.9 42.9	GS3/45 GS3/45 GS3/45	AS3	59 59 59
Raisin 3/4/2.5 ACSR	22% CBL	320 m	S - 2700x175x125	S - 2700x175x125	12.5 14 15.5	8 8 8	37.4 37.6 37.7	GS3/45 GS3/45 GS3/45	AS2	72 72 71
Sultana 4/3/3.0ACSR	22% CBL	320 m	D - 2700x175x125	D - 2700x175x125	12.5 14 15.5	8 8 8	44.5 44.7 44.8	GS3/45 GS3/45 GS3/45	AS3	56 56 56
3/2.75 SC/GZ	25% CBL	350 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 5	33.3 33.4	GS3/45 or GS3/60 GS3/45 or GS3/60	AS2	86 86
3/2.75 SC/AC	25% CBL	350 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 5	32.5 32.6	GS2/45 GS3/45 or GS3/60	AS2	46 88

Note: The Limit State Conductor Termination Load listed is relative to the pole tip.

10.17 Strain / Termination Rural 33kV Poles – Stay requirements for common applications

Non-Cyclonic Area

For a 3 Phase Construction with no LV Conductor on Pole

Foundations standard depth plus 150mm

Crossarm size based on weight span of 70% of ruling span for termination and 110% of ruling span for strain

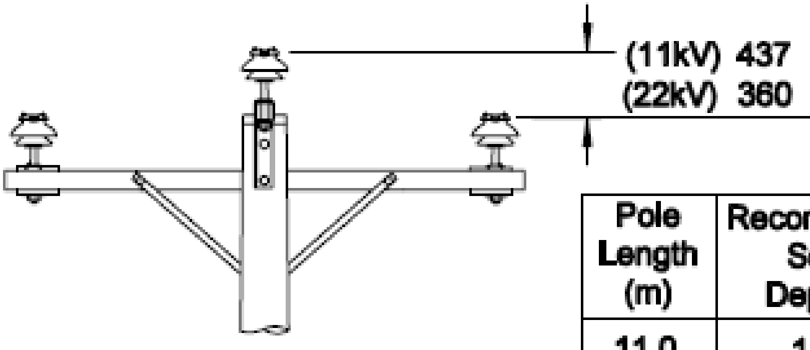
Table 11-16 – Stay Requirements for Rural Strain/Termination Wood Pole (33kV, Non-Cyclonic Area)

Conductor Type	Stringing Condition	Assumed Ruling Span	Required crossarm for termination	Required crossarm for strain 0° deviation	Standard Pole Ht (m)	Pole Strength Tip Rating (kN)	Limit State Conductor Termination Load (kN)	Required stay for termination Preferred/alternative	Aerial stay	Maximum deviation angle - with bisect stay
Libra 7/3.00 AAC	20% CBL	150 m	S - 2700x150x100	S - 2700x150x100	12.5 14	5 5	16.1 16.1	GS1/45 GS1/45	AS1	71 70
Mars 7/3.75 AAC	20% CBL	150 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 5	21.6 21.7	GS1/45 GS1/45	AS1	48 48
Moon 7/4.75 AAC	20% CBL	150 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 5	29.4 29.6	GS2/45 GS2/45	AS1	56 56
Pluto 19/3.75 AAC	20% CBL	150 m	D - 2700x175x125	D - 2700x175x125	12.5 14	5 5	42.2 42.4	GS3/45 GS3/45	AS2	65 65
Chlorine 7/2.5 AAAC	20% CBL	250 m	S - 2700x150x100	S - 2700x150x100	12.5 14 15.5	5 5 5	16.6 16.7 16.7	GS1/45 GS1/45 GS1/45	AS1	62 62 61
Helium 7/3.75 AAAC	20% CBL	250 m	S - 2700x175x125	S - 2700x175x125	12.5 14 15.5	5 5 5	31.0 31.1 31.2	GS2/45 GS2/45 GS2/45	AS2	49 49 49
Iodine 7/4.75 AAAC	20% CBL	250 m	D - 2700x175x125	D - 2700x150x100	12.5 14 15.5	8 8 8	41.9 42.0 42.2	GS3/45 GS3/45 GS3/45	AS2	62 62 62
Apple 6/1/3.0 ACSR	22% CBL	250 m	S - 2700x175x125	S - 2700x175x125	12.5 14 15.5	5 5 5	26.3 26.4 26.5	GS2/45 GS2/45 Gs2/45	AS1	63 62 62
Banana 6/1/3.75 ACSR	22% CBL	250 m	S - 2700x175x125	S - 2700x175x125	12.5 14 15.5	5 5 5	35.6 35.8 35.9	GS3/45 or GS3/60 GS3/45 or GS3/60 GS3/45 or GS3/60	AS2	79 79 79
Raisin 3/4/2.5 ACSR	22% CBL	320 m	S - 2700x175x125	S - 2700x175x125	12.5 14 15.5	5 5 5	31.8 31.9 32.0	GS2/45 GS2/45 GS2/45	AS2	50 50 50
Sultana 4/3/3.0 ACSR	22% CBL	320 m	D - 2700x175x125	D - 2700x175x125	12.5 14 15.5	5 5 8	37.6 37.8 37.9	GS3/45 GS3/45 GS3/45	AS2	74 74 73
3/2.75 SC/GZ	25% CBL	350 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 5	28.7 28.9	GS2/45 GS2/45	AS1	58 58
3/2.75 SC/AC	25% CBL	350 m	S - 2700x175x125	S - 2700x175x125	12.5 14	5 5	28.2 28.3	GS2/45 GS2/45	AS1	59 59

Note: The Limit State Conductor Termination Load listed is relative to the pole tip.

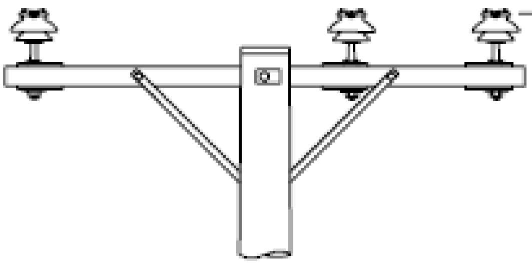
11. Layout Clearances

11.1 11/22/33kV Conductor Heights



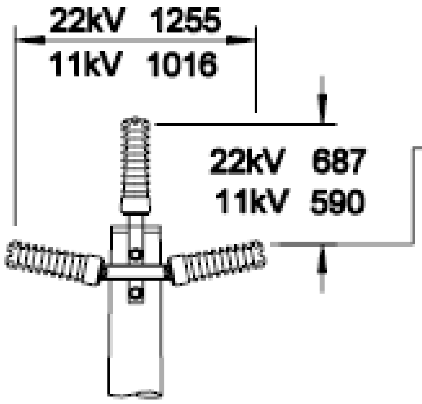
DELTA INTERMEDIATE

Pole Length (m)	Recommended Setting Depth (m)	Conductor Height (m)		
		11kV	22kV	33kV
11.0	1.85	9.01	9.09	9.10
12.5	2.00	10.36	10.44	10.45
14.0	2.15	11.71	11.79	11.80
15.5	2.30	13.06	13.14	13.15



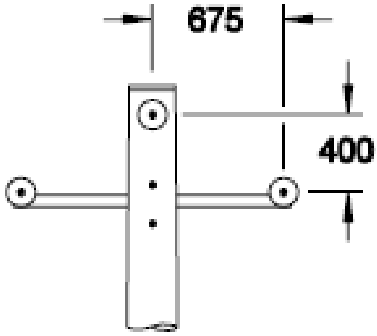
FLAT INTERMEDIATE

Pole Length (m)	Recommended Setting Depth (m)	Conductor Height (m)		
		11kV	22kV	33kV
11.0	1.85	9.20	9.28	9.29
12.5	2.00	10.55	10.63	10.64
14.0	2.15	11.90	11.98	11.99
15.5	2.30	13.25	13.33	13.34



TRIDENT INTERMEDIATE

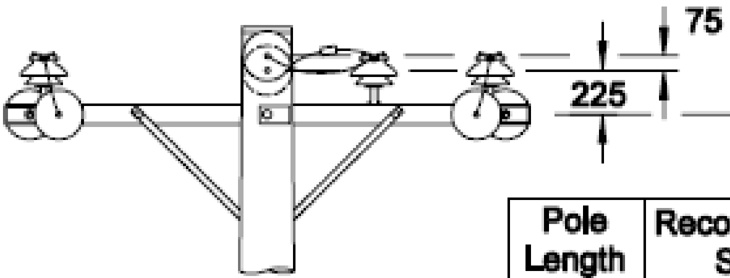
Pole Length (m)	Recommended Setting Depth (m)	Conductor Height (m)	
		11kV	22kV
11.0	1.85	9.03	9.05
12.5	2.00	10.38	10.40
14.0	2.15	11.73	11.75
15.5	2.30	13.08	13.10



TRIDENT

STRAIN / TERMINATION

Pole Length (m)	Recommended Setting Depth (m)	Conductor Height (m)	
		11kV	22kV
11.0	1.85	8.60	8.60
12.5	2.00	9.95	9.95
14.0	2.15	11.30	11.30
15.5	2.30	12.65	12.65



STRAIN CONSTRUCTION

Pole Length (m)	Recommended Setting Depth (m)	Conductor Height (m)		
		11kV	22kV	33kV
11.0	1.85	8.70	8.70	8.70
12.5	2.00	10.05	10.05	10.05
14.0	2.15	11.40	11.40	11.40
15.5	2.30	12.75	12.75	12.75

Figure 12-1 – 11/22/33kV Construction Conductor Heights

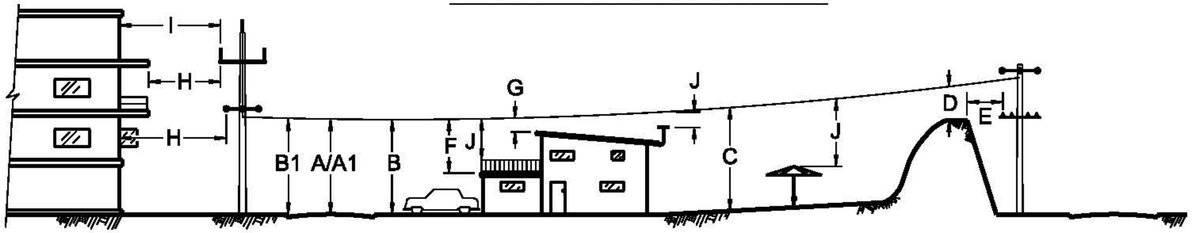
Notes:

1. Recommended setting depth based on one tenth of the pole height plus 0.75m
2. Additional depth may be required for poor soils

11.2 Minimum Clearances – Distribution, Sub-transmission and Low Voltage

11.2.1 Minimum Clearance Requirements – Mains Notes

CLEARANCE REQUIREMENTS



1. "High Risk"Locations are areas where machinery, plant, irrigation or other types of equipment are likely to operate in proximity to power lines. Examples are: Agricultural areas, Quarries, Mines and the like where high equipment is often used (including Aircraft). Planners and designers are required to determine the most appropriate solution to minimise the risk of any contact with power lines by equipment. Possible solutions for consideration would be to (a) Build power lines to an alternate non "High Risk"route, (b) Increase clearances, (c) Install insulated/CCT conductor or insulated line covers/barriers, (d) Install powerline markers
2. Clearances are a minimum to which a conductor may sag or swing (blowout) under the following conditions:
   a. Maximum Sag: maximum conductor design temperature in still air
   b. Max Horizontal Swing (Blowout): conductor temperature of 30°C (SEQ) and 35°C (N/S) with 500 Pa wind pressure on the conductor
   c. Minimum Sag: conductor temperature of 5°C (SEQ) or 0°C (N/S) in still air
3. Either the vertical clearance or the horizontal clearance specified must be maintained. Also, in the zone outside the vertical clearance alignment of the building, road cutting, embankments and similar places, either the horizontal clearance from the vertical alignment or the vertical clearance from the horizontal level on which a person may stand shall be maintained.
4. This item does not apply if code 'd' or 'e' applies.
5. For lights over roadways, no part of the light, its fittings or its support to a pole is to be less than 5.5m above the carriageway of a road.
6. For control cables and stay wires, a cable temperature of 50°C (SEQ) or 60°C (N/S) in still air shall apply in calculating clearances. Stay wires are to have a stay insulator(s) installed to ensure any part of the stay within public reach will not become energised (minimum 2.4m vertically above ground or from a structure).
7. The clearances above sugar cane applies to both green harvest and burnt cane areas and should be maintained along headlands as well as over cane. When practical, a steel-cored conductor should be used to minimise loss of conductor height due to cane fire heating.
8. The clearances for bin unloading areas is only necessary in specific locations where the activity may occur. Avoidance of these areas is the preferred option.
9. Clearances for HV ABC are for HV ABC with Earthed Metallic Screen at 90°C design temperature (base profile on catenary wire @ 50°C SEQ or 55° N/S). Exposed electrical terminations of HV ABC are to be considered as Bare HV Mains for clearance purposes. For Non-Screened HVABC, clearances are as per Bare Wire HV Conductor.

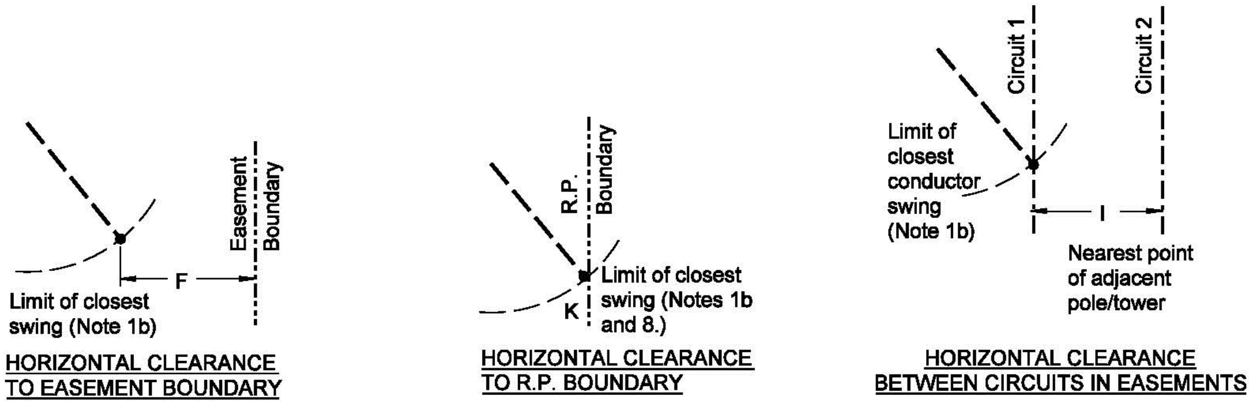
REFERENCE:

Electrical Safety Regulation 2013, Sections 207, 208, and Schedules 4 and 5.

11.2.2 Minimum Clearance Requirements – Mains Notes Continued

MAINS CLEARANCE REQUIREMENTS - Notes Continued

10. High Load Corridor Routes are managed by Qld Transport and Main Roads.
    Refer TMR website or 'QLD Globe' mapping system for TMR Heavy Vehicle Route Maps.
11. The "Minimum Clearances" sheet is based on minimum statutory regulation / EQL requirements. Conductors must not fall below these values.
12. For Vegetation Clearing Profiles refer to EQL WCS1.6 Vegetation Management Plan
13. Conductors normally in the road reserve shall not cross real property boundaries under blowout conditions (30°C SEQ or 35°C N/S, with a wind pressure of 500Pa) unless approved by the local design office.
14. Some values in the "Preferred Clearances" sheet have an additional margin for vertical clearances to allow for minor changes in the physical environment over time or specific saftey initiatives. This additional margin is the preferred practice but is not mandatory under the Electrical Safety Regulations.
15. Staywire clearances are minimum "mid air" clearances, not clearances at the pole attachment. Movement / blowout of conductors also needs to be taken into consideration.

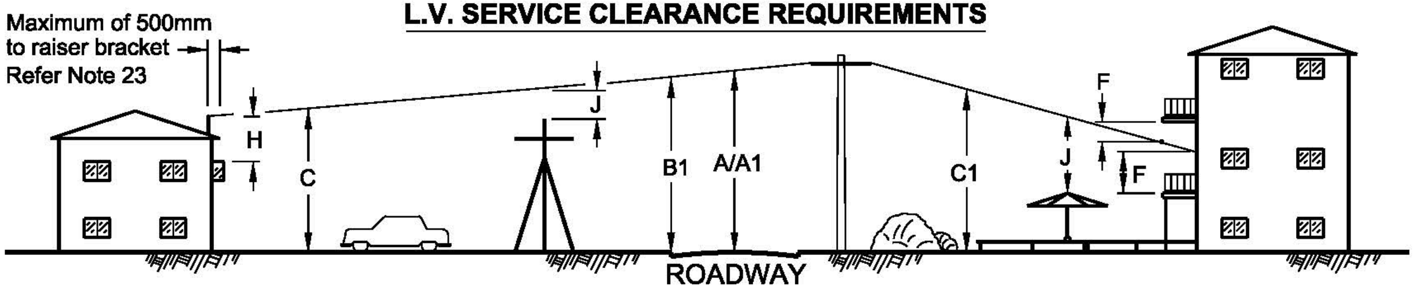


REFERENCE:

Electrical Safety Regulation 2013, Sections 207, 208, and Schedule 5.

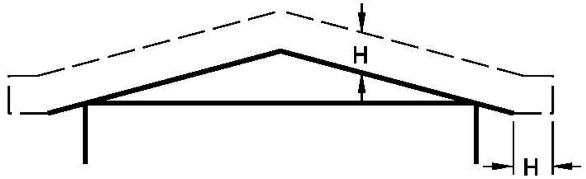
11.2.3 Minimum Clearance Requirements – Notes Low Voltage Service

L.V. SERVICE CLEARANCE REQUIREMENTS



NOTES:-

20. Clearances are a minimum to which a conductor may sag or swing under the following conditions:
    (a) Maximum conductor temperature of 75°C in still air (maximum sag condition).
    (b) Conductor temperature of 35°C (North South) & 30°C (South East) with 500 Pa wind pressure on the conductor (maximum horizontal swing condition).
    (c) Conductor temperature of 0°C (North South) & 5°C (South East) in still air (minimum sag condition).
    An addition of 200mm to vertical clearances shown measured under average stringing temperature will typically allow for sag increase under maximum operating temperatures.
21. Either the vertical clearance or the horizontal clearance specified must be maintained. Also, in the zone outside the vertical alignment of the building or structure, either the horizontal clearance from the vertical alignment or the vertical clearance above the horizontal level on which a person may stand shall be maintained. eg. minimum clearance of service conductor from a roof when service is not attached to roof is given by 'H'.



22. The clearance specified is applicable when the service line is not attached to the part of the building described.
23. If point of service attachment (including metal bracket or riser supporting it) is less than 25mm from nearest metalwork, effectively earth by bonding to the service neutral. Point of service attachment shall not be readily accessable to persons.
24. Maintain a minimum 25mm clearance from service conductor and / or consumers mains to any metal work.
25. Where there is no formed footpath, the kerb line means: the kerb line of proposed footpath (edge of bitumen), or where not footpath is proposed, the edge of the existing carriageway (edge of bitumen) or of an proposed widening thereof.

REFERENCE:

Electrical Safety Regulation 2013, Sections 207, 208, and Schedule 5.

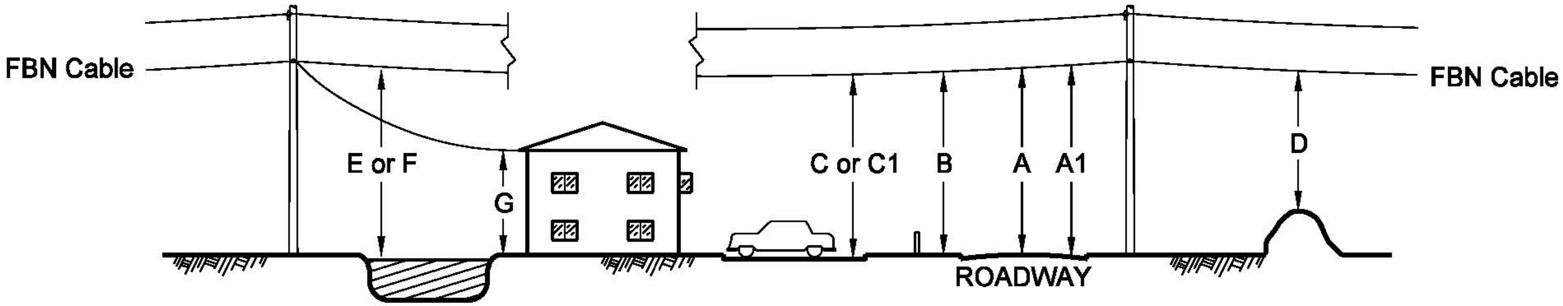
11.2.4 Minimum Clearance Requirements

MINIMUM CLEARANCE REQUIREMENTS (Note 11)				L.V. CONDUCTOR			H.V. CONDUCTOR			EQL COMMS CABLE & OH AERIAL STAYS	REFER NOTES (Sh 1, 2 & 3)
CATEGORY	CODE	LOCATION DESCRIPTION	PRESCRIBED DISTANCE	INSULATED SERVICE (Notes 20-25)	LVABC MAINS	LV BARE	11kV HVABC (Note 9)	> 1000V ≤ 33kV	> 33kV ≤ 66kV		
MIN. CLEARANCE FROM GROUND – ROADS	A	At centre line of carriageway	Vertically	5.5m	5.5m		5.5m	6.7m	6.7m	5.5m	2
	B	At other positions	Vertically	-	5.5m		5.5m	5.5m	6.7m	4.9m	2
	B1	At kerb line (Bottom of kerb)	Vertically	4.9m	-		5.5m	6.7m	6.7m	4.9m	-
	C1	At fence alignment	Vertically	3.7m	-		-	-	-	-	-
	A1	High load corridor routes	Vertically	5.5m	5.5m		5.5m	6.7m	6.7m	5.5m	2, 4 & 10
MIN. CLEARANCE FROM GROUND – OTHER	C	Private driveways and elevated vehicle access	Vertically	4.5m	5.5m		5.5m	5.5m	6.7m	4.6m	2 & 20
	D	Areas not normally accessible to vehicles	Vertically	2.7m	4.5m		4.5m	4.5m	5.5m	3.0m	2
	E	Road cuttings, embankments and the like	Horizontally	1.5m	1.5m		1.5m	2.1m	4.6m	1.5m	2
CULTIVATION		Over or adjacent cultivation	Vertically	-	5.5m	5.5m	-	5.5m	6.7m	5.5m	1 & 7
SUGAR CANE		Over or adjacent to cane	Vertically	-	n/a	5.5m	-	5.5m	6.7m	5.5m	1 & 7
		Sugar cane bin unloading areas	Vertically	-	5.5m	5.5m	-	5.5m	6.7m	5.5m	1 & 8
WATERWAYS		Waterways - Recreational/navigable	As agreed with appropiate controlling body								-
		Waterways & other areas subject to flooding - Above flood - main channel	Vertically	-	4.5m	4.5m	-	4.5m	5.5m	4.5m	-
MINIMIUM CLEARANCE FROM STRUCTURES, BUILDINGS & STAYWIRES	F	Unroofed terraces, balconies, sundecks, paved areas & similar areas that are subject to pedestrian traffic only, that have a surrounding hand rail or wall and on which a person is likely to stand	Vertically Above	2.4m	2.7m	3.7m	2.7m	4.6m	5.5m	-	2 & 3 20, 21 & 22
			Vertically Below	1.2m	-	-	-	-	-	-	
			Horizontally	0.9m	1.2m	1.5m	1.2m	2.1m	4.6m	-	
	G	Roofs or similar structures not used for traffic or resort but on which a person is likely to stand - includes parapets	Vertically	0.5m	2.7m	3.7m	2.7m	3.7m	4.6m	-	
			Horizontally	0.2m	0.9m	1.5m	0.9m	2.1m	4.6m	-	
	H	Covered places of traffic or resort, including for example, windows capable of being opened, roofed open verandahs and covered balconies.	In Any Direction	1.2m	1.2m	1.5m	1.2m	2.1m	4.6m	- -	2 & 3 20 & 22
	I	Blank walls / windows which cannot be opened	Horizontally	0.2m	0.6m	1.5m	0.6m	1.5m	3.0m	-	
	J	Other structures not normally accessible to persons	Vertically	1.2m In Any Direction	0.6m	2.7m	0.6m	3.0m	3.0m	-	2 & 3
			Horizontally		0.3m	1.5m	0.3m	1.5m	3.0m	-	
		Stays (Stay Insulator must be installed below lowest energised circuit)	In Any Direction	0.1m	0.1m	0.3m	0.1m	0.5m	0.8m	-	15
RAILWAYS		Railway tracks (non-electrified areas)	Vertically	7.6m	7.6m		-	7.6m	8.5m	6.7m	30 - 41 Sh 7 for additional clearances
		Electrical traction wiring and supports (electrified areas)	-	U.G.	U.G.		-	3.0m	3.0m	3.0m	
		Telegraph, telephone, stays, signal lines, and electrical lines 1000V and below	Vertically	0.6m	0.6m	1.2m	-	1.2m	1.8m	0.6m	
		Electrical lines over 1000V to 33kV excluding electrical traction wiring	Vertically	1.2m	1.2m		-	1.2m	1.8m	1.2m	
TELECOM		Mid-span separation to telecom	Refer CONSTRUCTION PRACTICES FOLDER Dwg. 1051 Sh 8							-	-

11.2.5 Preferred Clearance Requirements

PREFERRED CLEARANCE REQUIREMENTS (Note 14)				L.V. CONDUCTOR			H.V. CONDUCTOR			EQL COMMS CABLE & OH AERIAL STAYS	REFER NOTES (Sh 1, 2 & 3)
CATEGORY	CODE	LOCATION DESCRIPTION	PRESCRIBED DISTANCE	INSULATED SERVICE (Note 20-25)	LVABC MAINS	LV BARE	11kV HVABC (Note 9)	> 1000V ≤ 33kV	> 33kV ≤ 66kV		
MIN. CLEARANCE FROM GROUND – ROADS	A	At centre line of carriageway	Vertically	5.5m	5.8m		5.8m	7.0m	7.0m	5.8m	2
	B	At other positions	Vertically	-	5.8m		5.8m	5.8m	7.0m	5.2m	2
	B1	At kerb line (Bottom of kerb)	Vertically	4.9m	-		5.8m	7.0m	7.0m	5.2m	-
	C1	At fence alignment	Vertically	3.7m	-		-	-	-	-	-
	A1	High load corridor routes	Vertically	7.0m	7.0m		7.0m	7.5m	8.0m	7.0m	2, 4 & 10
MIN. CLEARANCE FROM GROUND – OTHER	C	Private driveways and elevated vehicle access	Vertically	4.5m	5.8m		5.8m	5.8m	7.0m	4.9m	2 & 20
	D	Areas not normally accessible to vehicles	Vertically	2.7m	4.8m		4.8m	4.8m	5.8m	3.3m	2
	E	Road cuttings, embankments and the like	Horizontally	1.5m	1.5m		1.5m	2.1m	4.6m	1.5m	2
CULTIVATION		Over or adjacent cultivation	Vertically	-	8.0m	8.0m	-	8.0m	8.5m	8.0m	1 & 7
SUGAR CANE		Over or adjacent to cane	Vertically	-	n/a	8.0m	-	8.0m	8.5m	8.0m	1 & 7
		Sugar cane bin unloading areas	Vertically	-	12.5m	12.5m	-	12.5m	12.5m	12.5m	1 & 8
WATERWAYS		Waterways - Recreational/navigable	As agreed with appropiate controlling body								-
		Waterways & other areas subject to flooding - Above flood - main channel	Vertically	-	4.8m	4.8m	-	4.8m	5.8m	4.8m	-
MINIMUM CLEARANCE FROM STRUCTURES, BUILDINGS & STAYWIRES	F	Unroofed terraces, balconies, sundecks, paved areas & similar areas that are subject to pedestrian traffic only, that have a surrounding hand rail or wall and on which a person is likely to stand	Vertically Above	2.4m	3.0m	4.0m	3.0m	4.9m	5.8m	-	2 & 3
			Vertically Below	1.2m	-	-	-	-	-	-	
			Horizontally	0.9m	1.2m	1.5m	1.2m	2.1m	4.6m	-	
	G	Roofs or similar structures not used for traffic or resort but on which a person is likely to stand - includes parapets	Vertically	0.5m	3.0m	4.0m	3.0m	4.0m	4.9m	-	
			Horizontally	0.2m	0.9m	1.5m	0.9m	2.1m	4.6m	-	
	H	Covered places of traffic or resort, including for example, windows capable of being opened, roofed open verandahs and covered balconies.	In Any Direction	1.2m	1.2m	1.5m	1.2m	2.1m	4.6m	- -	2
	I	Blank walls / windows which cannot be opened	Horizontally	0.2m	0.6m	1.5m	0.6m	1.5m	3.0m	-	
	J	Other structures not normally accessible to persons	Vertically	1.2m In Any Direction	0.9m	3.0m	0.9m	3.3m	3.3m	-	2 & 3
			Horizontally		0.3m	1.5m	0.3m	1.5m	3.0m	-	
		Stays (Stay Insulator must be installed below lowest energised circuit)	In Any Direction	0.1m	0.1m	0.3m	0.1m	0.5m	0.8m	-	15
RAILWAYS		Railway tracks (non-electrified areas)	Vertically	7.6m	7.9m		-	7.9m	8.8m	7.0m	30 - 41 Sh 7 for additional clearances
		Electrical traction wiring and supports (electrified areas)	-	U.G.	U.G.		-	3.3m	3.3m	3.3m	
		Telegraph, telephone, stays, signal lines, and electrical lines 1000V and below	Vertically	0.6m	0.9m	1.5m	-	1.5m	2.1m	0.9m	
		Electrical lines over 1000V to 33kV excluding electrical traction wiring	Vertically	1.2m	1.5m		-	1.5m	2.1m	1.5m	
TELECOM		Mid-span separation to telecom	Refer CONSTRUCTION PRACTICES FOLDER Dwg. 1051 Sh 8							-	

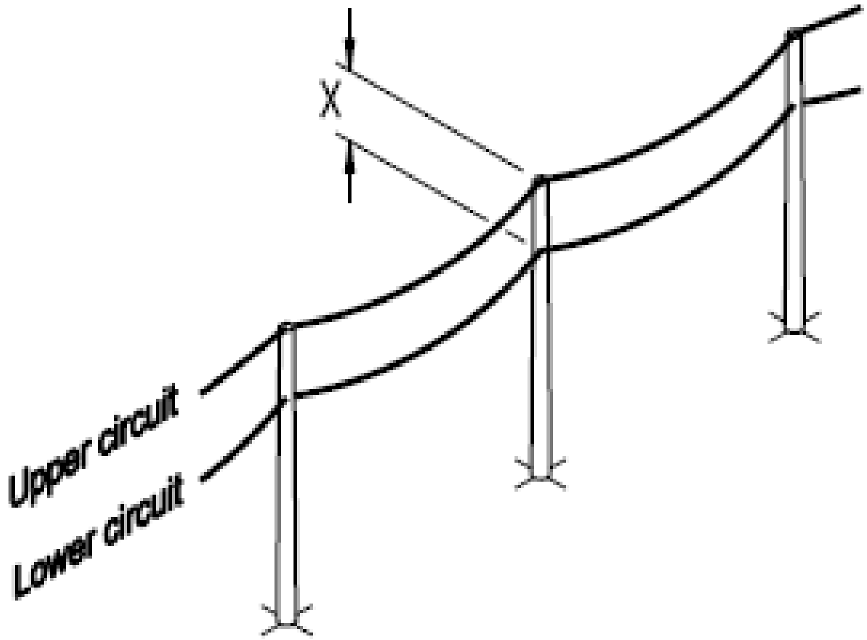
11.2.6 Minimum Clearance Requirements – Telecommunications Cables



CODE	LOCATION	TELECOMMUNICATIONS CABLE
A	Roads: Centre line of carriageway crossing	5.5m
A-1	Designated "over-dimensioned route" or "high load corridors"	7.0m
B	Roads: At kerb line or future kerb line in span (including footpath)	4.9m
C	Domestic driveways	4.6m
C-1	Commercial driveways	5.0m
D	All other land crossings	4.6m
E	Waterways: Navigable	Agreed with appropriate controlling body
F	Waterways: Non-navigable	4.5m
G	Fibre cables over premises land not traversable by vehicle	3.0m

11.3 Minimum Separation of Conductors of Different Circuits

11.3.1 Circuits on a Common Support 'x'



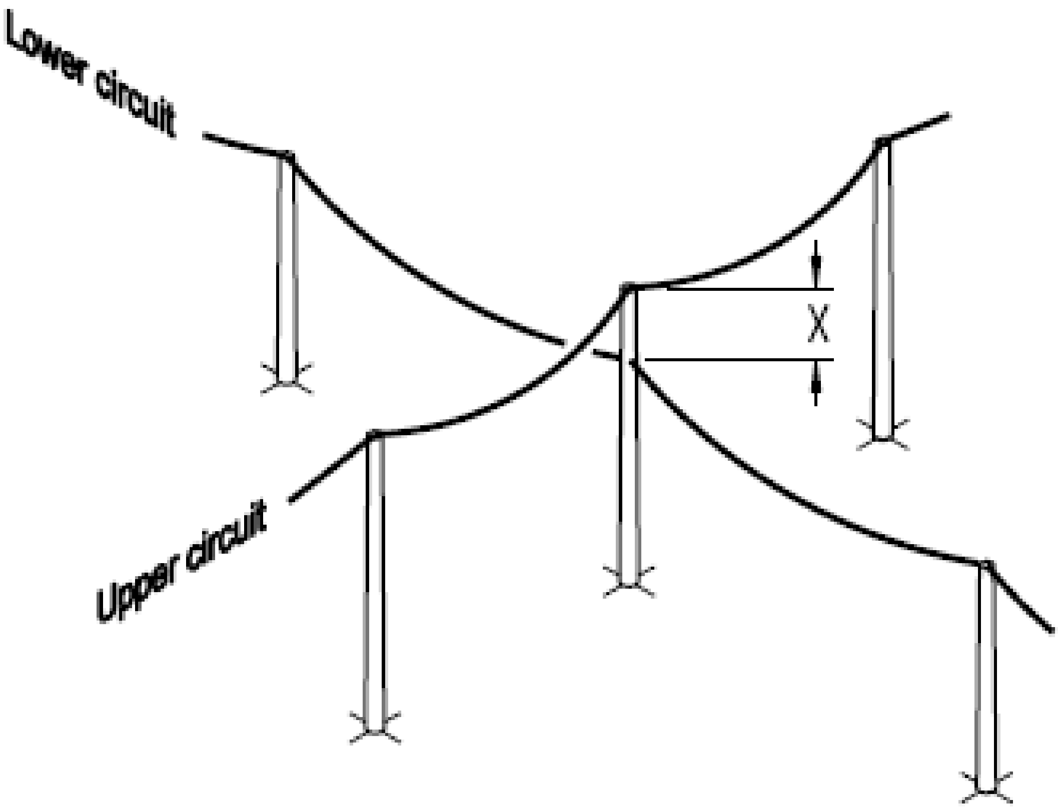


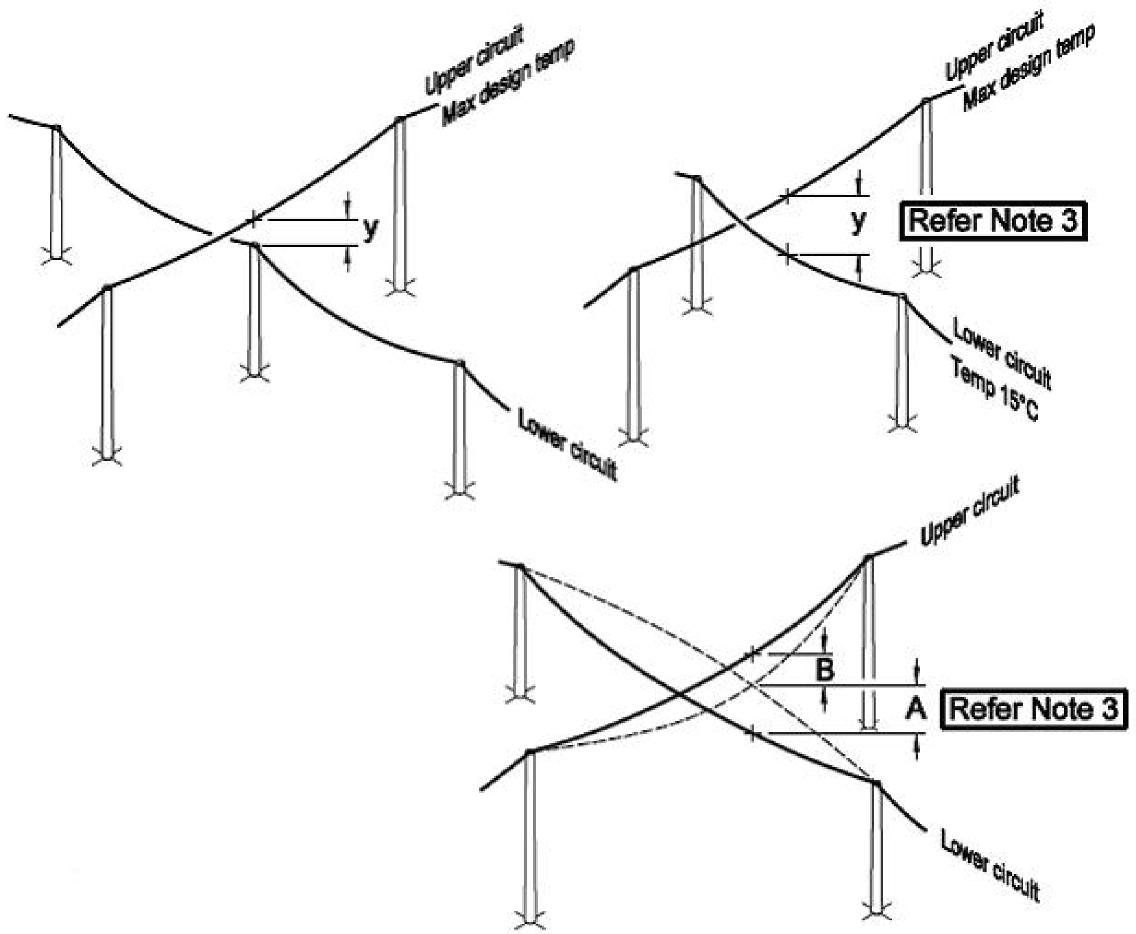
Table 12-1 – Minimum Clearances for Circuits on a Common Support 'x'

Voltage of Conductor of Lower Circuit	Voltage of Conductor of Circuit Immediately Above	Minimum Separation
L.V.	L.V.	0.5m
L.V.	11/22/33kV	2.0m
L.V.	S.W.E.R.	2.0m
L.V.	66kV	2.0m
S.W.E.R.	11/22/33kV	1.2m
S.W.E.R.	66kV	1.8m
11/22/33kV	11/22/33kV	1.2m
11/22/33kV	66kV	1.8m

Notes:

1. Refer Section 12.3.2 for minimum conductor separations for circuit not attached to common support
2. Refer Section 12.4 for criteria for intercircuit separations at mid span
3. Clearances apply to bare of covered conductors
4. To allow for live line work new constructions should be constructed with 2.0 meters clearance between the lowest HV circuit and the highest LV circuit. Refer section 11.4.3 Minimum Design Clearance at Pole
5. All separations are vertical distances measured at the points of support applicable

11.3.2 Circuits Non-Attached to Common Support 'y' (Includes Crossings)



Minimum Separation - Double Envelope Method

A = 2 x sag at maximum design temp lower circuit
B = sag at maximum design temp upper circuit
Minimum separation = A (Refer note 3)

Table 12-2 – Minimum Clearances for Circuits Non-Attached to Common Support 'y'

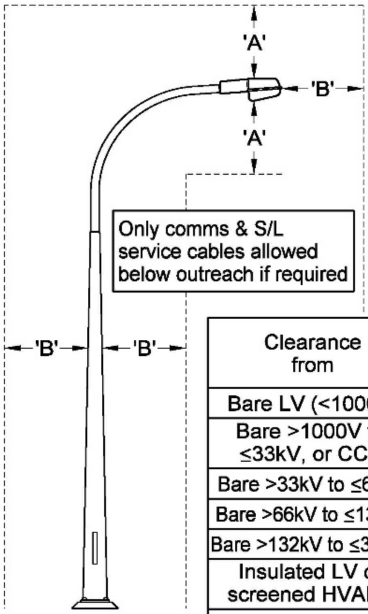
Voltage of Conductor of Lower Circuit	Voltage of Conductor of Circuit Immediately Above	Minimum Separation
L.V.	L.V.	1.2m
L.V.	11/22/33kV	1.5m
L.V.	S.W.E.R.	1.5m
L.V.	66kV	2.1m
S.W.E.R.	11/22/33kV	1.5m
S.W.E.R.	66kV	2.1m
11/22/33kV	11/22/33kV	1.5m
11/22/33kV	66kV	2.1m
11/22/33kV	132kV	3.0m
11/22/33kV	275kV	4.6m
S.W.E.R.	132kV	3.0m
S.W.E.R.	275kV	4.6m

Notes:

1. Standard maximum design temperature is 75°C but may vary on some feeders
2. Upper circuit maximum design temperature must be verified prior to design of lower circuits
3. For undercrossings the separation should be the greater of the separations specified in the above table or dimension 'A' as calculated by the double envelope method
4. Clearances apply to bare or covered conductors

11.4 Criteria for Intercircuit Clearances

11.4.1 Clearance over Public Lighting

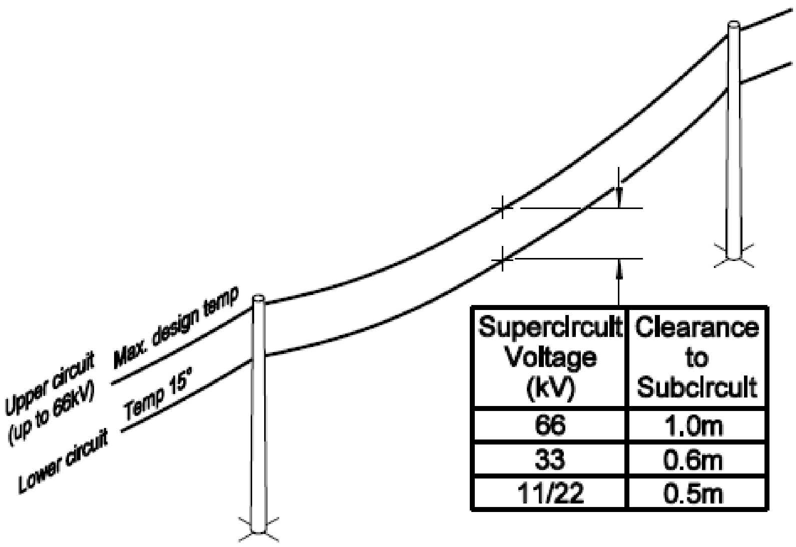


Clearance from	Minimum Distance[1]	
	Vert. 'A'	Horiz. 'B'
Bare LV (<1000V)	3.0m[3]	1.5m
Bare >1000V to ≤33kV, or CCT	3.3m[3]	1.5m
Bare >33kV to ≤66kV	3.3m[3]	3.0m
Bare >66kV to ≤132kV	4.9m[3]	4.6m
Bare >132kV to ≤330kV	5.8m[3]	5.5m
Insulated LV or screened HVABC	0.9m[3]	0.3m
LV services[2]	1.2m	1.2m
Comms	0.05m	0.05m

Notes:

1. Clearances shall be maintained under:
   a. - Maximum & minimum conductor temperatures
   b. - Blowout conditions
2. Clearance for LV services not attached to the streetlight
3. Vertical clearance is for new constructions and includes additional 0.3m margin.
   For minimum statutory requirements reduce by 0.3m.

11.4.2 Intercircuit Clearances at Midspan



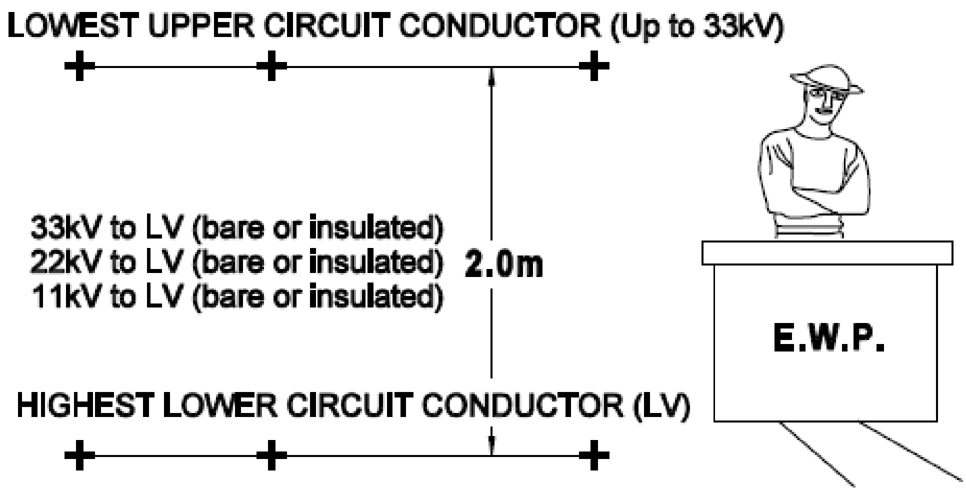
Supercircuit Voltage (kV)	Clearance to Subcircuit
66	1.0m
33	0.6m
11/22	0.5m

Notes:

1. Standard Maximum Design temperature is 75°C but may vary on some feeders
2. Upper circuit Maximum Design Temperature must be verified prior to design of lower circuits
3. Clearances apply to bare or covered conductors

11.4.3 Minimum Design Clearance at Pole

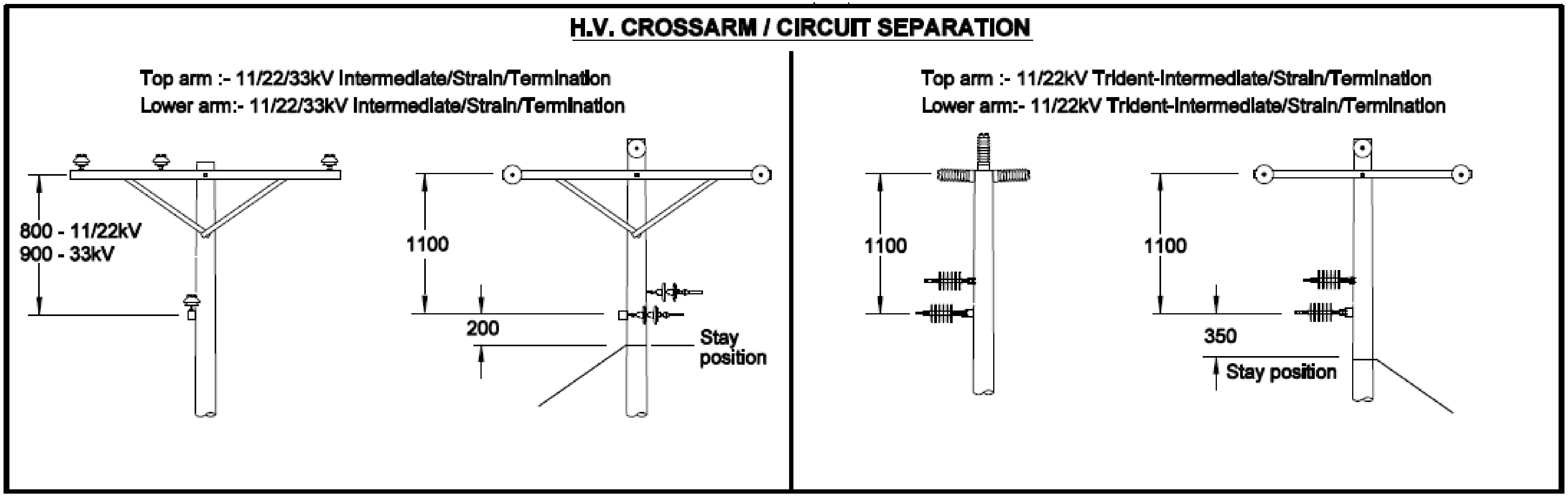
(This clearance allows for live line work)



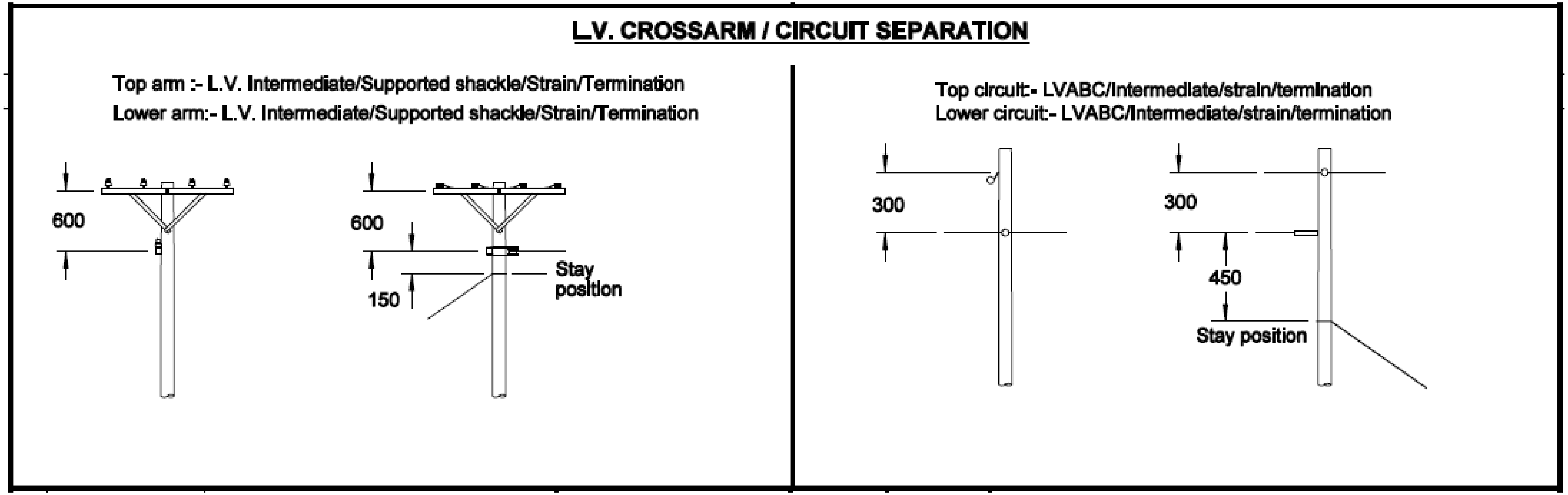
Notes:

1. Standard Maximum Design temperature is 75°C but may vary on some feeders
2. Upper circuit Maximum Design Temperature must be verified prior to design of lower circuits
3. Clearances apply to bare or covered conductors

11.5 Crossarm Separation for Same HV Circuits



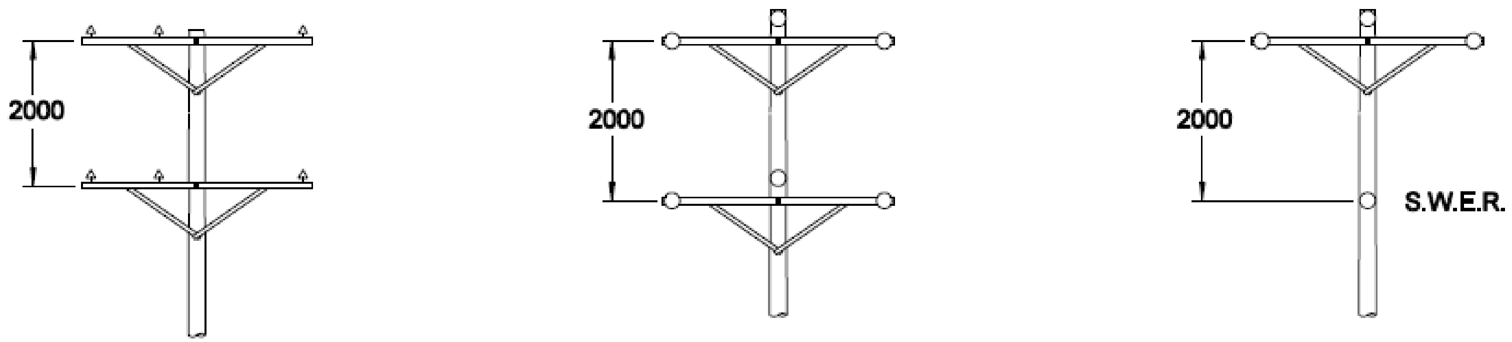
11.6 Crossarm Separation for Same LV Circuits



11.7 Crossarm Separation for Different HV Circuits

H.V. CROSSARM/CIRCUIT SEPARATION

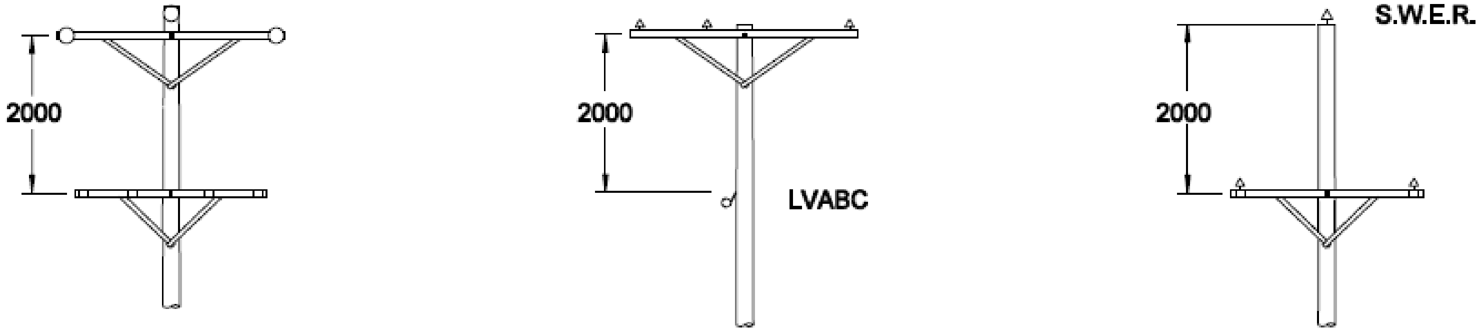
Top circuit :- 11/22/33kV/S.W.E.R. Intermediate/Strain/Termination
Different circuit:- 11/22/33kV/S.W.E.R. Intermediate/Strain/Termination



11.8 Crossarm Separation for Different HV and LV Circuits

H.V./L.V. CROSSARM/CIRCUIT SEPARATION

Top circuit :- 11/22/33kV/S.W.E.R. Intermediate/Strain/Termination
Different circuit:- L.V./Intermediate/Strain/Termination



12. Agreements

12.1 QR Design requirements

12.1.1 Span Lengths

The length of the crossing span shall be kept to the minimum reasonably required to satisify other requirements. All poles shall be located outside the boundaries of the railway property except where poles are required within such boundaries in order to achieve an acceptable length of crossing span.

12.1.2 Pole Location

Poles near railway tracks are to be positioned such that in the event of a failure, they do not fall within two metres of a railway track. If this is not practical, the pole must be stayed away from the track or a special design used to eliminate the hazard.

12.1.3 Coach Screws

Coach screws shall not be used for the attachment of insulators on brackets supporting conductors crossing railway tracks.

12.1.4 Mid Span Joints

No joints are allowed in the crossing span. Joints in adjacent spans are allowed.

12.1.5 Electrical Connections

No connections are to be made to conductors in tension over railway land. All connections must be made to conductor tails.

12.1.6 Insulation

Pin insulators shall not be used on any conductors in tension crossing railway tracks.

12.1.7 Crossing Angle

The crossing span angle to the track shall not be less than 45° unless by specific agrement.

12.1.8 Low Voltage (650V and below) Lines – Stays and Overhead Earth Wires

(i) No part of LV 650V and below lines shall be constructed over railway tracks in the electrified area of the railway system.

(ii) Stays and overhead earth wires which cross railway tracks as part of an 11kV or higher voltage line are excluded from the provisions of (i) above.

12.1.9 Crossings

(i) Ergon lines shall cross above low voltage electrical lines, telegraph telephone signal, and similar lines of the railway.

(ii) All of the group of Ergon crossing lines shall cross above the railway lines where the highest voltage of the Ergon crossing group is greater than the highest railways high voltage line.

(iii) In electrified rail areas, all Ergon HV lines will cross above railway traction wiring.

12.1.10 Clearances

Clearance over Railway tracks and lines shall be as given in the table on the following page.

12.1.11 Pole raisers

Pole raisers shall not be used to support conductors other than overhead earthwires in the crossing span and then only when the support has been specifically designed for the purpose.

12.1.12 Intermediate Structures

Use of intermediate structure types on one side of the crossing is acceptable provided that the design allows for the reduced clearances provided for under short term broken conductor contingency in an adjacent span are met. In order for this design to be applied, account must be taken of the following factors:

- pole strength and flexibility when broken wire loads are applied
- insulator strength and conductor grip strength
- the effect of impact loads under broken wire conditions
- construction practicalities.

Table 13-1 – Vertical Clearances for Ergon Conductors and Railway Equipment

Railway Equipment	**Vertical Clearance (Meters) Ergon Conductors and Railway Equipment**						
	Ergon Conductors						**Short Time Emergency e.g. Broken Conductor**
	Pilot Wires, Stays, E/Wire	**S/Light & LV**		**Over 650V up to 33kV**	**Over 33kV up to 66kV**	**Over 66kV up to 132kV**	
		Insul'd	**Bare**				
Railway Tracks	6.7	7.6	7.6	7.6	8.5	8.5	6.7
Electrical Traction Wiring and Supoprts	3.0	Underground		3.0	3.0	4.6	2.0
Telephone and Signal Lines, Stays and Elect. <650V	0.6	0.6	1.2	1.2	1.8	2.4	-
Lines >650V & <33kV excluding electric traction wiring	1.2	1.2	1.2	1.2	1.8	2.4	-

12.1.13 Procedure to be Followed

1. Written notice of works to be carried out, including plans and specifications must be forwarded to Queensland Rail for agreement. The plan must specify the railway kilometre distance and the nearest station. Queensland Rail has 2 weeks in which to reply and may impose terms and conditions on the work.
2. When Ergon Energy has been notified in writing of this approval, at least 2 weeks' notice must be given to Queensland Rail before work commences.
3. On completion of work, Queensland Rail must again be notified promptly in writing, and a copy of the "as constructed drawings" of the infrastructure, the subject or the result of the work is to be provided. These drawings shall be prepared in accordance with construction and design methods approved by a professional engineer or certified by a professional engineer if required by law.

12.2 Powerline Warning Markers

Refer to technical instruction *TSD0211 – OH Aerial Markers* for details on Aerial Markers.

12.3 Procedures for Obtaining Sanction of Water Crossings

12.3.1 Purpose

The purpose of this document is to ensure that Ergon Energy fulfils its statutory obligations when carrying out any works across tidal lands or waterways and all navigable waterways including recreational dams.

It is imperative that Ergon Energy fulfils such statutory obligations as failure to do so renders the crossing illegal and exposes Ergon Energy to liability. The group responsible for design of the crossing should contact the environmental operations group for assistance with obtaining planning and environmental approvals for the crossings.

12.3.2 Scope

The following sets out the procedure for preparation and lodgement of an Integrated Development Assessment System ("IDAS") application under the *Sustainable Planning Act 2009* for approval of crossings of tidal and non-tidal waters including referral of applications to Regional Harbour Masters ("RHM") for navigable waters (both tidal and non-tidal).

For tidal works in a local government tidal area, the assessment manager will generally be the Local Government Authority, but applications involving tidal works will also need to be referred to the State Assessment and Referral Agency (**SARA**) for assessment. This agency will seek input from Maritime Safety Queensland about the works. For non-tidal works the SARA will be the assessment manager.

This procedure should be considered in conjunction with the Australian Standard AS6947-2009 Crossing of Waterways by Electricity Infrastructure and the Ergon Energy Environmental Planning for Works series of documents in particular "EPW Environmental Legislation and Triggers"

This procedure covers crossings over or under waterways, and all navigable waterways including inland streams and recreational dams and applies to all Ergon Energy works including:

- Overhead lines including pilot wires, street light mains and stays
- Submarine cables

- Cables or lines attached to or through bridges (where conduit/attachment is not provided as part of original bridge structure)
- Any other miscellaneous works within tidal waters or waterways (e.g., construction / demolition of jetties or pontoons)

It is applicable to the following construction scenarios:

- New construction of tidal works
- Any alteration to construction, clearance or location, or voltage changes (increase/decrease in voltage)
- Total removal of construction

Geographically, the instruction covers:

- Tidal waters including rivers, creeks, coastal bays and passages
- Land under tidal water (tidal land - e.g., salt flats inundated at high tide)
- Navigable waterways including inland streams and dams, with particular attention paid to those on which the controlling authority allows recreational boating.

Note: that where non-tidal works will not interfere with water, then there is no need for approval. Where non-tidal works will interfere with water, the works may not require approval if they comply with the Riverine protection permit exemption requirements.

No approval is required for tidal works that are:

- erecting safety and warning signs, or other minor works such as fencing, bollards, revegetation works, or works with a footprint of 5 square metres or less
- constructing temporary tracks involving earthworks of less than 100 cubic metres of material
- installing power connections in an erosion prone area for approved development such as toilet blocks, jetties and picnic shelters etc.
- installing electrical network infrastructure in an erosion prone area; that does not involve locating infrastructure further seaward of existing permanent development (e.g., formed roads or houses), which would be protected if threatened by sea erosion.

(Source: letter from Department of Environment and Heritage Protection dated 3 April 2013)

Notes: Tidal works completely or partly within a State managed boat harbour or on strategic port land or for a port authority or port operator, or a public marine facility constructed by or for Queensland Transport, a port authority or a port operator are an exception to this process and will need to be considered individually. The Port Authority or SARA will generally be the assessment manager, rather than local government.

12.3.3 Definitions

A ***Waterway Crossing*** shall be deemed to be a ‘Crossing of navigable waterways by electricity infrastructure’ in the spirit of Australian Standard AS6947-2009 Crossing of Waterways by Electricity Infrastructure.

Tidal Water is defined as: the sea and any part of a harbour or watercourse ordinarily within the ebb and flow of the tide at spring tides; or the water downstream from a downstream limit declared under the *Water Act 2000*.

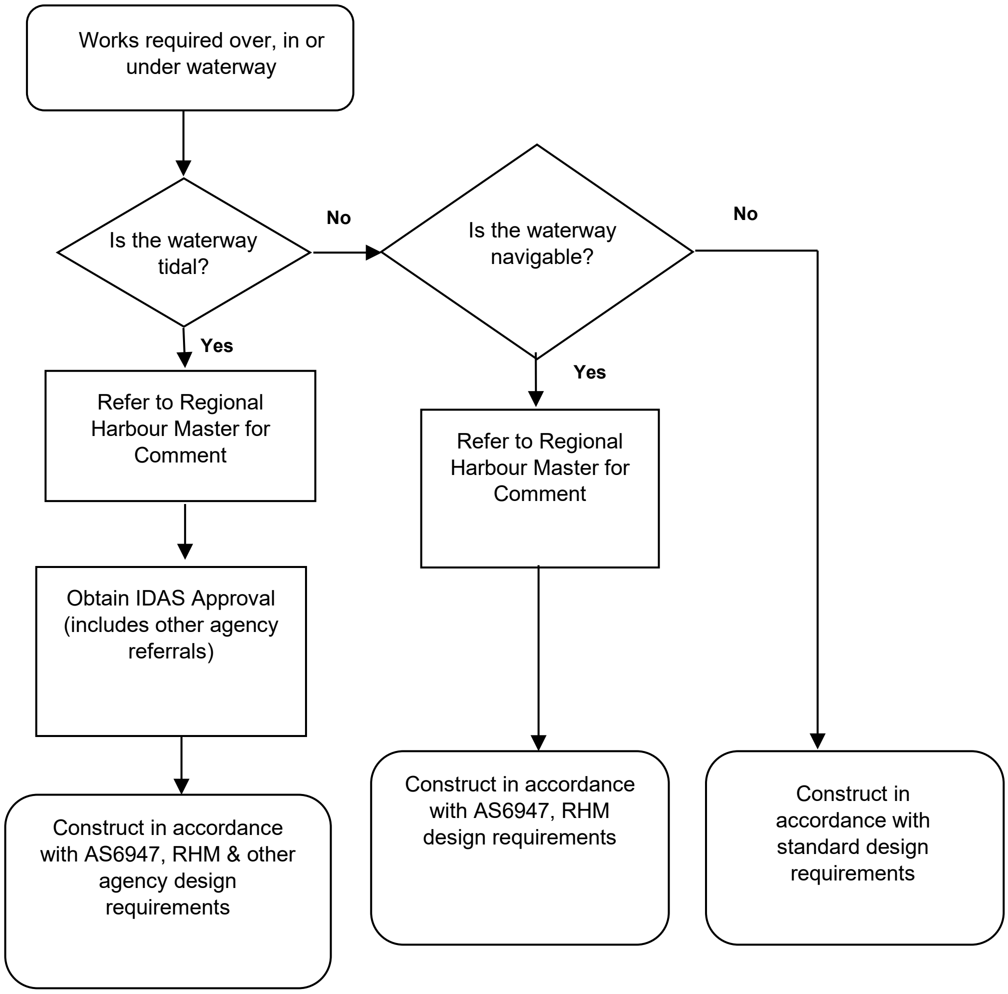
Navigable Water is defined as Waters where it can, under normal conditions, be reasonably expected that a vessel may gain access either by being launched from a transport vehicle or by navigating along the waterway (i.e., not flood conditions and not waterways only accessible by launching canoes or dinghies from the bank).

12.3.4 Procedure

Flowchart 1 shows **where** this approval process is necessary to obtain authorisation to begin construction of an overhead or underwater cable crossing of a waterway, excluding tidal waters in the coastal management district.

Flowchart 2 shows the detailed procedure on **how** to obtain authorisation to begin construction of an overhead or underwater cable crossing of a waterway, excluding tidal waters in the coastal management district.

12.4 Flowchart 1



To determine if a project site is above or below the tidal limit of a particular waterway a licensed surveyor can be engaged to relate tidal planes calculated by Maritime Safety Queensland (MSQ) to the site. These tidal planes can be obtained from the MSQ website https://www.msq.qld.gov.au/tides/tidal-planes.

Note:

1. Formal definitions of “navigable” may also encompass waterways accessible only to smaller dinghies etc. these are covered by statutory clearance regulations and are not part of this process

12.5 Flowchart 2

Activity	Details Also refer to Ecoaccess Guideline "Prescribed Tidal Works"
1. Is the waterway tidal	If "yes" Sustainable Planning Act 2009 approval under the IDAS process and RHM referral is required
↓	
2. Is the waterway Navigable	If "yes" then referral to RHM is required (See steps 1 to 8) If "no" to both 1 & 2 then normal design conditions and approvals apply
↓	
3. Stakeholder Negotiations	If the proposal invokes an affirmative answer to one or more of the above questions, then the preliminary discussions and negotiations will need to be held with the stakeholders to determine any special requirements for construction, or if the works will be able to proceed at all. (Note: IDAS approvals for tidal works below high water mark and outside a canal will require the consent of the owner of the land be submitted with application. Non-tidal waters will require approvals as for normal works plus RHM sanction.) Stakeholders may include but would not be limited to: • Regional Harbour Master (Must discuss acceptable clearances at this stage). Refer to Sheet 7 for listing of Maritime Safety (RHM) Contact Details • Department of State Development, Infrastructure and Planning (DSDIP) • Department of Environment and Heritage Protection (EHP) • Department of Agriculture, Fisheries & Forestry (DAFF) • Department of Natural Resources & Mines (DNRM) • Relevant Port Authority or Port Operator • Local Government or Gold Coast Waterways Authority (in Gold Coast waters) • Landholders / Developers of adjacent properties.
↓	
4. Introductory Works 1. Check for any previous approvals 2. Obtain tidal information / relevant	Existing crossings may be subject to previous approvals that will need to be referenced Crossing drawings will need to show the HAT, LAT, and MHWS levels for tidal waters and full supply levels for non-tidal waters. • For tidal waters the reference datum is Highest Astronomical Tide (HAT) above Australian height datum (AHD) plus wave effects and is available by contacting Maritime Safety Queensland (Tidal Information) (Refer to Sheet 7 for Contact Details)

water level datum 3. Obtain tenure information 4. Obtain property owner's consent	• For non-tidal waters the maximum water level is typically the peak of the bank plus wave effects. Note: Clearances greater than statutory clearance may be required for some waterways for reasons other than navigation e.g., flood clearance. This falls outside the scope of this process and is considered as part of standard design procedure Conduct title searches for land on which works will be constructed or land that abuts or adjoins the proposed crossing. Obtain real property plans If Ergon does not hold tenure over the land, the IDAS assessment manager may require written confirmation from the owner of the land that they consent to the undertaking of the works for which the approval is sought

↓

5. Field Survey & Design 1. Carry out a field survey of the proposed crossing	Carry out survey and mark support positions and stays. IDAS approvals (tidal works) will need surveys tied into a Permanent Survey Mark (PSM) or an acceptable GPS established datum level for location and levels. Non-tidal works need only be referenced to an appropriate reliable water level mark. Complete crossing sag and catenary design to provide appropriate clearance for crossing at maximum conductor design temperature. (A registered surveyor may be required to tie works back to a remote PSM or alternatively to establish a new PSM or level datum close to the crossing to enable an engineering surveyor to tie in the crossing survey). Take digital photographs of the area for inclusion in the application If the waterway is navigable (by the definition above) normally provide a minimum 13-meter clearance (10m mast height plus 3m safety margin) above the water level datum, at maximum conductor design temperature, unless other requirements dictate. Refer later in this document for safety clearances. RHM or specific location may require allowance for greater or lesser vessel height. This must be discussed and determined in preliminary stakeholder negotiations

↓

6. Determine "Water Allocation Area"	The IDAS approval process provides for a "water allocation area" around the crossing in some situations. A water allocation area is a nominated clearance area around the works at the shoreline to ensure the safety and integrity of the works. The Regional Harbour Master will look at whether the proposal impedes the navigation access to the property or adjacent properties or causes a safety hazard for vessels and will also check that there are no existing or proposed structures within the proposed water allocation area which would prevent the location of the works in that area. Generally, a water allocation area would only be required for cable crossings from land other than roadways. There is no time limit on the process for obtaining endorsement of a water allocation area plan

↓

7. Prepare Crossing Plan 1. Have drawings approved by a RPEQ 2. Log plan on GIS	Complete a Crossing and Signage plan to the standard typical format shown in drawing 3143 Sheets 9 and 10. The drawings submitted for approval must clearly define any water allocation area as well as the type, location and extent of the works including poles, stays, signs etc. Refer to the DEHP's Operational Policy "Building and Engineering Standards for Tidal Works" Drawings must be signed by a Registered Professional Engineer of Queensland ("RPEQ") who is responsible for ensuring compliance with the above standard and Ergon design standards Log the proposed works in Ergon's GIS. This is done by creating a "waterway crossing object" by inputting the mandatory data fields. The GIS will then allocate a Waterway Crossing ID to be used as a reference number for the approval process. Commence a Waterway Crossing GIS Data Entry Form for the crossing to be used by Network Data for final entry of crossing data.

↓

8. Submit to RHM for comment	Send two (2) copies of the drawings showing the water allocation area to the Regional Harbour Master ("RHM") for comment on the proposed works Make any amendments suggested by the RHM and resubmit as necessary

↓

End of Process For Non-Tidal Waters

9. Notify and request comment from relevant authorities	Formally notify relevant authorities/parties of the proposal, send copies of drawings (endorsed by RHM if tidal waters) and locality plan and request written approval in support of application. This applies to: • Local Authorities – letter of comment. • DAFF for fish habitat areas requesting advice on resource allocation. • DNRM for other than fish habitat areas requesting advice on resource allocation. • Port Authority or Port Operator for relevant port area if applicable – letter of comment. • Other statutory authorities who may have an interest in the waterway or adjacent land if applicable (e.g., Gold Coast Waterway Authority for works in Gold Coast waters). • Owners/developers of adjacent land that will be affected by the works and others as the site dictates.

↓

10. Draw cheque for IDAS application fee	Local Governments are generally the Assessment Managers for all prescribed tidal works and this includes waterway crossings. As such each Local Authority may set its own application fee structure to cover these approvals. Contact the relevant Council to determine any fees involved and draw a cheque to cover any fees which need to be lodged with the application.

↓

11. Complete and submit the IDAS Application Complete the IDAS development application forms, compile the supplementary documents and submit to the assessment manger as detailed in form 1 part A	The application is to include: • IDAS Development Application Form 1 (Application details) • IDAS Development Application Form 21 (Other work in a watercourse), where relevant • IDAS Development Application Form 23 (Tidal works and development within coastal management districts), where relevant • IDAS Assessment Checklist • Cheque for the prescribed fee • Three copies of drawings certified by RPEQ • Copy of the plan showing any water allocation area endorsed by RHM • Copy of tenure details and real property plans for adjacent land (search results) • Copy of letters of consent from land owners • Copies of any letters of comment from relevant authorities • Copy of UBD or locality plan • Other supporting information such as photographs of the area The application should be submitted to the relevant Local Government office with a covering letter headed. Development Application – Operational Works, Prescribed Tidal Works – being Powerline Crossing ……………………..

↓

12. Attend to requests for further information/ alteration	There may be ongoing negotiations with the assessment manager and the referral agencies over issues such as signage and their placement, spheres on conductors, clearing of marine vegetation etc. Digital photographs of the area can be invaluable tools in this process

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13. Receive IDAS approval	On receipt of the IDAS approval carry out the following: • Update records as approved • Record crossing approval details on the GIS Data form • Record any special conditions and alterations to construction requirements such as signs etc. on construction plans

↓

14. Construct as approved	In addition to the powerline construction particular site requirements and conditions may apply to certain waterways and these need to be included with construction file

↓

15. Notification of	Within three (3) months of completing the works, the RPEQ must send a letter certifying that the works have been constructed in accordance with the

construction completion	approved plans and conditions of development permit to both the assessment manager and RHM. Forward the completed GIS Data Form to the Network Data for entry of the crossing details into the GIS Send copy of plan and electronic shape file to the Spatial Services Unit of MSQ for inclusion in MSQ maps. See sheet 7.

Notes:

1. For Tidal Lands and Waterways. All proposals shall show the Highest Astronomical Tide (HAT) or Mean High Water Springs (MHWS) and the minimum design and safe clearances above this level
2. Refer to sample crossing (10476-10) and signage drawings (10476-9) in Appendix D – Waterways Crossing Signage
3. Refer to 'Guidelines for the Placement of Warning Signs' later in this document for guidelines on the placement of signs.
4. If crossing is assessable, are there options to avoid. Given the cost of design, approval, construction and maintenance of navigable crossings, alternative routes should be assessed thoroughly
5. The crossing span for crossings with designated (signed) clearances must be strained and stayed away from crossing on both sides
6. Signs need to be to Ergon standard for sign construction and guidelines for placement
7. Approval drawings need to be in standard format
8. Safety envelope guidelines under overhead conductors

   Permanently Unenergised e.g., staywires = 0.6m

   LV – insulated or bare aerial = 2.8m

   HV – greater than 650V and lower than 33kV = 3.1m

   greater than 33kV and less than 132kV= 4.3m

   safe clearance = minimum design clearance – safety envelope

   minimum design clearance = height of conductor at maximum design temperature above maximum expected water level.
9. If the procedure stalls for any reason, the approval authority will not pursue the matter. The crossing may be built, energised and remain illegal indefinitely
10. It is therefore essential that self-checking procedures be adhered to, and appropriate follow ups be performed by e-mails, faxes and/or phone, all requirement of statutory bodies be adhered to or renegotiated i.e., special clearances, warning signs etc.

12.5.1 Contact Details for Maritime Safety Queensland

(Regional Harbour Master)

Brisbane

MacArthur Avenue East, Pinkenba Phone (07) 3632 7500

Sunshine Coast

Old Pilot Station, Parkyn Parade, Mooloolaba Phone (07) 5373 2310

Gold Coast	
40-44 Sea World Drive, Main Beach	Phone (07) 55851810
Gladstone	
Level 7, 21 Yarron Street	Phone (07) 4971 5200
Bundaberg	
Floor 2, 46 Quay Street	Phone (07) 4132 6600
Hervey Bay	
Buccaneer Avenue	Phone (07) 4194 9600
Mackay	
44 Nelson Street.	Phone (07) 4944 3700
Airlie Beach	
384 Shute Harbour Road	Phone (07) 4841 4500
Townsville	
60 Ross Street, South Townsville	Phone (07) 4421 8100
Cairns	
100-106 Tingira Street, Portsmith	Phone (07) 4052 7400
Karumba	
Lot 75 Yappar Street	Phone (07) 4745 9281
Thursday Island	
Hastings Street	Phone (07) 4069 1351
Weipa	
1 Iraci Ave	Phone (07) 4069 7165

12.5.2 Contact Details for Maritime Safety Queensland (Tidal Information)

Tidal Services Unit	Telephone:	(07) 3066 3517
Maritime Safety Queensland	Email:	tides@msq.qld.gov.au
GPO Box 2595 Brisbane 4001	http://www.msq.qld.gov.au/Tides.aspx	

12.5.3 Contact Details for Maritime Safety Queensland (Charts)

Spatial Services Unit	Telephone:	(07) 3066 3900
Transport Safety Branch PO Box 673 Fortitude Valley Queensland 4006	Email:	msqmail@msq.qld.gov.au

12.6 Guidelines for the Placement of Warning Signs of Water Crossings and Boat Ramps (Launching Facilities)

To be read in conjunction with Section 3.3 and Section 4.3 of Australian Standard AS6947-2009 ‘Crossings of waterways by electricity infrastructure’.

Crossings of navigable waterways, which pose a threat to boating, will normally be required to have warning signage installed to the satisfaction of the Regional Harbour Master (and may require approval by SARA).

The intention of signage is to provide appropriate hazard mitigation by warning approaching boating traffic of the presence of either overhead or submarine cable crossings and for overhead crossings the safe clearance above maximum normal water level (Highest Astronomical Tide “HAT” plus wave effects for tidal waters) at the lowest point of the crossing span over the waterway.

Submarine cable crossing signs (Drawing 10476-08 Appendix D) are to be placed at a suitable visible location, on the embankments, at each end of the crossing.

Overhead crossing signs (Drawing 10476-04 / 06 Appendix D) are to be placed on the side closest to the navigable channel so that they can be seen when approaching the crossing from either direction. They need to be bi-directional and orientated at 45° to the shoreline. The signs shall be visible for at least 100m from the crossing up to the point of crossing so that they are visible from vessels approaching or transiting under or along the span. If the navigable channel exceeds 50m in width signs are to be placed on both sides of the crossing.

Where the crossing or immediate signage is obscured by bends in the waterway, vegetation or structures etc. then additional signs (Drawing 10476-07 Appendix D) may need to be placed at appropriate locations to warn of the crossing ahead.

Where crossings exist close to launching facilities additional signs (Drawing 10476-07 Appendix D) is required adjacent to the boat ramp. These signs shall be situated at locations such as formal public boat launching sites that provide access to the navigable waterway and that are within 5km from an overhead crossing.

Where for any reason the standard signage or placement is not considered appropriate or effective, the design may be varied where the safety outcome is improved. The design and placement of any special or varied signage must be agreed to by the approving authorities and Ergon Standards section.

13. Electrical Design

13.1 Conductor Layout Temperatures

The following temperatures are recommended for use as a standard for layout of Ergon Energy Corporation distribution lines in the absence of planning or other directions:

Rural HV and SWER distribution radial feeders

Layout to 60°C

Urban and semi urban HV distribution feeders where there is a possibility of load redistribution between zone substations

Layout to 75°C

Open wire LV – Both urban and rural

Layout to 75°C

LV Aerial Bundled Conductor

Layout to 80°C

13.1.1 Ambient Conditions for Thermal Ratings

Recommended Ambient conditions for calculation of thermal ratings are listed in the attached table in the absence of planning or other directions.

These conditions are based on dividing the ERGON supply area into four regions, North and Central (FN, NQ, MK and CA) and South (WB and SW) with a further division of Coastal (within 50km of the coast) and Inland.

Three operating conditions have been assumed as follows:

- Summer 6pm - generally the most onerous case.
- Summer Noon - can sometimes coincide with system peak for feeders with significant domestic air conditioning load.
- Winter Peak - can sometimes coincide with system peak for feeders in colder areas.

The following definitions apply with respect to the thermal rating of Overhead lines:

13.1.2 Normal Thermal Rating

A line's normal thermal rating is the maximum continuous electrical load which can be carried on that line with a minimal attendant risk of infringing design clearances. The normal thermal rating is dependent on the design maximum conductor temperature for the line and is calculated on a probabilistic basis for the relevant conditions. The specified conditions, summer noon, summer 6pm and winter 6pm have been selected on the basis of being the times when system loadings are likely to be the most critical.

13.1.3 Emergency Thermal Rating

A lines emergency thermal rating is the maximum electrical load which can be carried on that line under single contingency conditions with a similar attendant risk of infringing design clearances as the normal thermal rating after allowance for the limited time periods under which system contingency conditions are likely to apply.

Table 14-1 – Conductor Layout Temperatures

AREA	Temperature (°C)	Wind Speed (m/s)		Solar Radiation (Watts/m²)	
		Normal	Emergency	Direct	Diffuse
NORTH & CENTRAL - Far North, North Qld, Mackay, Capricornia					
Coastal Area within 50km of coast					
Summer Noon	35	0.7	2	1000	100
Summer 6pm	30	0.7	2	400	50
Winter 6pm	20	0.7	2	0	0
Inland Area					
Summer Noon	40	0.6	2	1000	100
Summer 6pm	30	0.6	2	400	50
Winter 6pm	20	0.6	2	0	0
SOUTH - Wide Bay, South West					
Coastal Area within 50km of coast					
Summer Noon	35	0.7	2	1000	100
Summer 6pm	30	0.7	2	400	50
Winter 6pm	10	0.7	2	0	0
Inland Area					
Summer Noon	40	0.6	2	1000	100
Summer 6pm	30	0.6	2	400	50
Winter 6pm	10	0.6	2	0	0

Angle of Conductor to wind assumed at 60°

Conductor Surface Conditions – assume weathered rural

Absorbitivity 0.5

Emissivity 0.5

Reflection of Ground 0.2

13.2 Conductor Thermal Ratings

Table 14-2 – Conductor Thermal Ratings for Areas North and Central (Far North, North Qld, Mackay, Capricornia)

Conductor Code	Conductor Type	Conductor Maximum Operating Temperature	Coastal Area - within 50km of the coast (Amps)						Inland Area - greater than 50km from the coast (Amps)					
			Summer Noon		Summer 6pm		Winter 6pm		Summer Noon		Summer 6pm		Winter 6pm	
			Normal	Emergency	Normal	Emergency	Normal	Emergency	Normal	Emergency	Normal	Emergency	Normal	Emergency
Libra	7/3.00 AAC	75°C	207	269	234	296	268	335	183	249	226	296	260	335
Mars	7/3.75 AAC	75°C	272	354	310	392	357	445	240	327	300	381	346	445
Moon	7/4.75 AAC	75°C	362	471	416	525	481	597	318	435	403	525	467	597
Pluto	19/3.75 AAC	75°C	499	651	582	732	677	836	437	601	563	732	657	836
Saturn	37/3.00 AAC	75°C	570	745	668	840	779	961	498	686	647	840	757	961
LV ABC	4 x 95 sq mm	80°C	205	NA	260	NA	310	NA	175	NA	250	NA	300	NA
LV ABC	2 x 95 sq mm	80°C	220	NA	270	NA	325	NA	190	NA	265	NA	315	NA
LV ABC	2 x 50 sq mm	80°C	140	NA	170	NA	205	NA	125	NA	165	NA	200	NA
LV ABC	4 x 50 sq mm	80°C	130	NA	165	NA	195	NA	115	NA	160	NA	190	NA
Chlorine	7/2.5 AAAC	60°C	124	165	151	192	183	229	100	143	145	192	177	229
Helium	7/3.75 AAAC	60°C	199	269	250	319	307	383	159	232	241	319	298	383
Iodine	7/4.75 AAAC	60°C	262	356	335	427	415	515	205	306	324	427	403	515
Apple	6/1/3.0 ACSR	60°C	137	183	169	215	206	257	110	159	163	215	200	257
Banana	6/1/3.75 ACSR	60°C	178	240	223	284	274	341	207	207	215	284	266	341
Raisin	3/4/2.5 ACSR	60°C	88	118	107	137	131	164	102	102	104	137	127	164
Sultana	4/3/3.0 ACSR	60°C	119	159	147	187	179	224	138	138	142	187	174	224
3/2.75	SC/GZ	60°C	33	44	40	51	48	61	27	38	38	51	47	61
3/2.75	SC/AC	60°C	48	64	58	74	70	87	39	56	56	74	67	87

Table 14-3 – Conductor Thermal Ratings for Areas South (Wide Bay, South West)

Conductor Code	Conductor Type	Conductor Maximum Operating Temperature	Coastal Area - within 50km of the coast (Amps)						Inland Area - greater than 50km from the coast (Amps)					
			Summer Noon		Summer 6pm		Winter 6pm		Summer Noon		Summer 6pm		Winter 6pm	
			Normal	Emergency	Normal	Emergency	Normal	Emergency	Normal	Emergency	Normal	Emergency	Normal	Emergency
Libra	7/3.00 AAC	75°C	207	269	234	296	291	363	183	249	226	296	282	363
Mars	7/3.75 AAC	75°C	272	354	310	392	387	482	240	327	300	392	375	482
Moon	7/4.75 AAC	75°C	362	471	416	525	521	648	318	435	403	525	506	648
Pluto	19/3.75 AAC	75°C	499	651	581	732	732	906	437	601	563	732	711	906
Saturn	37/3.00 AAC	75°C	570	745	668	840	834	1041	498	686	647	840	818	1041
LV ABC	4 x 95 sq mm	80°C	205	NA	260	NA	330	NA	175	NA	250	NA	325	NA
LV ABC	2 x 95 sq mm	80°C	220	NA	270	NA	345	NA	190	NA	265	NA	340	NA
LV ABC	2 x 50 sq mm	80°C	140	NA	170	NA	220	NA	125	NA	165	NA	210	NA
LV ABC	4 x 50 sq mm	80°C	130	NA	165	NA	210	NA	115	NA	160	NA	200	NA
Chlorine	7/2.5 AAAC	60°C	124	165	151	192	204	256	100	143	145	192	179	256
Helium	7/3.75 AAAC	60°C	199	269	250	319	342	427	159	232	241	319	331	427
Iodine	7/4.75 AAAC	60°C	262	356	335	427	462	574	205	306	324	427	448	574
Apple	6/1/3.0 ACSR	60°C	137	183	169	215	229	287	110	159	163	215	222	287
Banana	6/1/3.75 ACSR	60°C	178	240	223	284	305	381	207	207	215	284	296	381
Raisin	3/4/2.5 ACSR	60°C	88	118	107	137	146	183	102	102	104	137	141	183
Sultana	4/3/3.0 ACSR	60°C	119	159	147	187	200	250	138	138	142	187	193	250
3/2.75	SC/GZ	60°C	33	44	40	51	54	68	27	38	38	51	52	68
3/2.75	SC/AC	60°C	48	64	58	74	78	98	39	56	56	74	75	98

13.3 Sequence Impedances

Table 14-4 – Positive, Negative and Zero Sequence Impedances of Standard Conductors

(With standard intermediate construction configurations in the Overhead Construction Manual)

Conductor Code	Stranding	SEQUENCE IMPEDANCES (OHMS/PHASE/KM)															
		11kV Intermediate Delta to SCM Dwg 1039				22/33kV Intermediate Delta to SCM Dwg 1039				11kV Trident Construction to SCM Dwg 1079				22kV Trident Construction to SCM Dwg 1079			
		R_1 & R_2	X_1 & X_2	R_o	X_o	R_1 & R_2	X_1 & X_2	R_o	X_o	R_1 & R_2	X_1 & X_2	R_o	X_o	R_1 & R_2	X_1 & X_2	R_o	X_o
Libra	7/3.00 AAC	0.707	j0.370	0.855	j1.627	0.707	j0.387	0.855	j1.593	0.707	j0.361	0.855	j1.645	0.707	j0.349	0.855	j1.669
Mars	7/3.75 AAC	0.452	j0.356	0.600	j1.613	0.452	j0.373	0.600	j1.579	0.452	j0.347	0.600	j1.631	0.452	j0.335	0.600	j1.655
Moon	7/4.75 AAC	0.284	j0.341	0.432	j1.598	0.284	j0.358	0.432	j1.564	0.284	j0.332	0.432	j1.616	0.284	j0.320	0.432	j1.640
Pluto	19/3.75 AAC	0.168	j0.321	0.316	j1.578	0.168	j0.338	0.316	j1.544	0.168	j0.312	0.316	j1.596	0.168	j0.300	0.316	j1.620
Saturn	37/3.0 AAC	0.135	j0.309	0.283	j1.566	0.135	j0.326	0.283	j1.532	0.135	j0.300	0.283	j1.583	0.135	j0.288	0.283	j1.608
Chlorine	7/2.50 AAAC	1.05	j0.382	1.198	j1.638	1.05	j0.399	1.198	j1.605	1.05	j0.373	1.198	j1.656	1.05	j0.361	1.198	j1.681
Helium	7/3.75 AAAC	0.465	j0.356	0.613	j1.613	0.465	j0.373	0.613	j1.579	0.465	j0.347	0.613	j1.631	0.465	j0.335	0.613	j1.655
Iodine	7/4.75 AAAC	0.291	j0.341	0.439	j1.598	0.291	j0.358	0.439	j1.564	0.291	j0.332	0.439	j1.616	0.291	j0.320	0.439	j1.640
Apple	6/1/3.00 ACSR	0.91	j0.370	1.058	j1.627	0.91	j0.387	1.058	j1.593	0.91	j0.361	1.058	j1.645	0.91	j0.349	1.058	j1.669
Banana	6/1/3.75 ACSR	0.582	j0.356	0.730	j1.613	0.582	j0.373	0.730	j1.579	0.582	j0.347	0.730	j1.631	0.582	j0.335	0.730	j1.655
Raisin	3/4/2.5 ACSR	2.14	j0.382	2.288	j1.638	2.14	j0.399	2.288	j1.605	2.14	j0.373	2.288	j1.656	2.14	j0.361	2.288	j1.681
Sultana	4/3/3.0 ACSR	1.21	j0.370	1.358	j1.627	1.21	j0.387	1.358	j1.593	1.21	j0.361	1.358	j1.645	1.21	j0.349	1.358	j1.669
3/2.75	SC/GZ	14	j0.401	14.148	j1.657	14	j0.418	14.148	j1.624	14	j0.392	14.148	j1.675	14	j0.380	14.148	j1.700
3/2.75	SC/AC	5.75	j0.401	5.898	j1.657	5.75	j0.418	5.898	j1.624	5.75	j0.392	5.898	j1.675	5.75	j0.380	5.898	j1.700

Note:

These values are based on 75°C conductor temperature and 100 Ohm/m soil resistivity

13.4 Electro-Magnetic Fields (EMF)

Magnetic Fields are fields, resulting from the flow of current through wires or electrical devices, which increase in strength as the current increases. Magnetic fields emitted by powerlines are directly proportional to the distance between current carrying conductors. The smaller the distance between the conductors the smaller the magnetic field emitted at a given point.

Magnetic fields are measured in units of Gauss (G) or Tesla (T). Gauss is the unit most commonly used in Australia. Tesla is the internationally accepted scientific term. Since most environmental EMF exposures involve magnetic fields that are only a fraction of a Tesla or a Gauss, these are commonly measured in units of microtesla (μT) or milligauss (mG), multiply by 10. That is 1μT = 10mG.

Reference document Standard for Electric and Magnetic Field Design - 3060782 lists the distances from Electricity infrastructure at which point it can be expected that magnetic field strength levels will fall below the recommended level for continuous exposure. This applies to electrical infrastructure in the Ergon Energy network and relates to extremely low frequency (under 3 kHz), electric and magnetic fields.

For multiple circuits Ergon Energy Electrical System Designers can use Magnetic Field Calculator - 2914132.

13.5 Number of HV switching points

To avoid confusion during switching operations, Planners/Designers are to look for practical opportunities to limit the number of HV switching points to one per pole. Where practical the second switch should be moved to another pole along the line where suitable access is available. Should this not be practical due to site conditions, then as a last resort two switches can be placed on the same pole due to there not being another practical option.

Generally, for 3 phase lines, it is not practical to have two switches on the same pole, so this issue typically relates to SWER lines. Nonetheless, should 2 x 3 phase switches be proposed for the same pole, the same considerations shall apply for 3 phase lines.

Where the switching points are clearly for different voltages (e.g.: an 11kV ABS and 33kV ABS switch on the same pole), then this requirement can be relaxed as the opportunity for confusion is greatly reduced.

Where the use of multiple switches is on an approved construction in the Overhead Construction Manual this requirement need not apply e.g., ACR construction with incoming and outgoing links and bypass EDO's.

Appendix A

Informative

Overhead Design Programs

Refer to Reference Section 7 of Ergon Energy/Energex Overhead Design Manual – Distribution

Overhead Design Programs are packaged as part of a downloadable zipped folder titled Line Design Program obtained from Asset Standards Consultation and Collaboration SharePoint under Tools and Calculators. These come in excel format and provide inbuilt instructions of how to use them based on the current version, in the about tab.

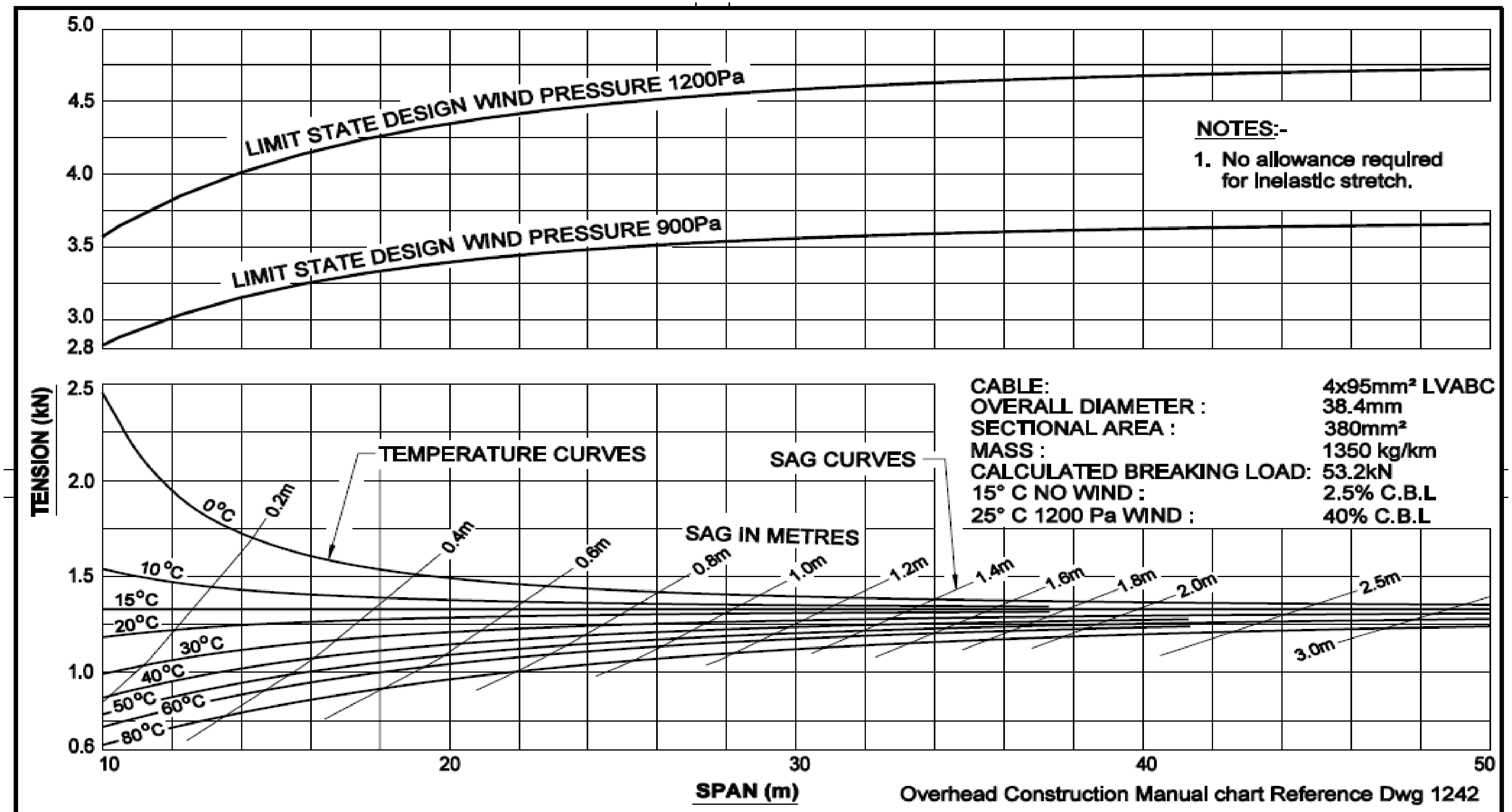
Appendix B

Informative

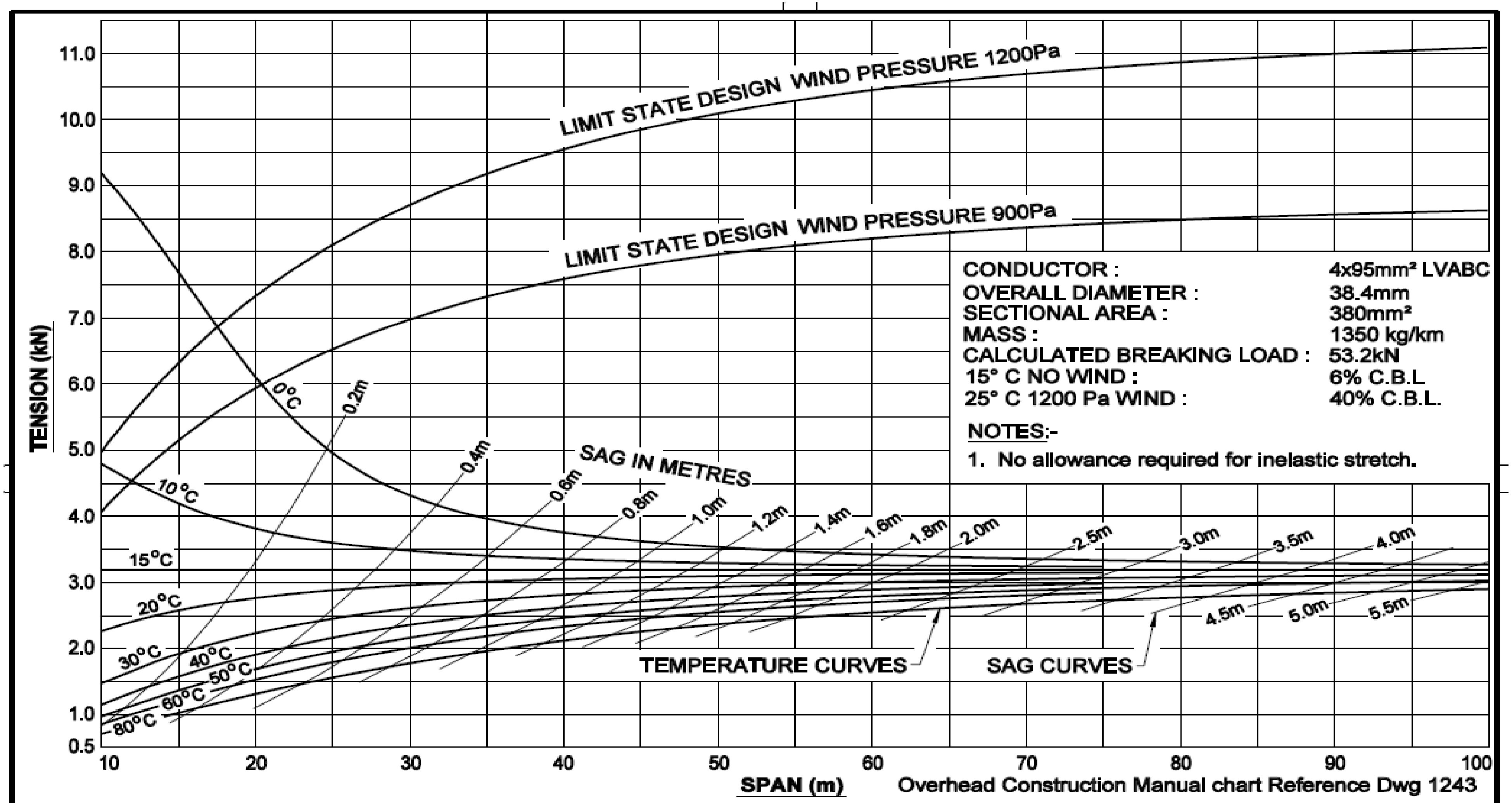
Stringing Charts

DESCRIPTION	DWG	DESCRIPTION	DWG
4x95 LVABC Slack Stringing 2.5% CBL – 900 and 1200 Pa wind	3015	Rural 'Mars' 7/3.75 AAC 20% CBL – 900 Pa wind	3004
Urban 4x95 LVABC 6% CBL - 900and 1200 Pa. wind	3016	Rural 'Mars' 7/3.75 AAC 20% CBL – 1200 Pa wind	3005
Semi-urban 4x95 LVABC 10% CBL – 900 and 1200 Pa. wind	3033		
		Rural 'Moon' 7/4.75 AAC 20% CBL – 900 Pa wind	3008
2x95 LVABC Slack Stringing 2.5% CBL – 900 and 1200 Pa wind	3006	Rural 'Moon' 7/4.75 AAC 20% CBL – 1200 Pa wind	3009
Urban 2x95 LVABC 6% CBL - 900and 1200 Pa. wind	3017	Rural 'Pluto' 19/3.75 AAC 20% CBL – 900 and 1200Pa wind	3031
Semi-urban 2x95 LVABC 10% CBL – 900 Pa. wind	3029		
Semi-urban 2x95 LVABC 10% CBL – 1200 Pa. wind	3024	Rural 'Fluorine' 7/3.0 AAAC 1120 20% CBL – 900 Pa wind	3166
		Rural 'Fluorine' 7/3.0 AAAC 1120 20% CBL – 1200 Pa wind	3167
4x50 LVABC Slack Stringing 2.5% CBL – 900 and 1200 Pa wind	3035		
Urban 4x50 LVABC 6% CBL – 900 and 1200 Pa. wind	3034	Rural 'Chlorine' 7/2.5 AAAC 20% CBL – 900 Pa wind	3012
Semi-urban 4x50 LVABC 10% CBL – 900 Pa. wind	3028	Rural 'Chlorine' 7/2.5 AAAC 20% CBL – 1200 Pa wind	3013
Semi-urban 4x50 LVABC 10% CBL – 1200 Pa. wind	3026		
		Rural 'Helium' 7/3.75 AAAC 20% CBL – 900 Pa wind	3010
2x50 LVABC Slack Stringing 2.5% CBL – 900 and 1200 Pa wind	3018	Rural 'Helium' 7/3.75 AAAC 20% CBL – 1200 Pa wind	3011
Urban 2x50 LVABC 6% CBL – 900Pa. wind	3037		
Urban 2x50 LVABC 10% CBL – 1200 Pa. wind	3023	Rural 'Iodine' 7/4.75 AAAC 20% CBL – 900 Pa wind	3000
Semi-urban 2x50 LVABC 10% CBL – 900 Pa. wind	3027	Rural 'Iodine' 7/4.75 AAAC 20% CBL – 1200 Pa wind	3001
Semi-urban 2x50 LVABC 10% CBL – 1200 Pa. wind	3025		
		Rural 'Raisin' 3/4/2.5 ACSR/GZ 22% CBL – 900 and1200 Pa wind	3032
Slack Stringing 'Libra' 7/3.00 AAC≈ 2.5% CBL – 900 and 1200 Pa wind	3039		
Slack Stringing 'Mars' 7/3.75 AAC≈ 2.5% CBL – 900 and 1200 Pa wind	3158	Rural 'Apple' 6/1/3.00 ACSR/GZ 22% CBL – 900 Pa wind	3021
Slack Stringing 'Moon' 7/4.75 AAC≈ 2.5% CBL – 900 and 1200 Pa wind	3161	Rural 'Apple' 6/1/3.00 ACSR/GZ 22% CBL – 1200Pa wind	3022
Slack Stringing 'Pluto' 19/3.75 AAC≈ 2.5% CBL – 900 and 1200 Pa wind	3164		
		'Sultana' 4/3/3.0 ACSR/GZ 22% CBL – 900 and 1200 Pa wind	3036
Urban 'Libra' 7/3.00 AAC≈ 6% CBL – 900 and 1200 Pa wind	3156		
Urban 'Mars' 7/3.75 AAC≈ 6% CBL – 900 and 1200 Pa wind	3159	Rural 'Banana' 6/1/3.75 ACSR/GZ 22% CBL – 900 Pa wind	3019
Urban 'Moon' 7/4.75 AAC≈ 6% CBL – 900 and 1200 Pa wind	3162	Rural 'Banana' 6/1/3.75 ACSR/GZ 22% CBL – 1200Pa wind	3020
Urban 'Pluto' 19/3.75 AAC≈ 6% CBL – 900 and 1200 Pa wind	3165		
		Rural 3/2.75 SC/AC 25% CBL – 900 and 1200 Pa wind	3014
Semi-Urban 'Libra' 7/3.00 AAC≈ 10% CBL – 900 and 1200 Pa wind	3038		
Semi-Urban 'Mars' 7/3.75 AAC≈ 10% CBL – 900 and 1200 Pa wind	3157	Rural 3/2.75 SC/GZ 25% CBL – 900 and 1200 Pa wind	3007
Semi-Urban 'Moon' 7/4.75 AAC≈ 10% CBL – 900 and 1200 Pa wind	3160		
Semi-Urban 'Pluto' 19/3.75 AAC≈ 10% CBL – 900 and 1200 Pa wind	3163	36-48 Fibre ADSS Cable – Long Span 6% CBL – 900 and 1200Pa wind	3454
		36-48 Fibre ADSS Cable – Short Span 10% CBL – 900Pa wind	3455
Rural 'Libra' 7/3.00 AAC 20% CBL – 900 Pa wind	3002	36-48 Fibre ADSS Cable – Short Span 10% CBL – 1200Pa wind	3456
Rural 'Libra' 7/3.00 AAC 20% CBL – 1200 Pa wind	3003	96 Fibre ADSS Cable – Short Span 5% CBL – 900 &1200 wind	3506
		96 Fibre ADSS Cable – Long Span 8% CBL – 900 & 1200 wind	3507

DESCRIPTION	DWG	DESCRIPTION	DWG
NBN Type 2, 72 Fibre 2% CBL – 900Pa and 1200Pa wind	3469		
NBN Type 2, 144 Fibre 2% CBL – 900Pa and 1200Pa wind	3470		
Rural ‘Leo’ 7/2.5 AAC 2.5% CBL – 900 & 1200 Pa wind	3502		
Rural ‘Leo’ 7/2.5 AAC 6% CBL – 900 & 1200 Pa wind	3503		
Rural ‘Leo’ 7/2.5 AAC 10% CBL – 900 & 1200 Pa wind	3504		
Rural ‘Chlorine’ 7/2.5 AAC 6.5% CBL – 900 & 1200 Pa wind	3505		



A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED	C. Noel	DISTRIBUTION DESIGN - OVERHEAD STRINGING CHARTS 4x95mm²LVABC - Slack Stringing 2.5% C.B.L. - 900 AND 1200 Pa WIND
B	01.03.02		DATE	25.5.01	
C	24.11.11		PASSED	C. Avenell	FILE: 5 33 3015 1 — Dwg 3015 Sh C
			DRAWN	L. Burton	



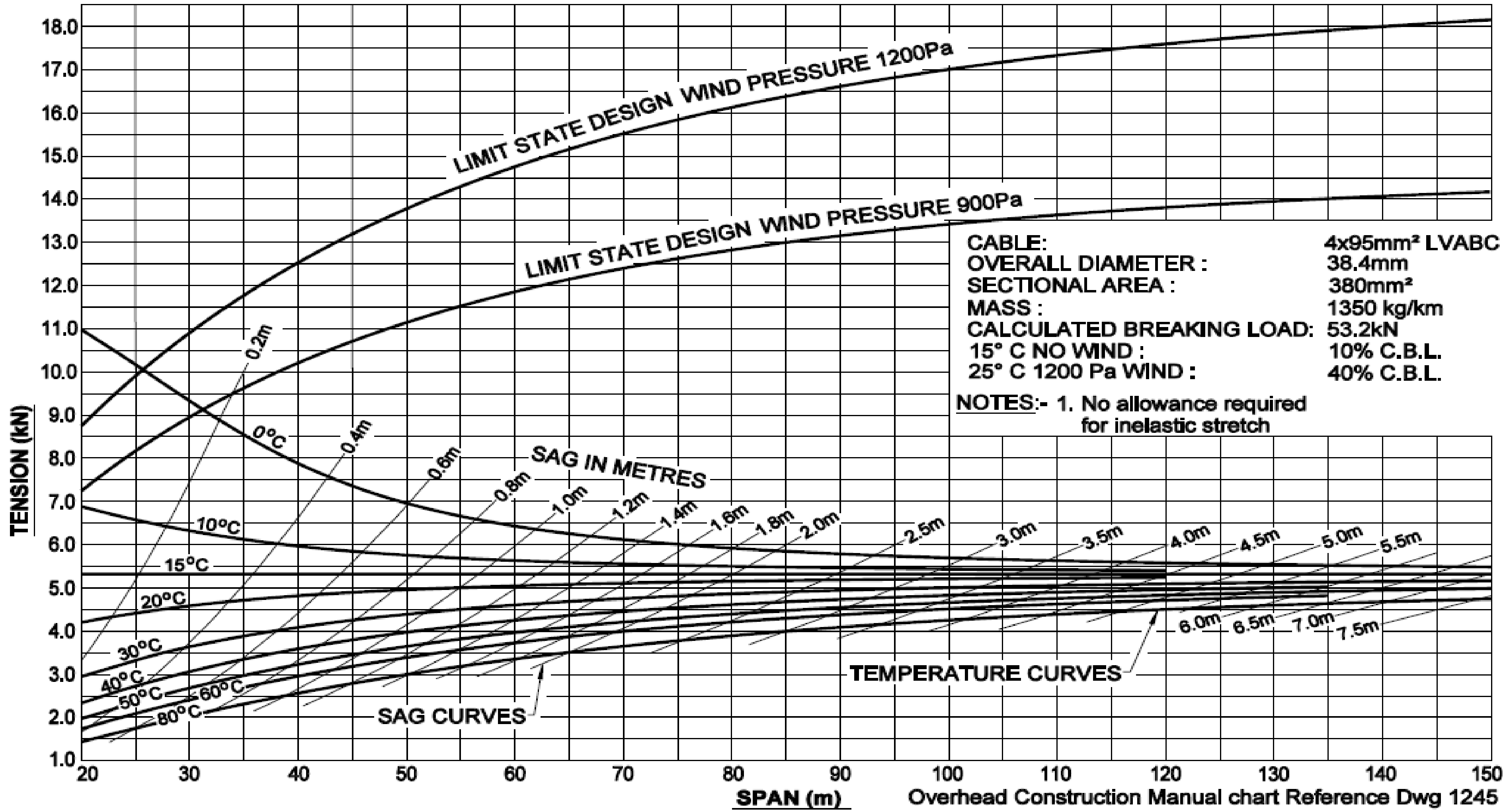
A	ORIGINAL ISSUE
B	01.03.02
C	24.11.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	25.5.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
URBAN 4x95mm² LVABC
6% C.B.L. – 900 AND 1200 Pa WIND

FILE: 5 33 3016 1 | Dwg 3016 Sh | C



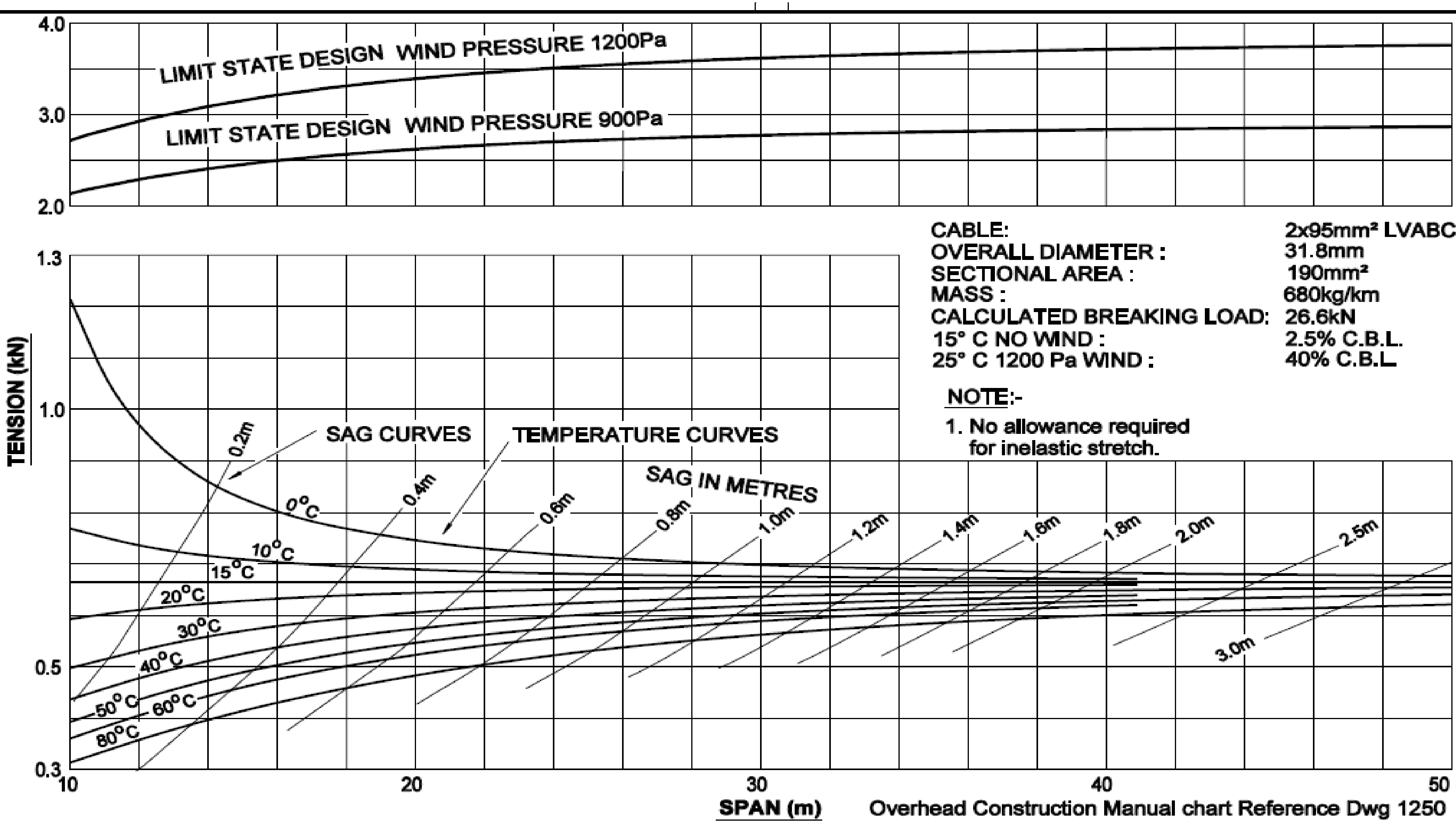
A	ORIGINAL ISSUE	
B	01.03.02	
C	24.11.11	

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	30.05.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
SEMI-URBAN 4x95mm² LVABC
10% C.B.L. - 900 AND 1200 Pa WIND

FILE: 5 33 3033 1 | Dwg 3033 Sh | C



CABLE:	2x95mm² LVABC
OVERALL DIAMETER :	31.8mm
SECTIONAL AREA :	190mm²
MASS :	680kg/km
CALCULATED BREAKING LOAD:	26.6kN
15° C NO WIND :	2.5% C.B.L.
25° C 1200 Pa WIND :	40% C.B.L.

NOTE:-

1. No allowance required for inelastic stretch.

Overhead Construction Manual chart Reference Dwg 1250

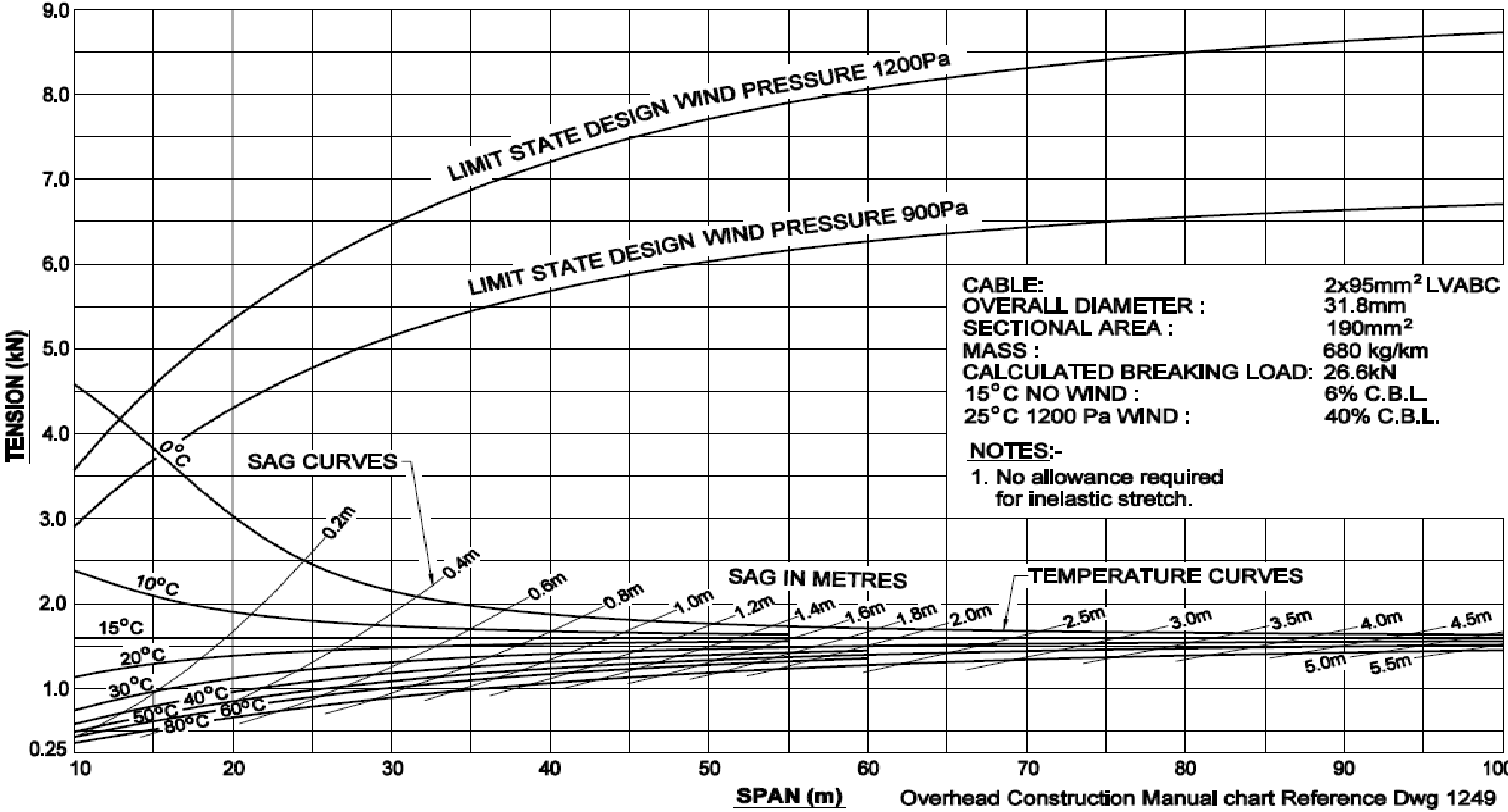
A	ORIGINAL ISSUE
B	01.03.02
C	24.11.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	8/3/01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
2x95mm² LVABC – SLACK STRINGING
2.5% C.B.L. - 900 AND 1200 Pa WIND

FILE: 5 33 3006 1 | Dwg 3006 Sh | C



Overhead Construction Manual chart Reference Dwg 1249

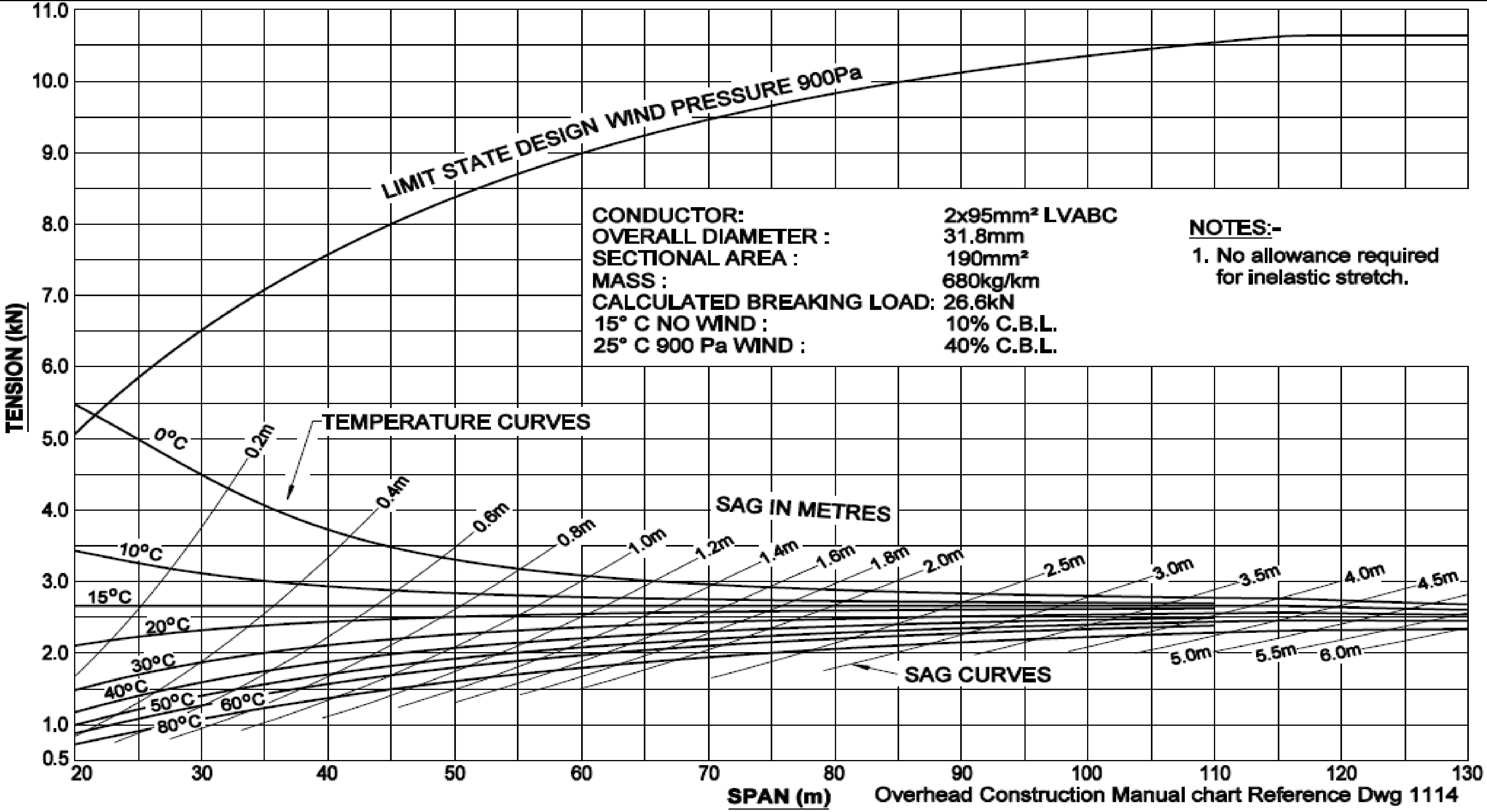
A	ORIGINAL ISSUE
B	01.03.02
C	24.11.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	25.5.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
URBAN 2x95mm² LVABC
6% C.B.L. - 900 AND 1200 Pa WIND

FILE: 5 33 3017 1 | Dwg 3017 Sh | C



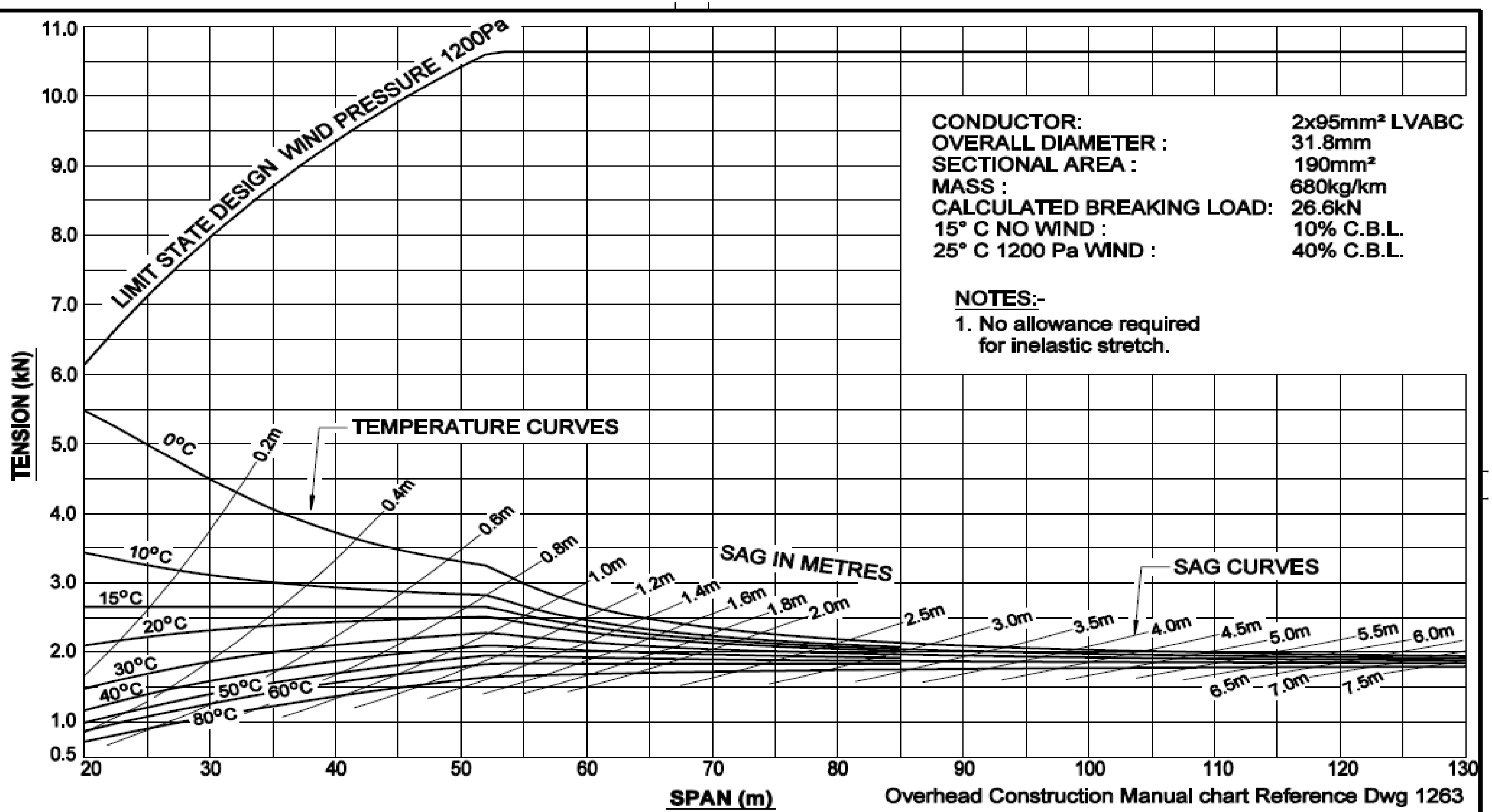
A	ORIGINAL ISSUE
B	01.03.02
C	25.11.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	14-05-01
PASSED	C. Avenell
DRAWN	L. Burton

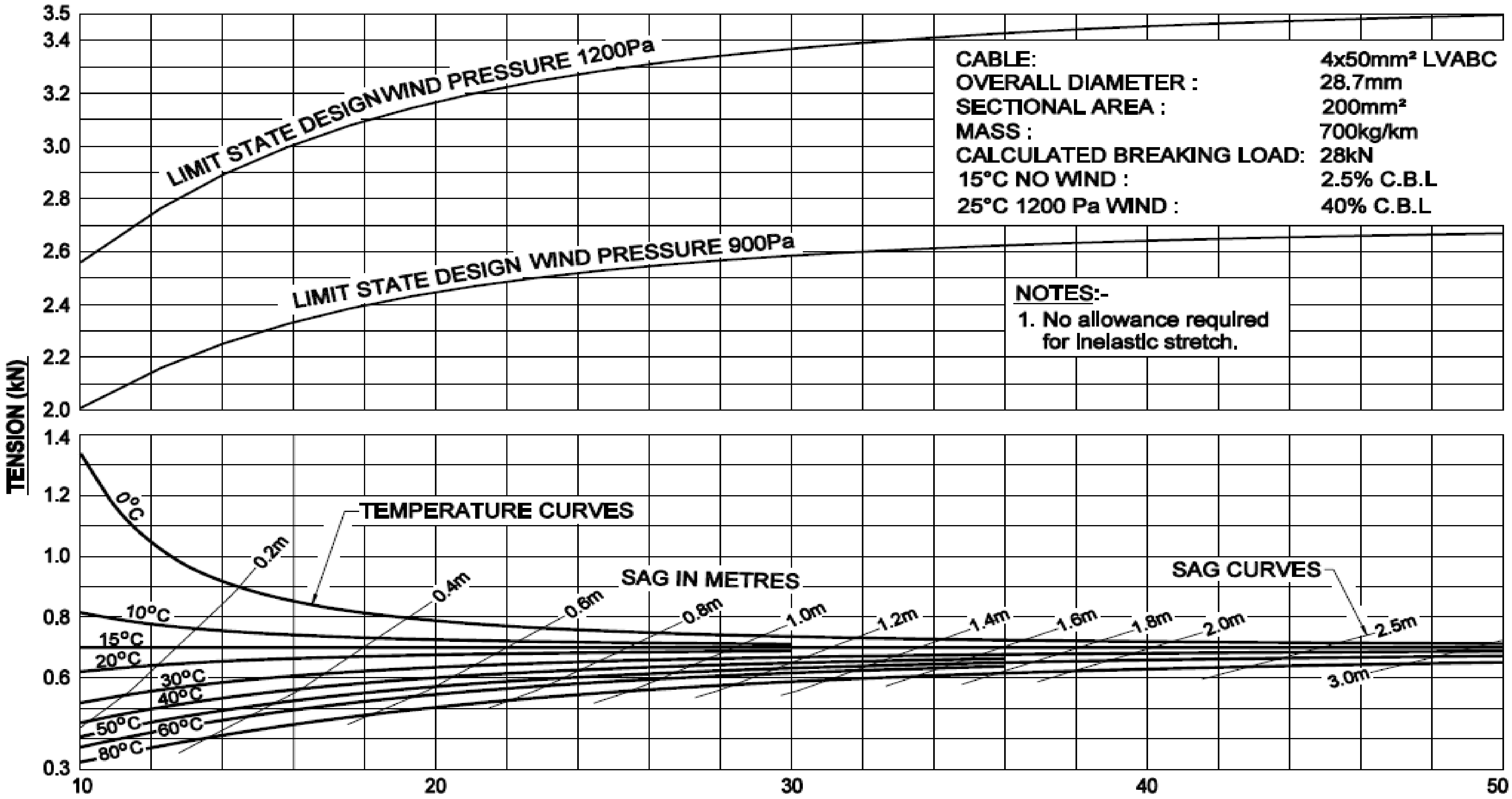
DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
SEMI-URBAN 2x95mm² LVABC
10% C.B.L. - 900 Pa WIND

FILE: 5 33 3029 1 | Dwg 3029 Sh | C



Overhead Construction Manual chart Reference Dwg 1263

A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED: C. Noel	DISTRIBUTION DESIGN - OVERHEAD STRINGING CHARTS SEMI-URBAN 2x95mm² LVABC 10% C.B.L. - 1200 Pa WIND
B	01.03.02		DATE: 09-05-01	
C	25.11.11		PASSED: C. Avenell	
			DRAWN: L. Burton	FILE: 5 33 3024 1 — Dwg 3024 Sh — C



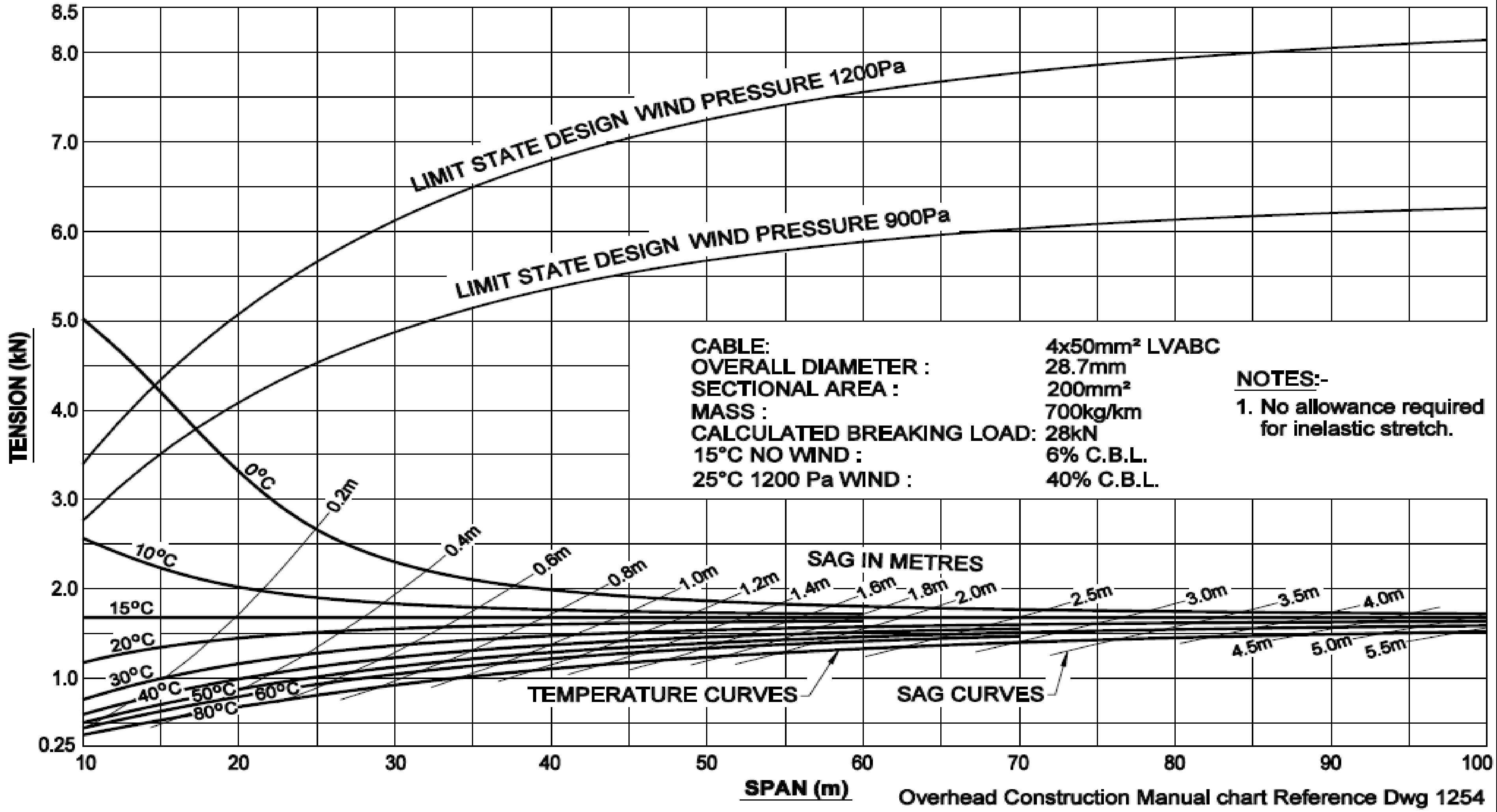
Overhead Construction Manual chart Reference Dwg 1255

A	ORIGINAL ISSUE	APPROVED	C. Noel
B	01.03.02	DATE	30.05.01
C	28.11.11	PASSED	C. Avenell
		DRAWN	L. Burton

Ergon Energy Corporation Ltd
ABN 50 087 646 062

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
4x50mm² LVABC - SLACK STRINGING
2.5% C.B.L. - 900 AND 1200 Pa WIND

FILE: 5 33 3035 1 | Dwg 3035 | Sh | C



Overhead Construction Manual chart Reference Dwg 1254

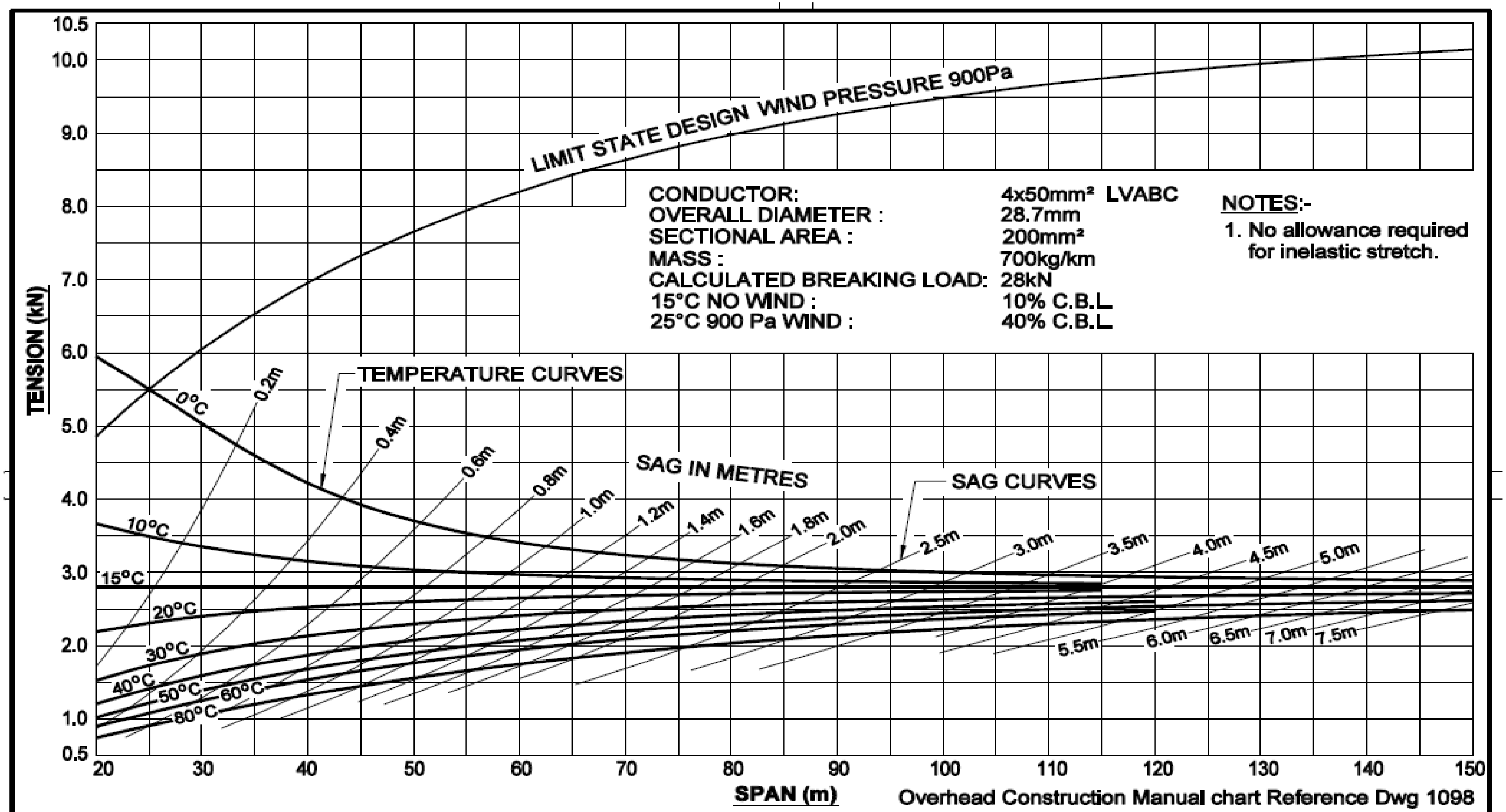
A	ORIGINAL ISSUE	
B	01.03.02	
C	28.11.11	

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	30.05.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
URBAN 4x50mm² LVABC
6% C.B.L. - 900 AND 1200 Pa WIND

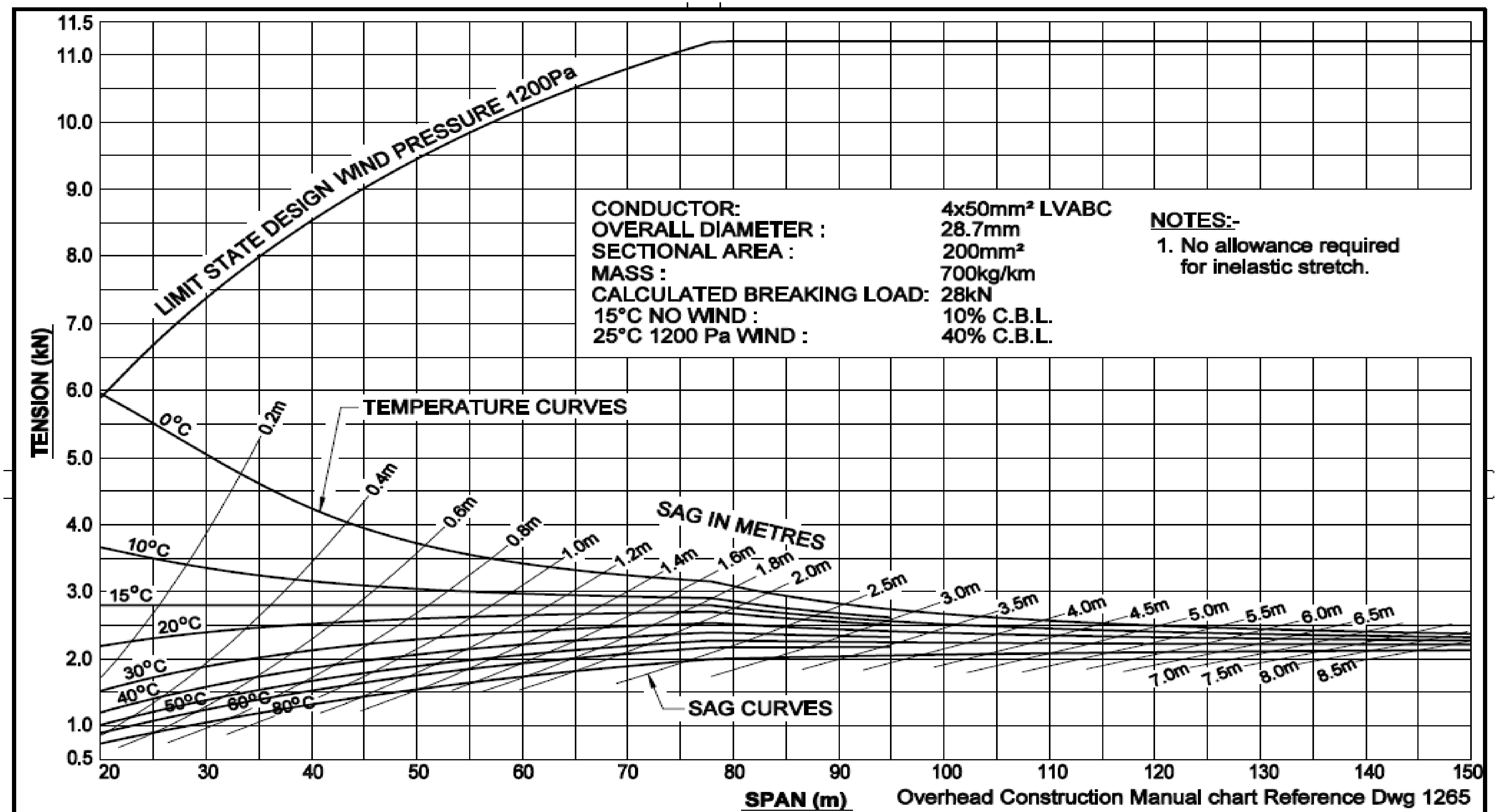
FILE: 5 33 3034 1 | Dwg 3034 Sh | C



A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED	C. Noel
B	01.03.02		DATE	28.11.11
C	28.11.11		PASSED	C. Avenell
			DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
SEMI-URBAN 4x50mm² LVABC
10% C.B.L. - 900 Pa WIND

FILE: 5 33 3028 1 | Dwg 3028 | Sh | C

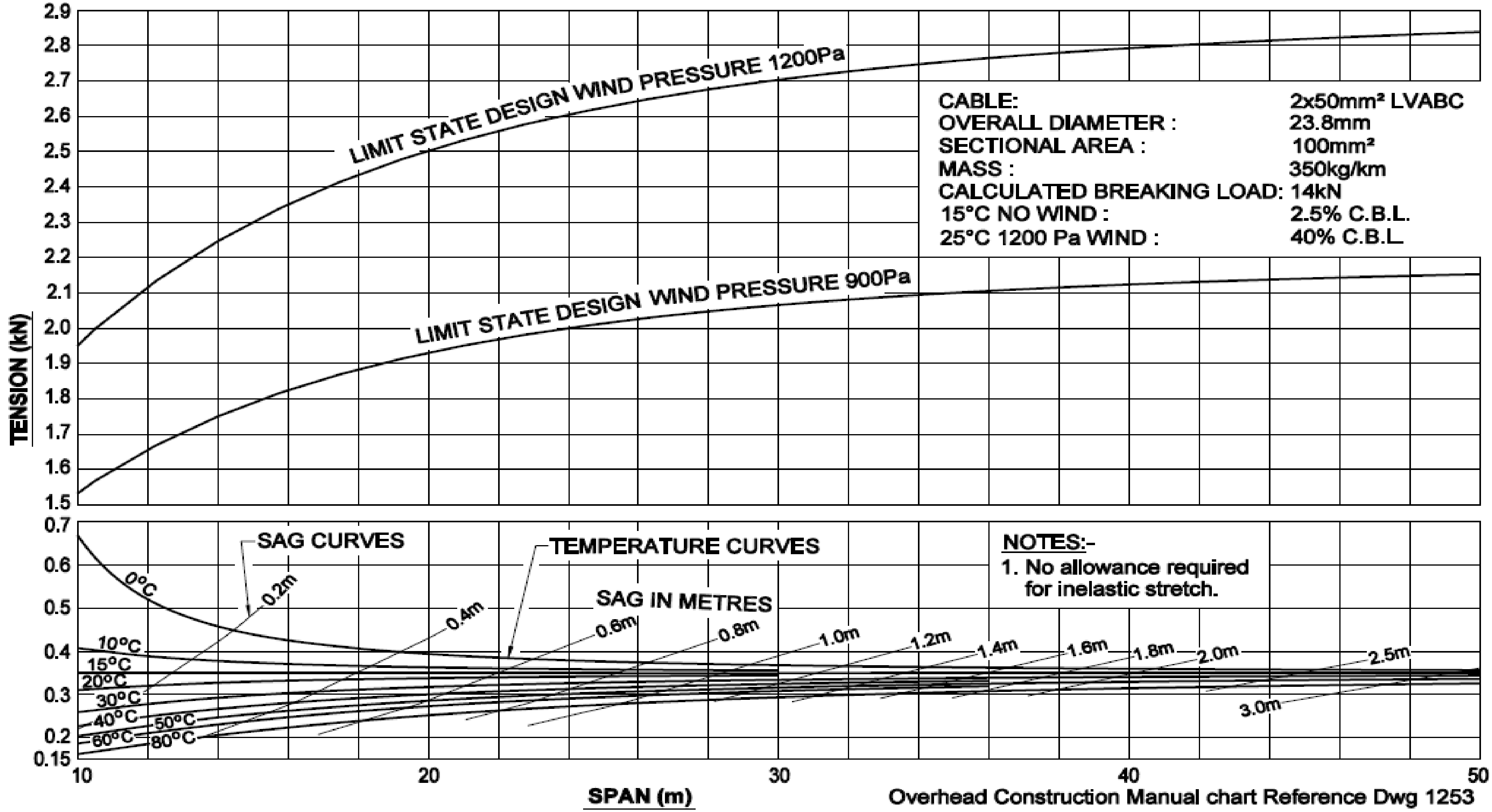


Overhead Construction Manual chart Reference Dwg 1265

A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED	C. Noel
B	01.03.02		DATE	09-05-01
C	25.11.11		PASSED	C. Avenell
			DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
SEMI-URBAN 4x50mm² LVABC
10% C.B.L. - 1200 Pa WIND

FILE: 5 33 3026 1 Dwg 3026 Sh C



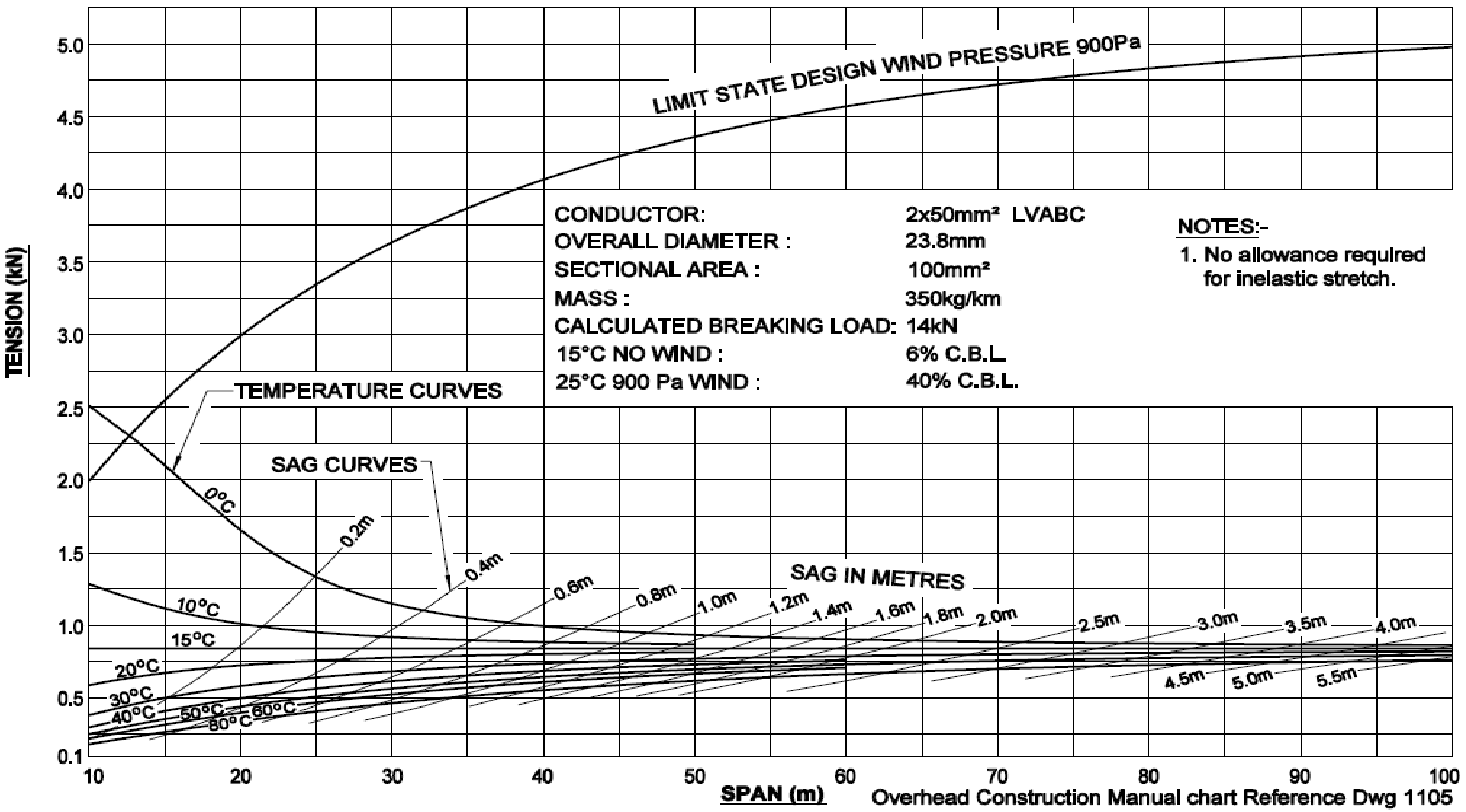
A	ORIGINAL ISSUE
B	01.03.02
C	28.11.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

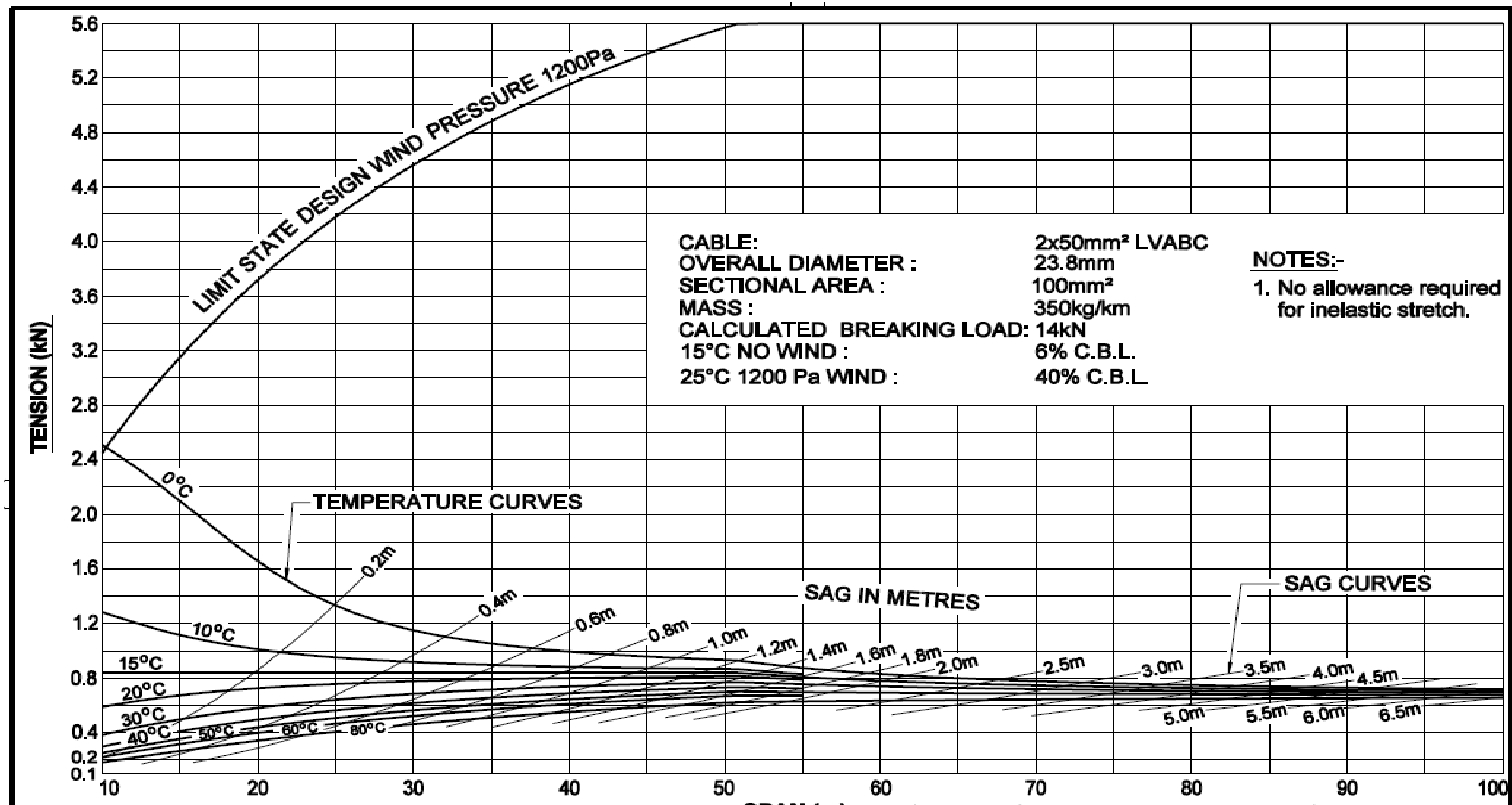
APPROVED	C. Noel
DATE	25.05.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
2x50mm^2 LVABC - SLACK STRINGING
2.5% C.B.L. - 900 AND 1200 Pa WIND

FILE: 5 33 3018 1 | Dwg 3018 Sh | C

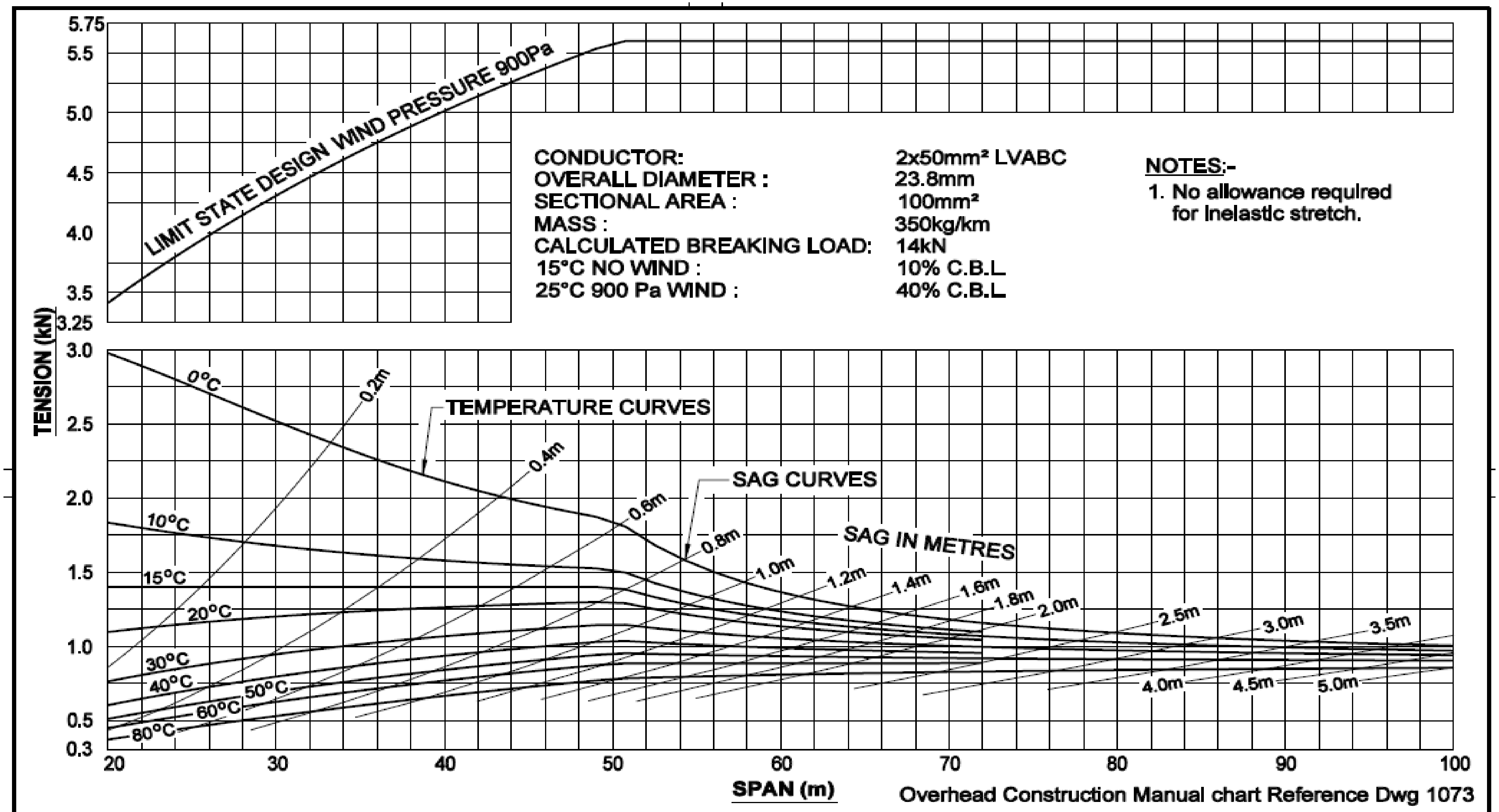


A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED	C. Noel	DISTRIBUTION DESIGN - OVERHEAD STRINGING CHARTS URBAN 2x50mm² LVABC 6% C.B.L. - 900 Pa WIND
B	01.03.02		DATE	30-05-01	
C	28.11.11		PASSED	C. Avenell	
			DRAWN	L. Burton	FILE: 5 33 3037 1 — Dwg 3037 Sh — C

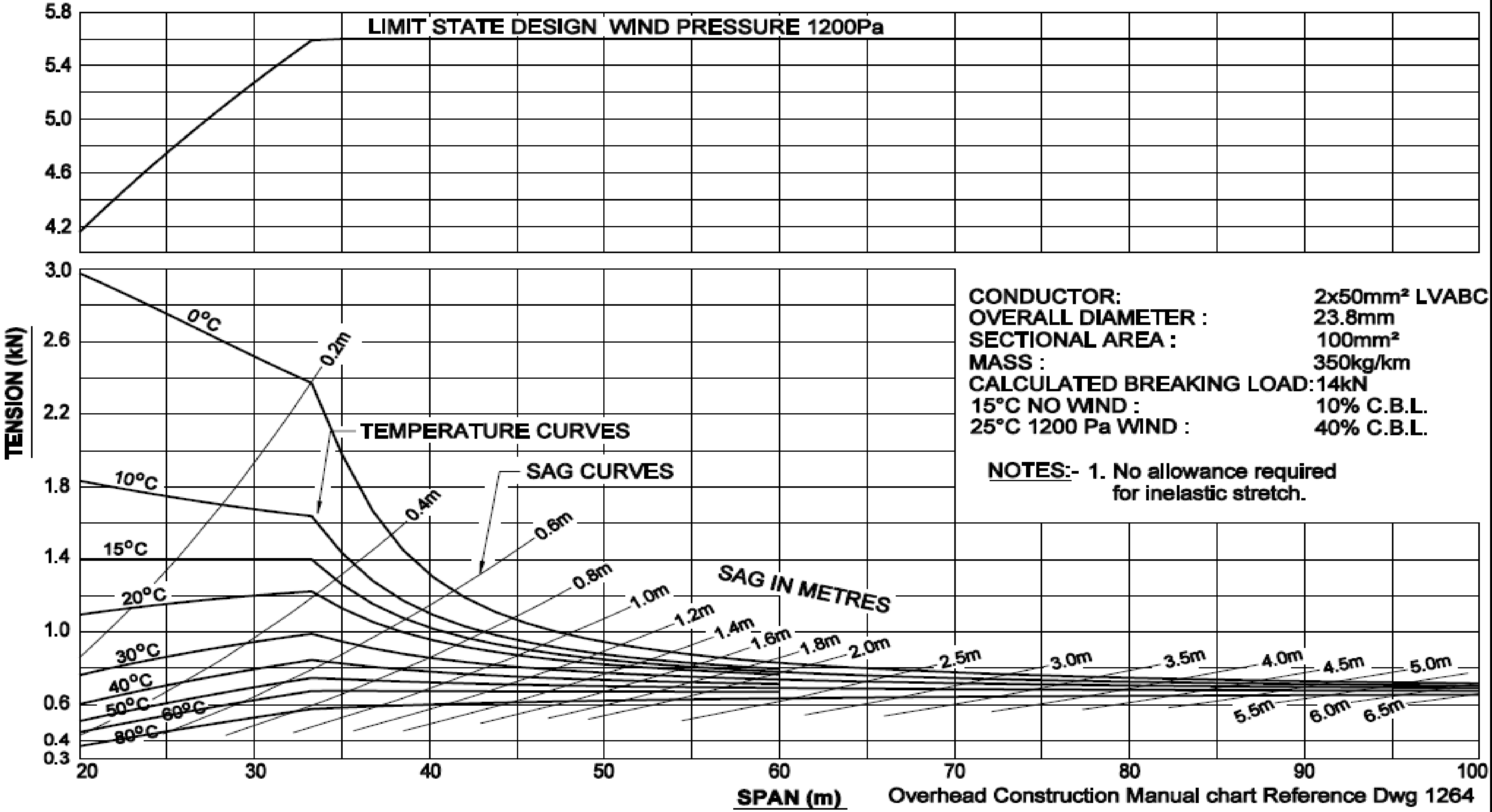


Overhead Construction Manual chart Reference Dwg 1252

A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED: C. Noel	**DISTRIBUTION DESIGN - OVERHEAD** STRINGING CHARTS URBAN 2x50mm² LVABC 6% C.B.L. - 1200 Pa WIND
B	01.03.02		DATE: 4.5.01	
C	28.11.11		PASSED: C. Avenell	
			DRAWN: L. Burton	FILE: 5 33 3023 1 — Dwg 3023 Sh — C



A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED	C. Noel	DISTRIBUTION DESIGN - OVERHEAD STRINGING CHARTS SEMI-URBAN 2x50mm²LVABC 10% C.B.L. - 900 Pa WIND
B	01.03.02		DATE	14-05-01	
C	28.11.11		PASSED	C. Avenell	
			DRAWN	L. Burton	FILE: 5 33 3027 1 — Dwg 3027 Sh — C



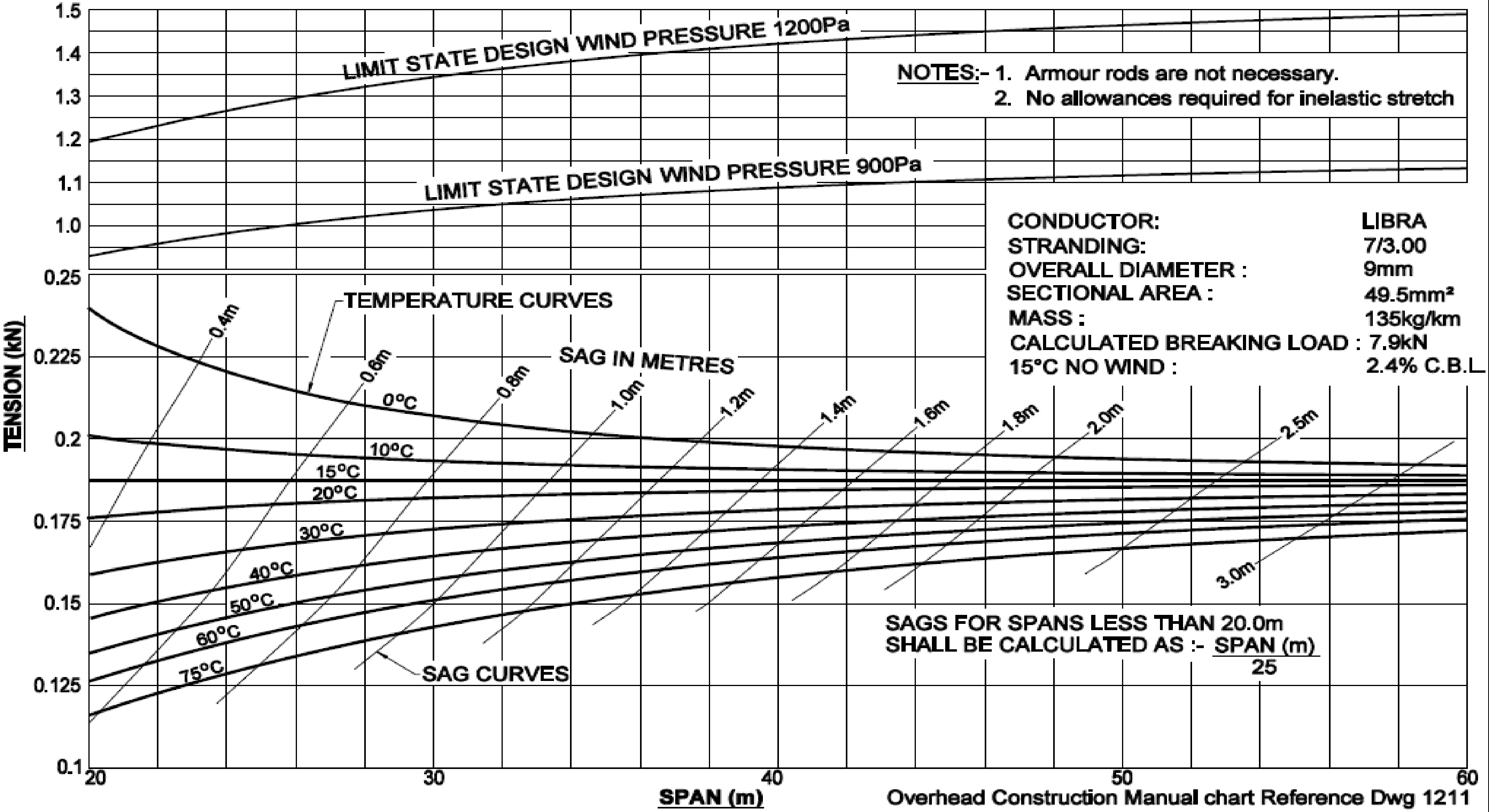
A	ORIGINAL ISSUE
B	01.03.02
C	29.11.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	09-05-01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
SEMI-URBAN 2x50mm² LVABC
10% C.B.L. - 1200 Pa WIND

FILE: 5 33 3025 1 | Dwg 3025 Sh | C



NOTES:- 1. Armour rods are not necessary.
2. No allowances required for inelastic stretch

CONDUCTOR:	LIBRA
STRANDING:	7/3.00
OVERALL DIAMETER :	9mm
SECTIONAL AREA :	49.5mm²
MASS :	135kg/km
CALCULATED BREAKING LOAD :	7.9kN
15°C NO WIND :	2.4% C.B.L.

SAGS FOR SPANS LESS THAN 20.0m SHALL BE CALCULATED AS :- $\frac{\text{SPAN (m)}}{25}$

Overhead Construction Manual chart Reference Dwg 1211

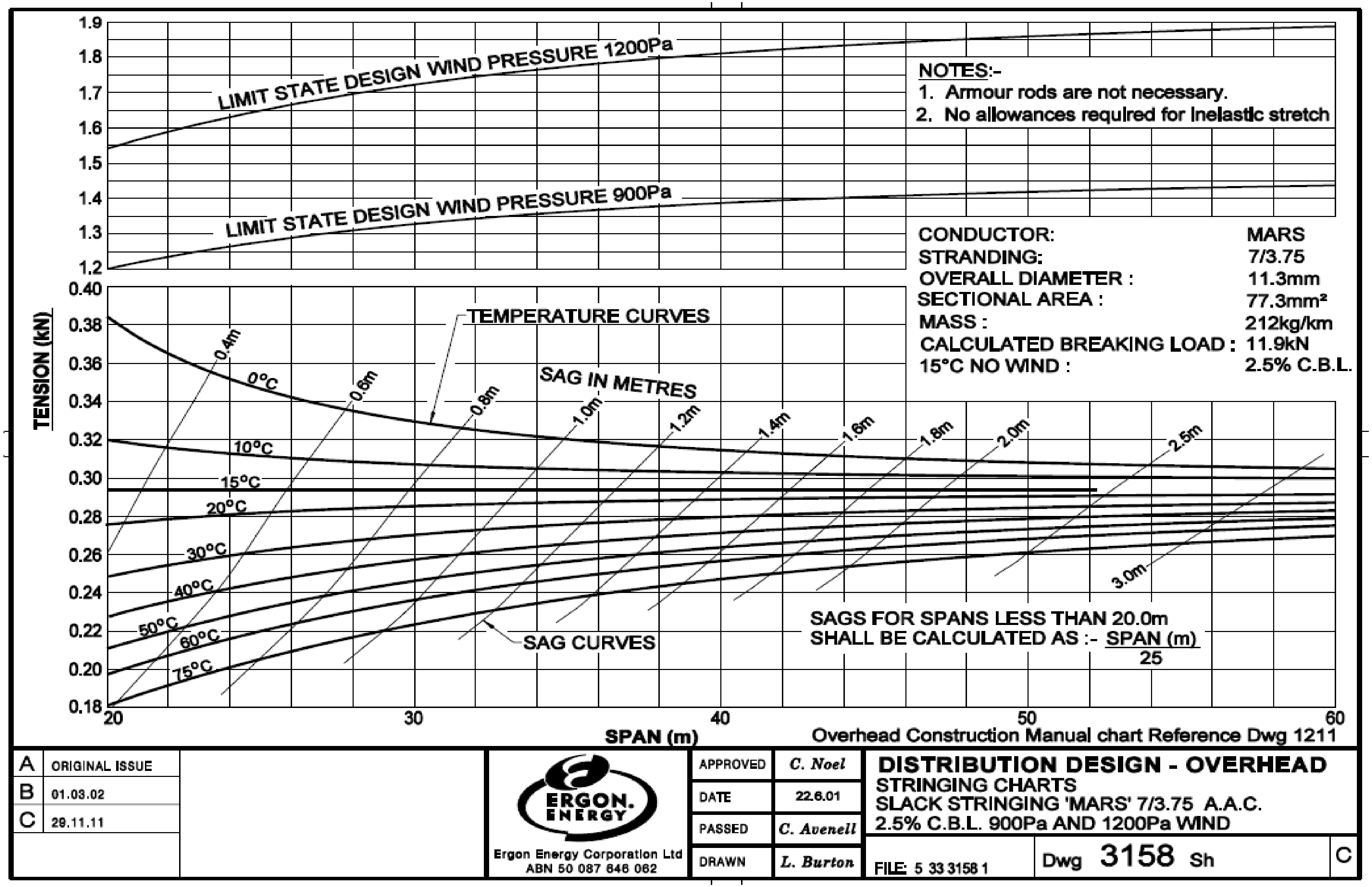
A	ORIGINAL ISSUE
B	01.03.02
C	29.11.11

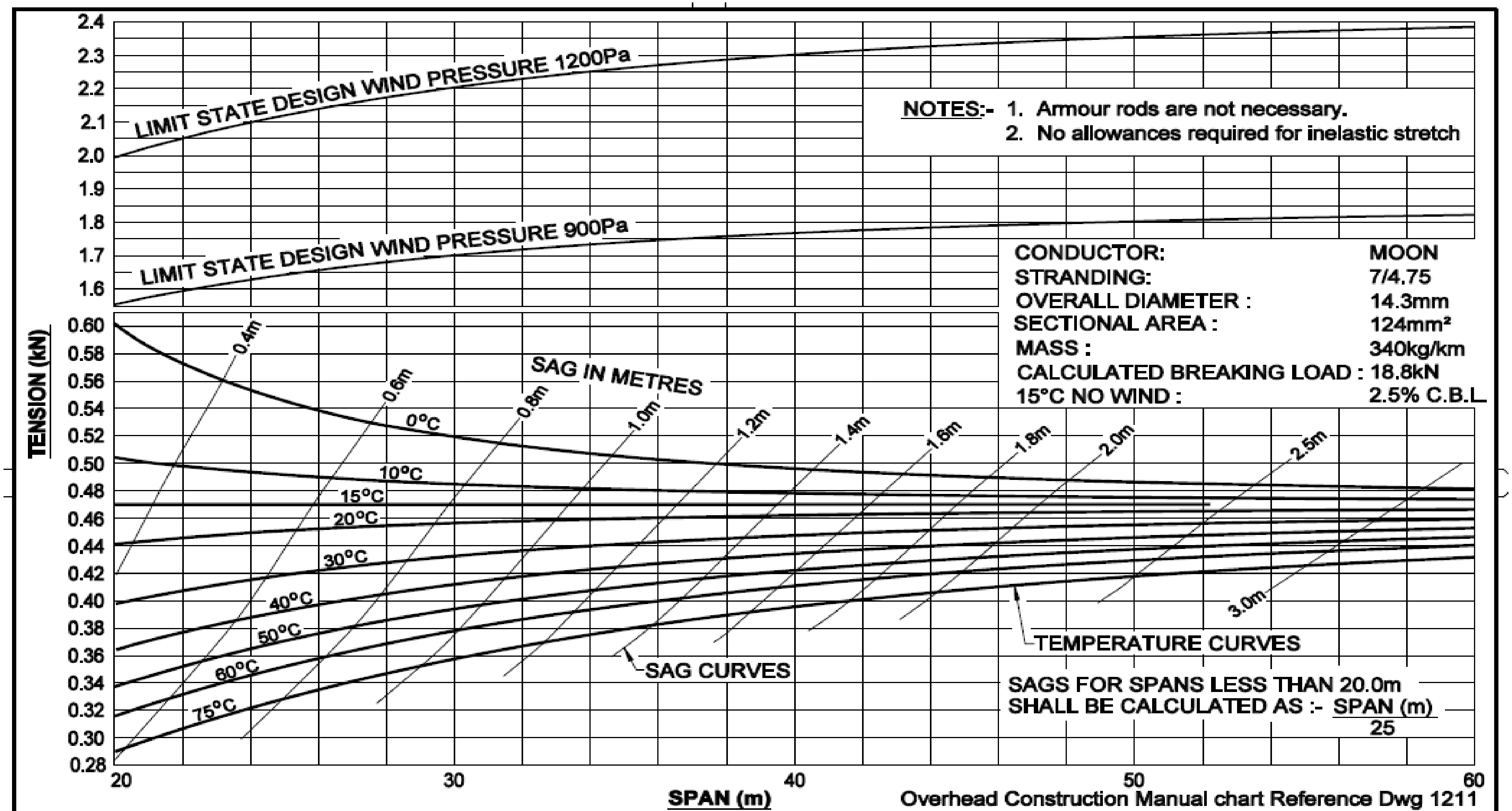
Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	21.6.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
SLACK STRINGING 'LIBRA' 7/3.00 A.A.C.
2.5% C.B.L. 900Pa AND 1200Pa WIND

FILE: 5 33 3039 1 Dwg 3039 Sh C


LIMIT STATE DESIGN WIND PRESSURE 1200Pa
LIMIT STATE DESIGN WIND PRESSURE 900Pa
NOTES:-
1. Armour rods are not necessary.
2. No allowances required for inelastic stretch
CONDUCTOR: MARS
STRANDING: 7/3.75
OVERALL DIAMETER : 11.3mm
SECTIONAL AREA : 77.3mm²
MASS : 212kg/km
CALCULATED BREAKING LOAD : 11.9kN
15°C NO WIND : 2.5% C.B.L.
TENSION (kN)
TEMPERATURE CURVES
SAG IN METRES
0°C
10°C
15°C
20°C
30°C
40°C
50°C
60°C
75°C
0.4m
0.6m
0.8m
1.0m
1.2m
1.4m
1.6m
1.8m
2.0m
2.5m
3.0m
SAG CURVES
SAGS FOR SPANS LESS THAN 20.0m
SHALL BE CALCULATED AS :- SPAN (m) / 25
SPAN (m)
Overhead Construction Manual chart Reference Dwg 1211
A ORIGINAL ISSUE
B 01.03.02
C 29.11.11
Ergon Energy Corporation Ltd
ABN 50 087 646 062
APPROVED C. Noel
DATE 22.6.01
PASSED C. Avenell
DRAWN L. Burton
DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
SLACK STRINGING 'MARS' 7/3.75 A.A.C.
2.5% C.B.L. 900Pa AND 1200Pa WIND
FILE: 5 33 3158 1
Dwg 3158 Sh C



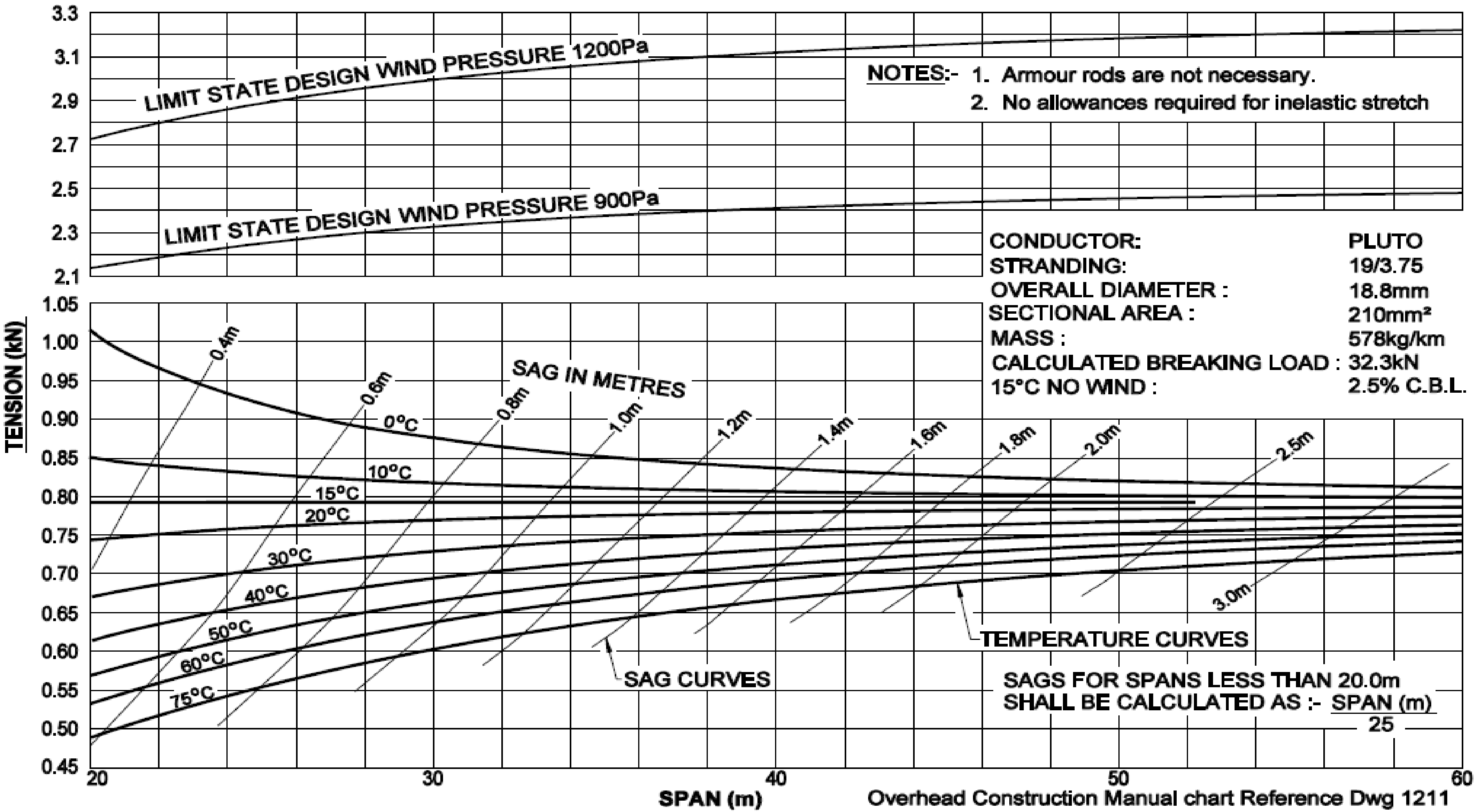
A	ORIGINAL ISSUE
B	01.03.02
C	28.11.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	22.6.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
SLACK STRINGING 'MOON' 7/4.75 A.A.C.
2.5% C.B.L. 900Pa AND 1200Pa WIND

FILE: 5 33 3161 1 | Dwg 3161 Sh | C

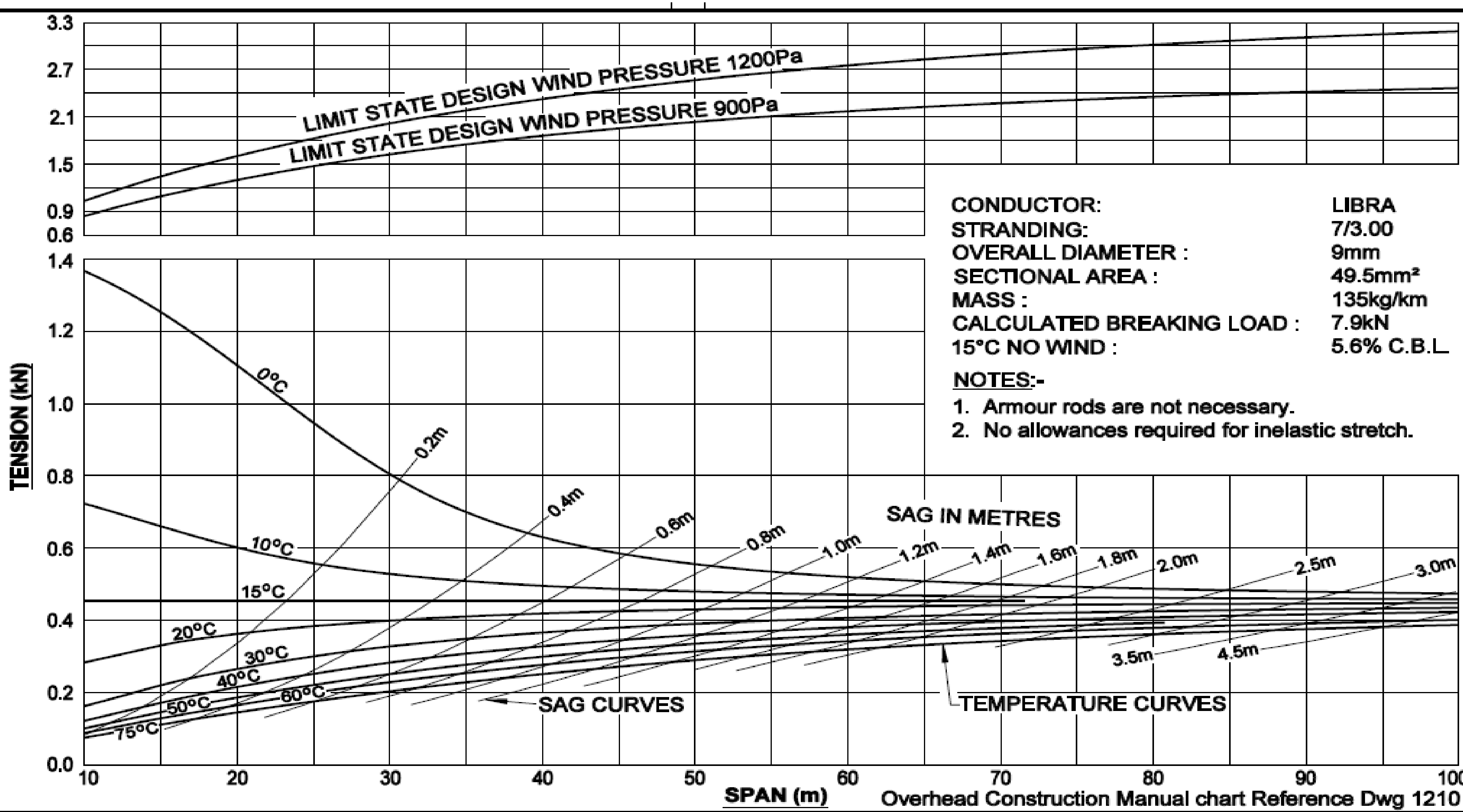


A	ORIGINAL ISSUE	APPROVED	C. Noel
B	01.03.02	DATE	21.6.01
C	28.11.11	PASSED	C. Avenell
		DRAWN	L. Burton

Ergon Energy Corporation Ltd
ABN 50 087 646 062

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
SLACK STRINGING 'PLUTO' 19/3.75 A.A.C.
2.5% C.B.L. 900Pa AND 1200Pa WIND

FILE: 5 33 3164 1 | Dwg 3164 Sh | C



CONDUCTOR:	LIBRA
STRANDING:	7/3.00
OVERALL DIAMETER :	9mm
SECTIONAL AREA :	49.5mm²
MASS :	135kg/km
CALCULATED BREAKING LOAD :	7.9kN
15°C NO WIND :	5.6% C.B.L.

NOTES:-

1. Armour rods are not necessary.
2. No allowances required for inelastic stretch.

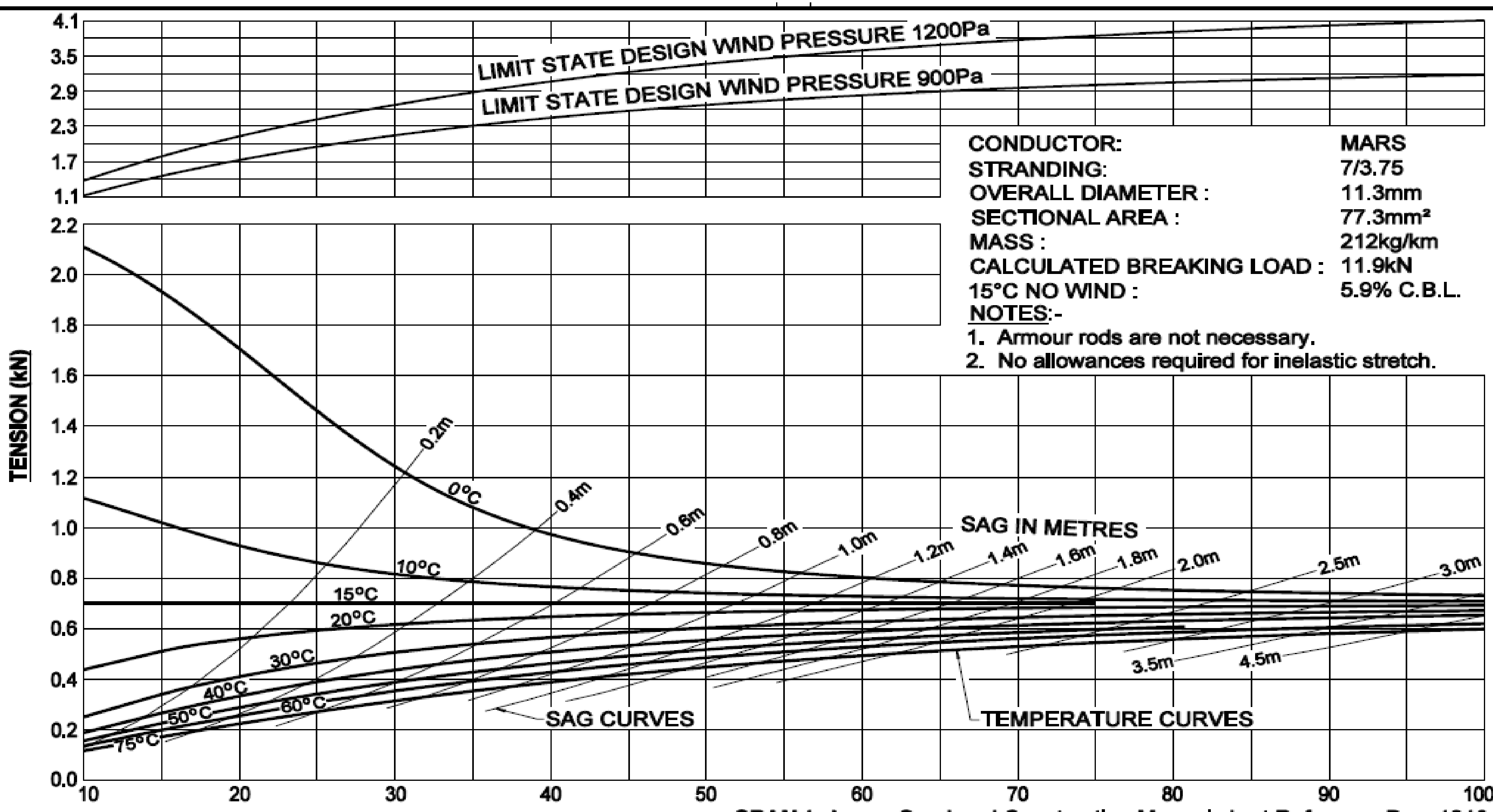
A	ORIGINAL ISSUE
B	01.03.02
C	28.11.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	22.6.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
URBAN 'LIBRA' 7/3.00 A.A.C.
≈ 6% C.B.L. 900Pa AND 1200Pa WIND

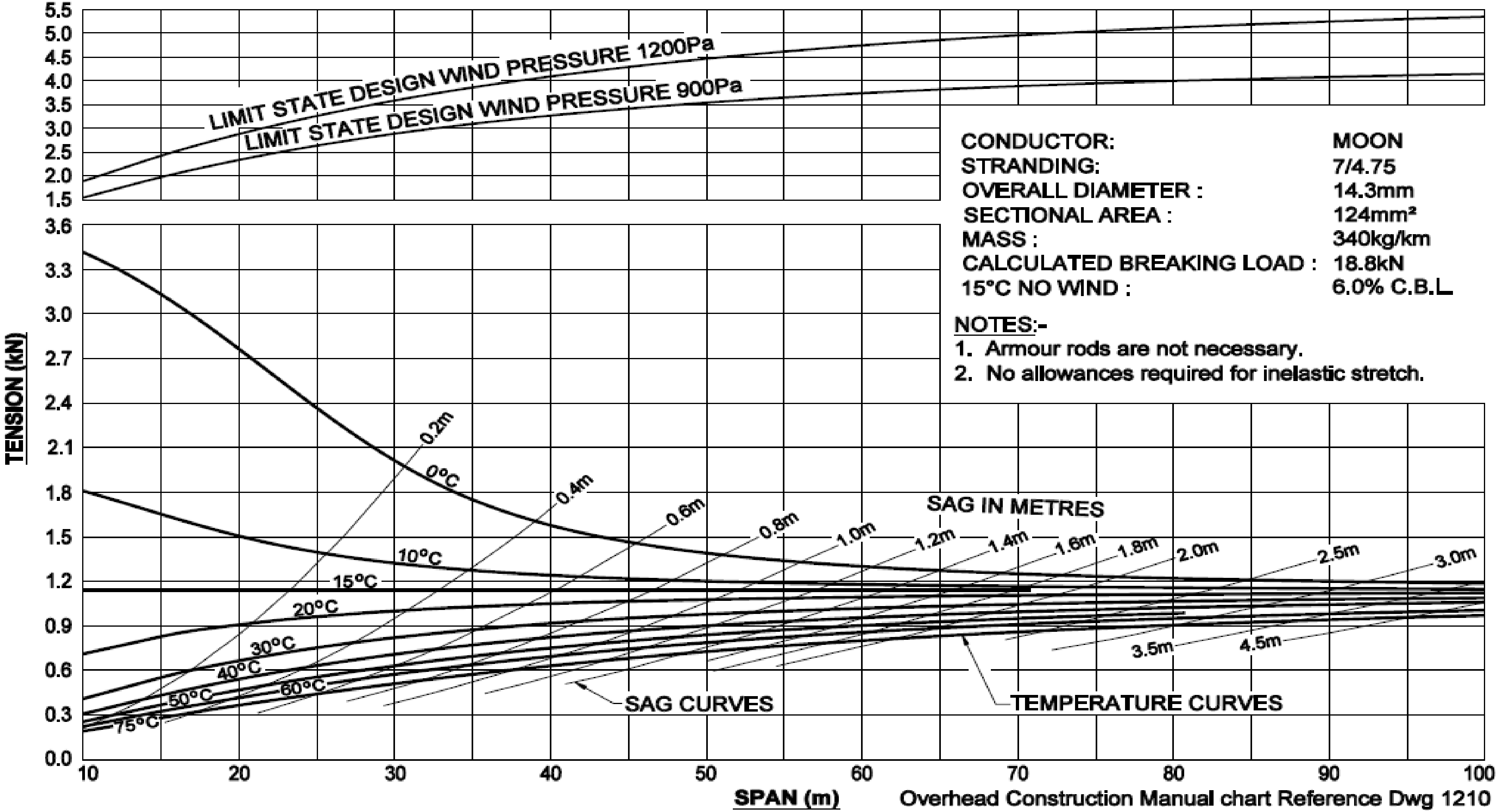
FILE: 5 33 3156 1 | Dwg 3156 Sh | C



Overhead Construction Manual chart Reference Dwg 1210

A	ORIGINAL ISSUE	APPROVED	C. Noel	DISTRIBUTION DESIGN - OVERHEAD
B	01.03.02	DATE	25.6.01	STRINGING CHARTS
C	30.11.11	PASSED	C. Avenell	URBAN 'MARS' 7/3.75 A.A.C. ≈ 6% C.B.L. 900Pa AND 1200Pa WIND
		DRAWN	L. Burton	FILE: 5 33 3159 1 — Dwg 3159 Sh — C

Ergon Energy Corporation Ltd
ABN 50 087 646 062



CONDUCTOR: MOON
STRANDING: 7/4.75
OVERALL DIAMETER : 14.3mm
SECTIONAL AREA : 124mm²
MASS : 340kg/km
CALCULATED BREAKING LOAD : 18.8kN
15°C NO WIND : 6.0% C.B.L.

NOTES:-

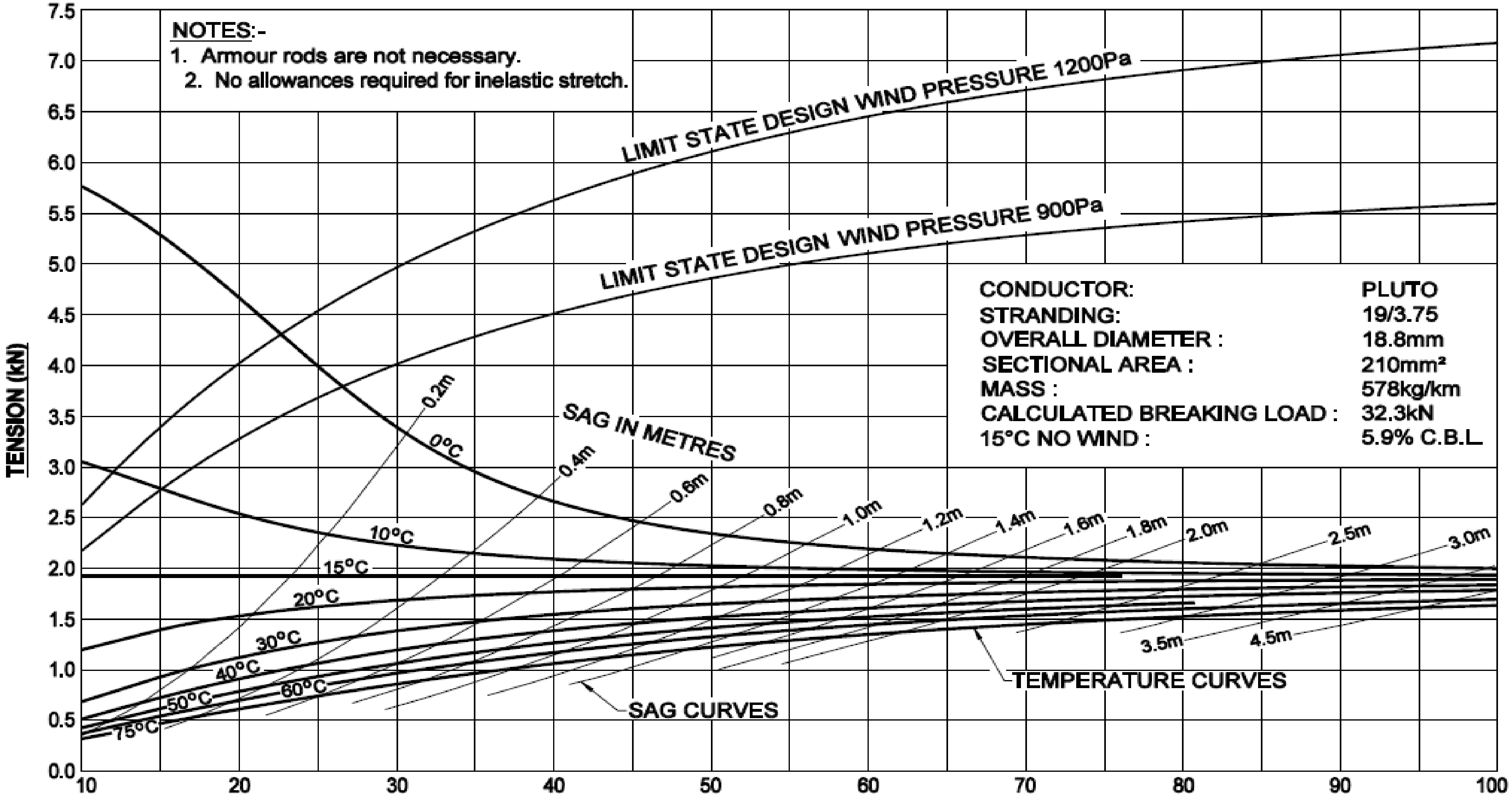
1. Armour rods are not necessary.
2. No allowances required for inelastic stretch.

Overhead Construction Manual chart Reference Dwg 1210

A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED	C. Noel
B	01.03.02		DATE	25.6.01
C	30.11.11		PASSED	C. Avenell
			DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
URBAN 'MOON' 7/4.75 A.A.C.
6% C.B.L. 900Pa AND 1200Pa WIND

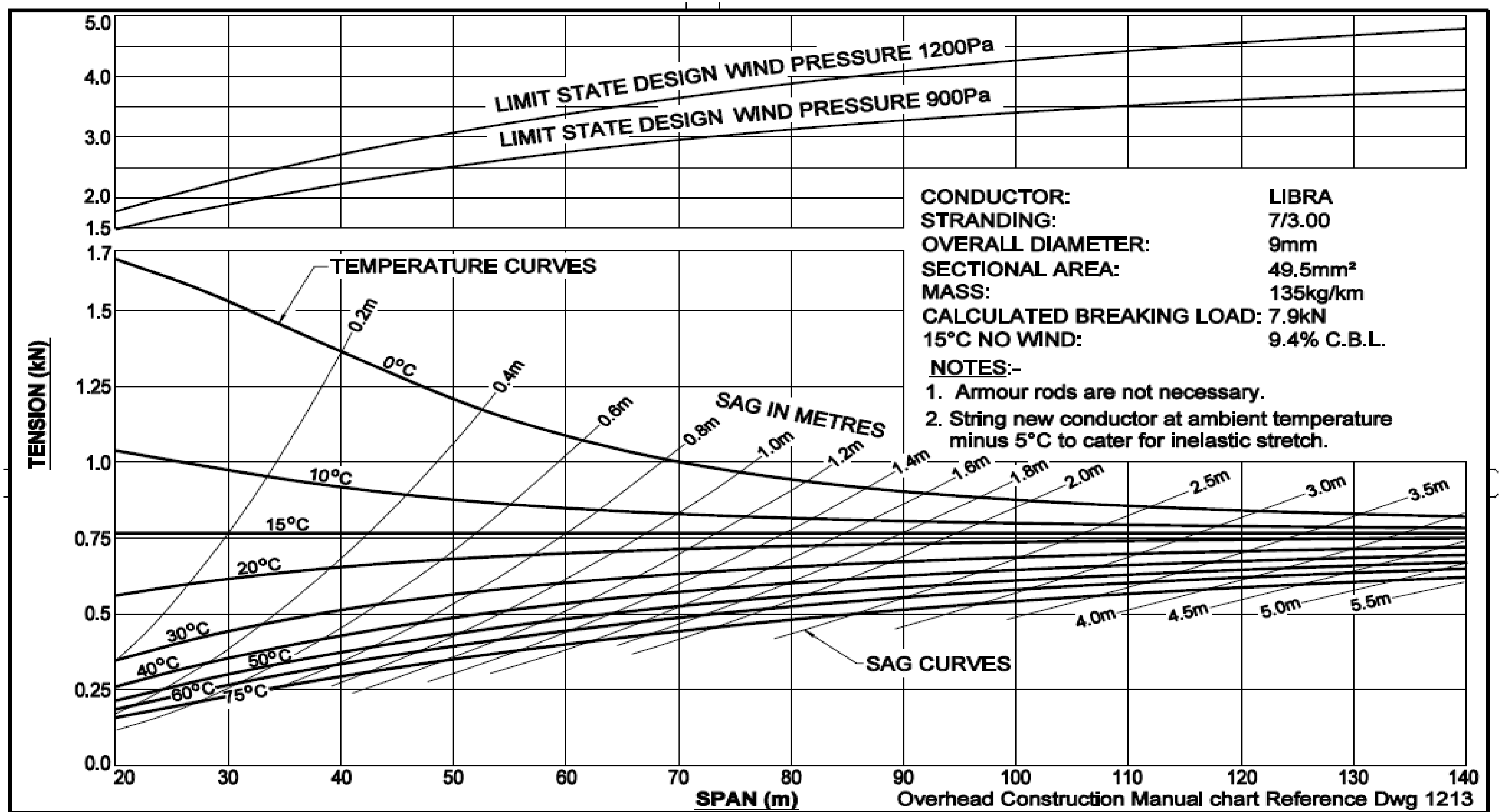
FILE: 5 33 3162 1 — Dwg 3162 Sh C



Overhead Construction Manual chart Reference Dwg 1210

A	ORIGINAL ISSUE	APPROVED	C. Noel	**DISTRIBUTION DESIGN - OVERHEAD** STRINGING CHARTS URBAN 'PLUTO' 19/3.75 A.A.C. ≈ 6% C.B.L. 900Pa AND 1200Pa WIND
B	01.03.02	DATE	25.6.01	
C	30.11.11	PASSED	C. Avenell	
		DRAWN	L. Burton	FILE: 5 33 3165 1 — Dwg 3165 Sh — C

Ergon Energy Corporation Ltd
ABN 50 087 646 062



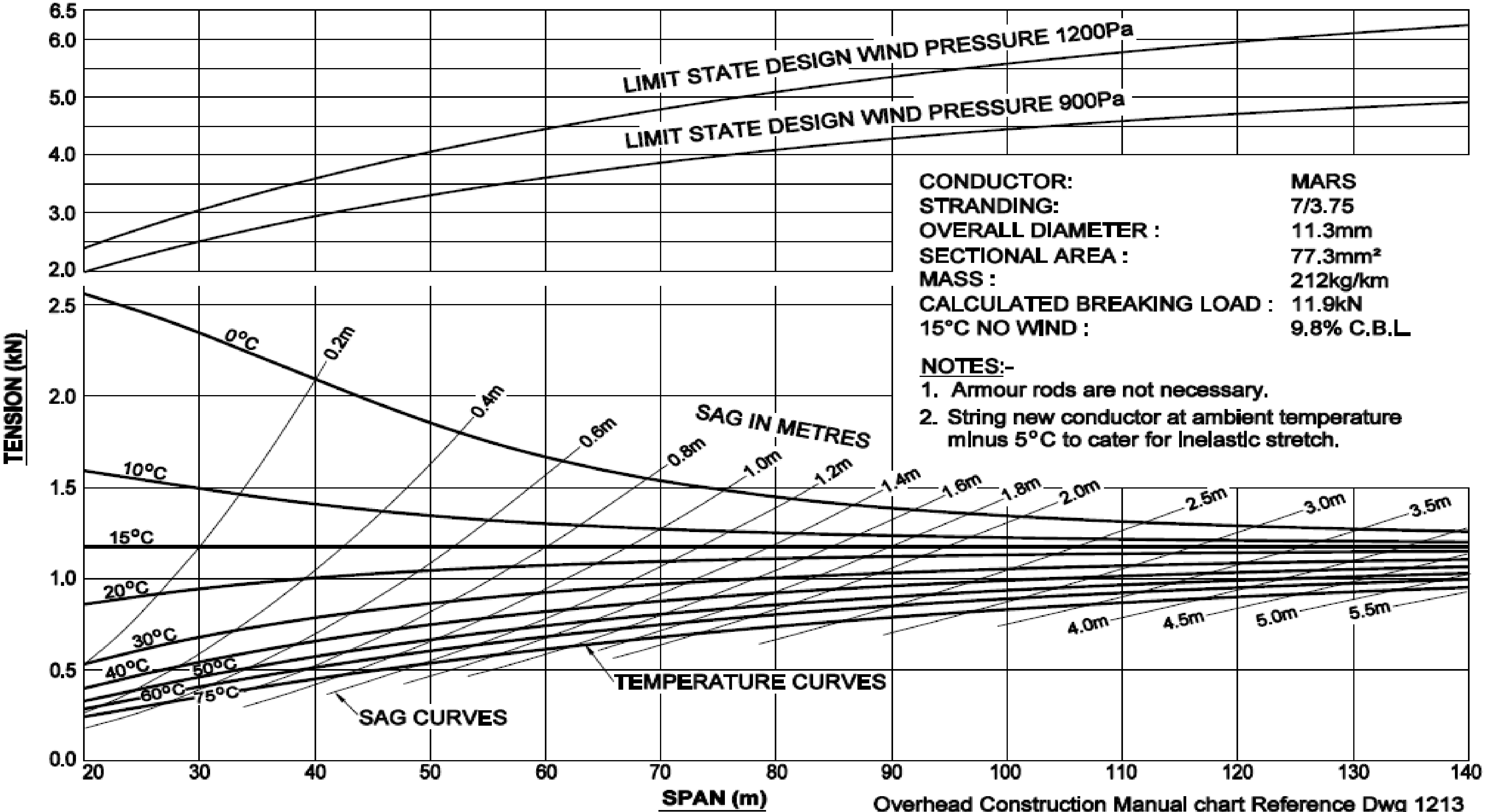
A	ORIGINAL ISSUE
B	01.03.02
C	30.11.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	25.6.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
SEMI-URBAN 'LIBRA' 7/3.00 A.A.C.
≈ 10% C.B.L. 900Pa AND 1200Pa WIND

FILE: 5 33 3038 1 | Dwg 3038 Sh | C



CONDUCTOR:	MARS
STRANDING:	7/3.75
OVERALL DIAMETER :	11.3mm
SECTIONAL AREA :	77.3mm²
MASS :	212kg/km
CALCULATED BREAKING LOAD :	11.9kN
15°C NO WIND :	9.8% C.B.L.

NOTES:-

1. Armour rods are not necessary.
2. String new conductor at ambient temperature minus 5°C to cater for inelastic stretch.

Overhead Construction Manual chart Reference Dwg 1213

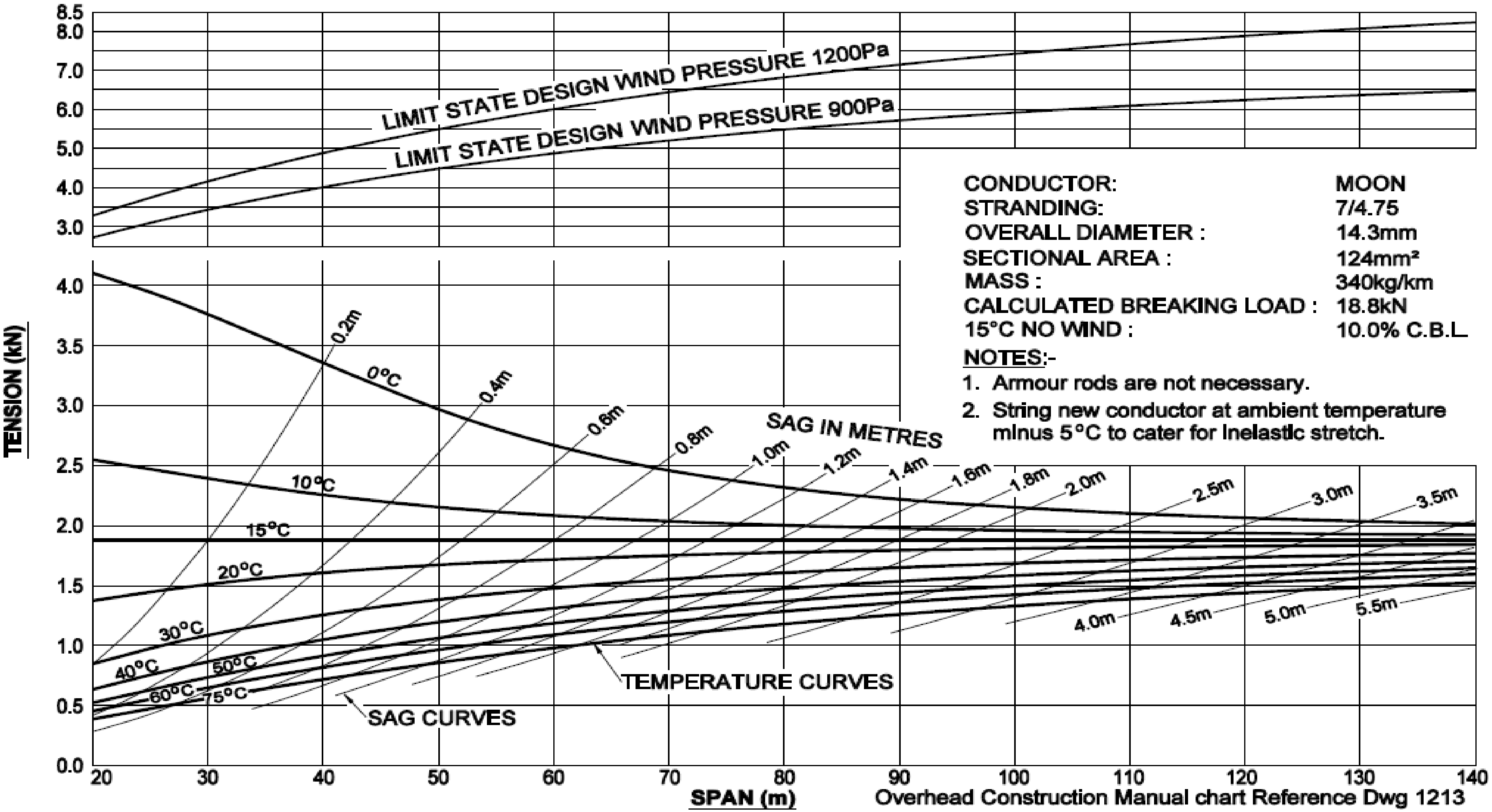
A	ORIGINAL ISSUE
B	01.03.02
C	30.11.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	22.6.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
SEMI-URBAN 'MARS' 7/3.75 A.A.C.
≈ 10% C.B.L. 900Pa AND 1200Pa WIND

FILE: 5 33 3157 1 | Dwg 3157 Sh | C



CONDUCTOR: MOON
STRANDING: 7/4.75
OVERALL DIAMETER : 14.3mm
SECTIONAL AREA : 124mm²
MASS : 340kg/km
CALCULATED BREAKING LOAD : 18.8kN
15°C NO WIND : 10.0% C.B.L.

NOTES:-

1. Armour rods are not necessary.
2. String new conductor at ambient temperature minus 5°C to cater for inelastic stretch.

Overhead Construction Manual chart Reference Dwg 1213

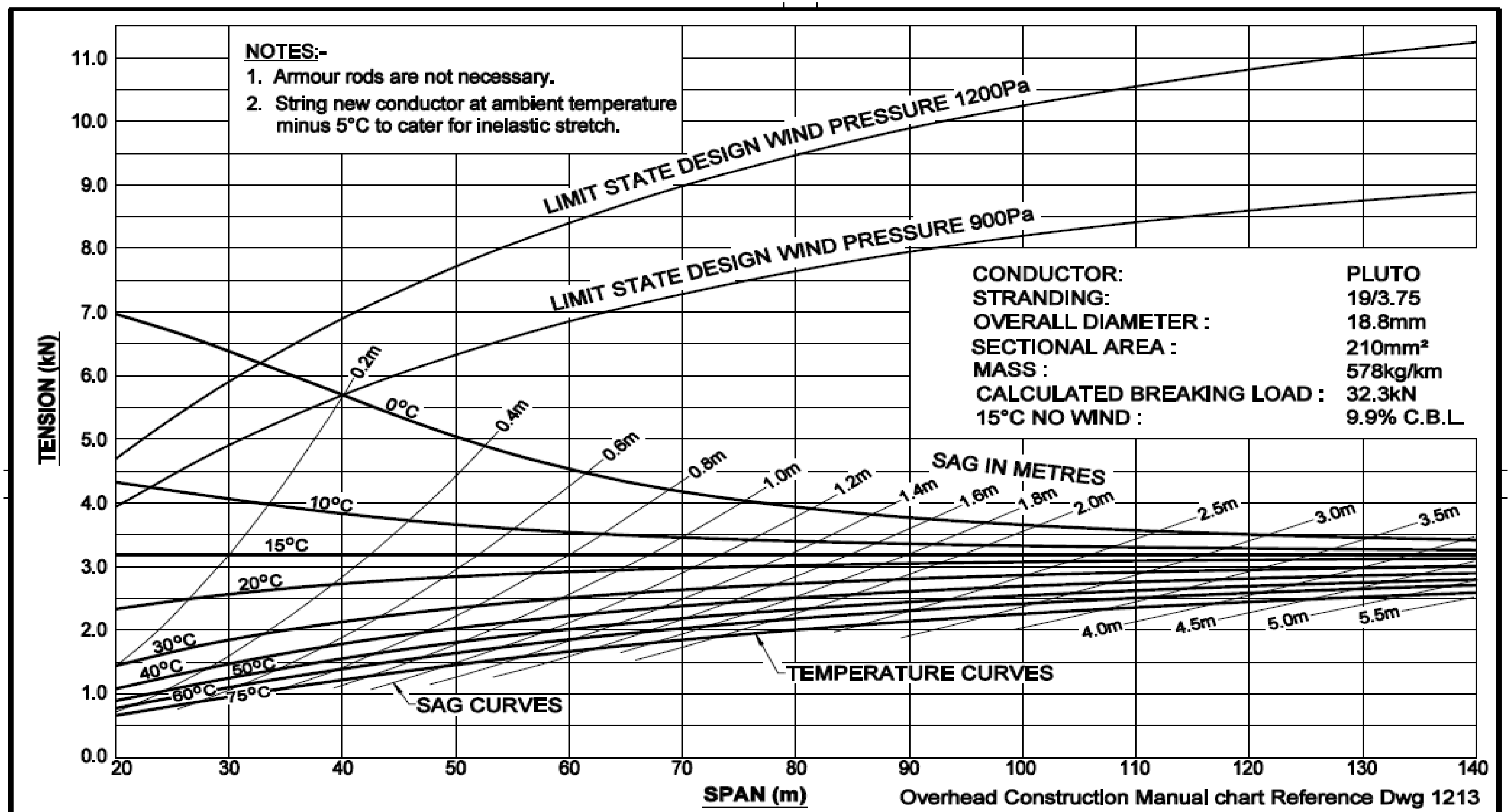
A	ORIGINAL ISSUE
B	01.03.02
C	30.11.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	26.6.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
SEMI-URBAN 'MOON' 7/4.75 A.A.C.
≈ 10% C.B.L. 900Pa AND 1200Pa WIND

FILE: 5 33 3160 1 | Dwg 3160 Sh | C



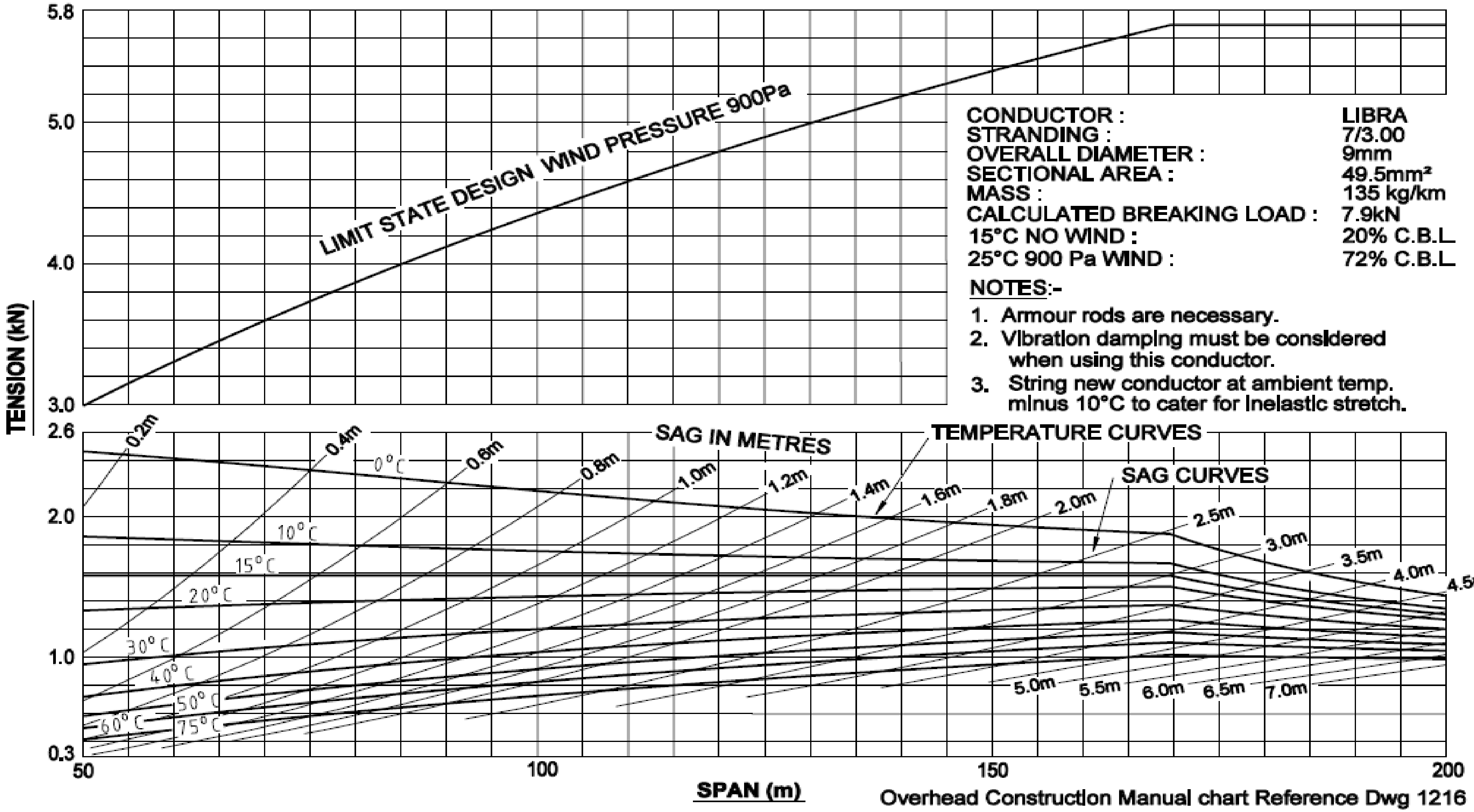
A	ORIGINAL ISSUE
B	01.03.02
C	30.11.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	25.6.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
SEMI-URBAN 'PLUTO' 19/3.75 A.A.C.
≈10% C.B.L. 900Pa AND 1200Pa WIND

FILE: 5 33 3163 1 | Dwg 3163 Sh | C



CONDUCTOR :	LIBRA
STRANDING :	7/3.00
OVERALL DIAMETER :	9mm
SECTIONAL AREA :	49.5mm²
MASS :	135 kg/km
CALCULATED BREAKING LOAD :	7.9kN
15°C NO WIND :	20% C.B.L
25°C 900 Pa WIND :	72% C.B.L

NOTES:-

1. Armour rods are necessary.
2. Vibration damping must be considered when using this conductor.
3. String new conductor at ambient temp. minus 10°C to cater for inelastic stretch.

Overhead Construction Manual chart Reference Dwg 1216

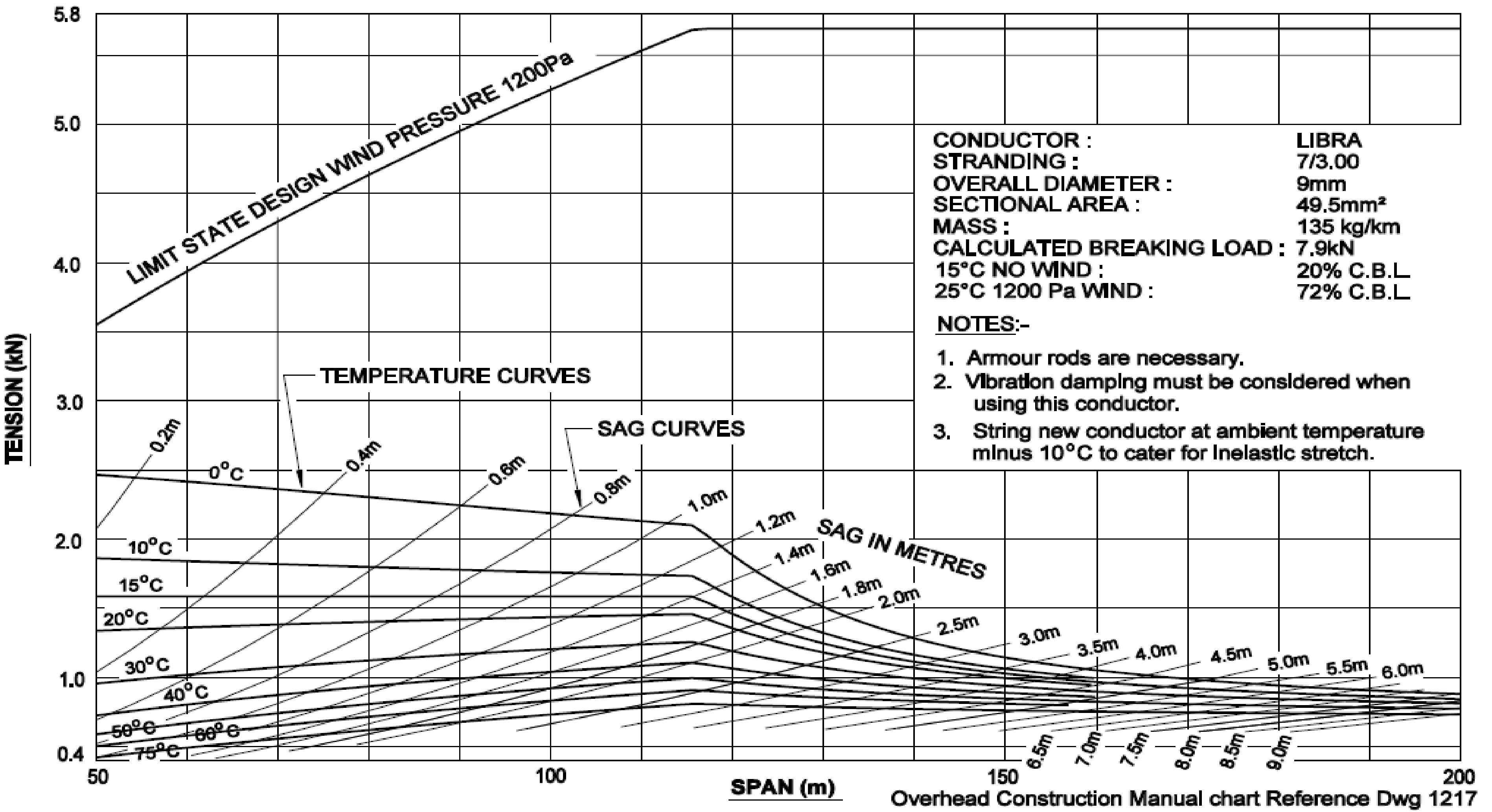
A	ORIGINAL ISSUE
B	01.03.02
C	30.11.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	15.8.00
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 'LIBRA' 7/3.00 AAC
20% C.B.L. - 900 Pa WIND

FILE: 5 33 3002 1 | Dwg 3002 Sh | C

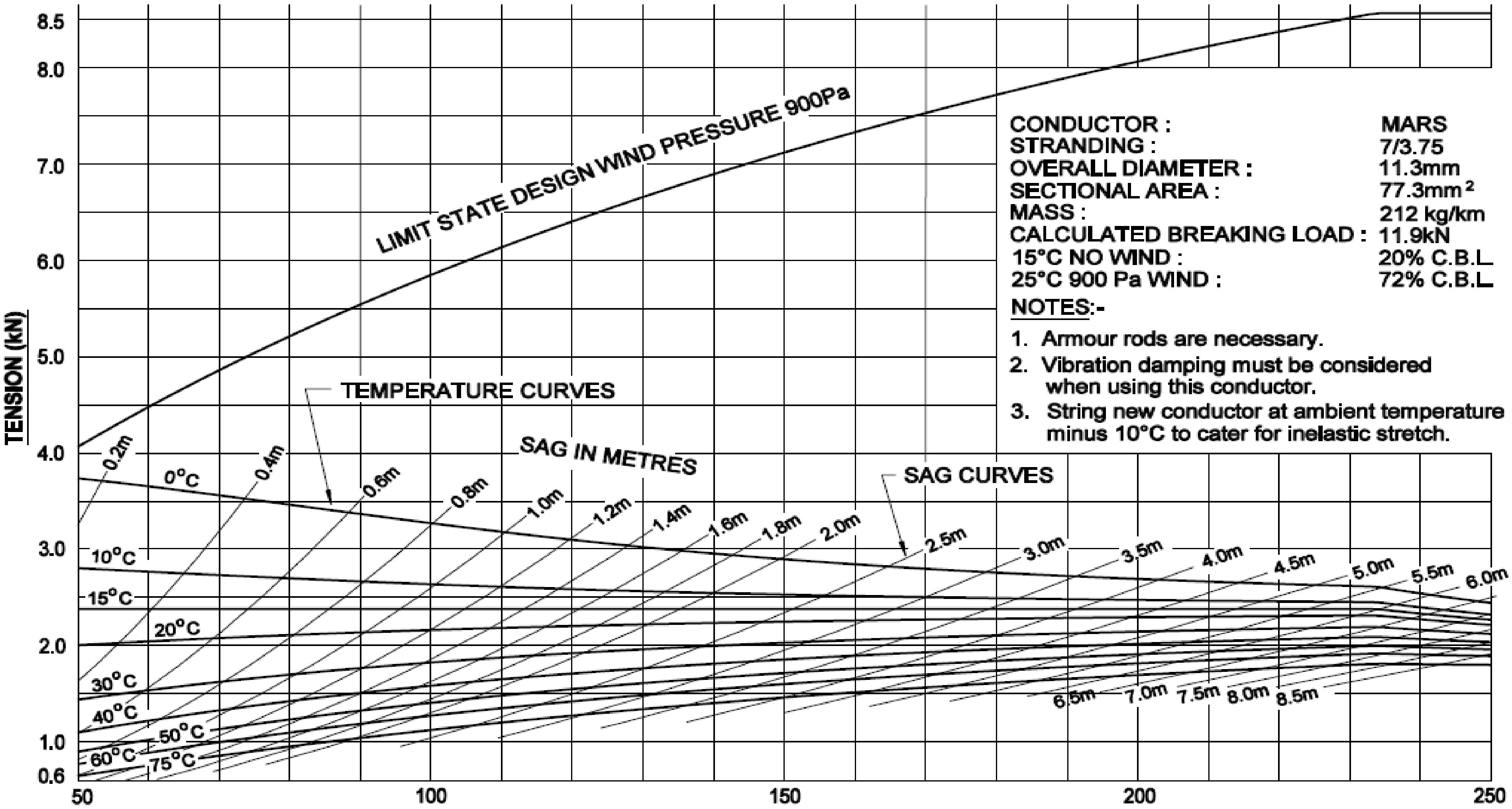


A	ORIGINAL ISSUE	APPROVED	C. Noel
B	01.03.02	DATE	5.3.01
C	30.11.11	PASSED	C. Avenell
		DRAWN	L. Burton

Ergon Energy Corporation Ltd
ABN 50 087 646 062

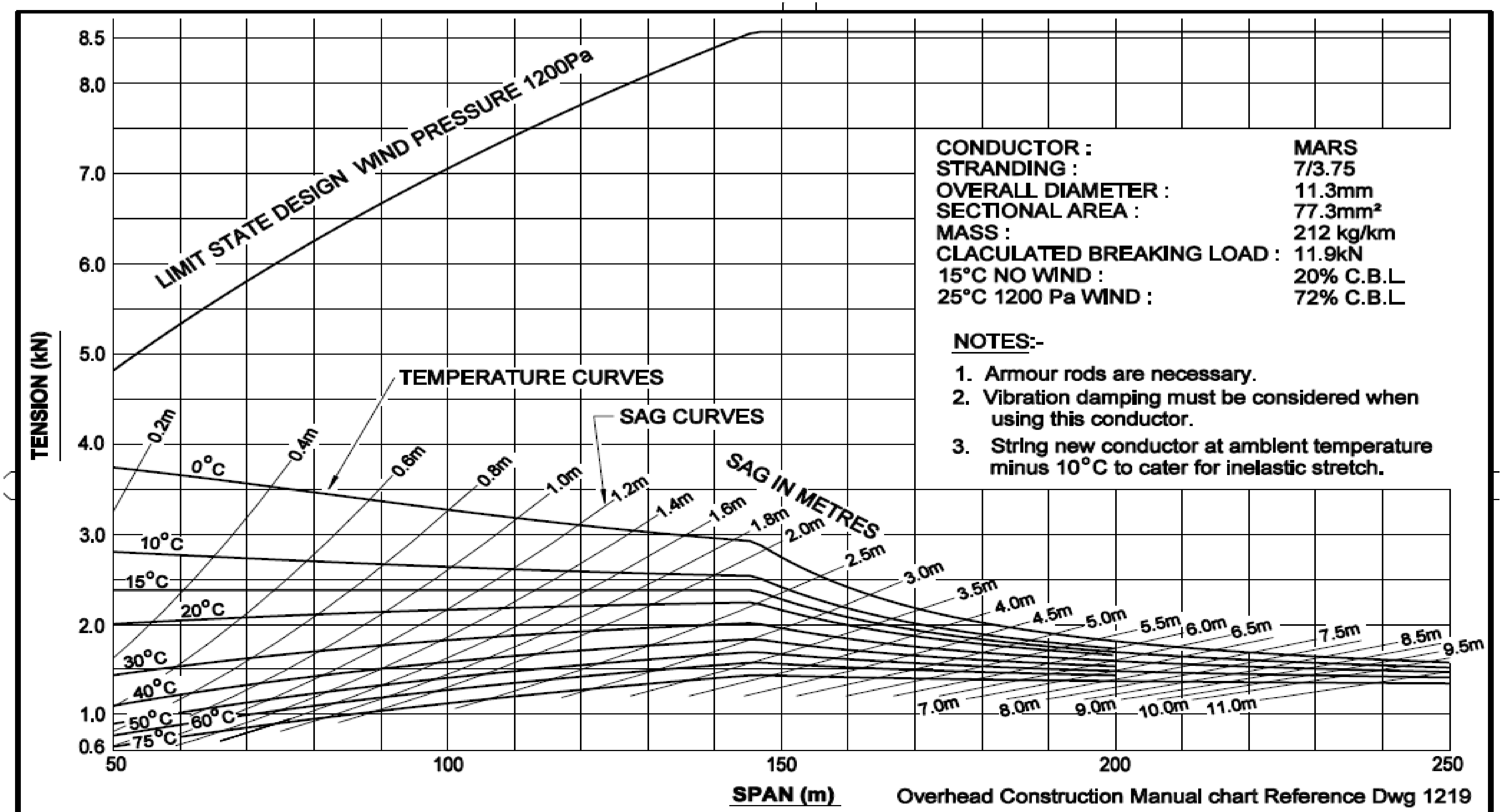
DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 'LIBRA' 7/3.00 AAC
20% C.B.L. - 1200 Pa WIND

FILE: 5 33 3003 1 | Dwg 3003 Sh | C



A	ORIGINAL ISSUE	APPROVED	C. Noel	DISTRIBUTION DESIGN - OVERHEAD STRINGING CHARTS RURAL 'MARS' 7/3.75 AAC 20% C.B.L. - 900 Pa WIND
B	01.03.02	DATE	6.3.01	
C	2.12.11	PASSED	C. Avenell	
		DRAWN	L. Burton	FILE: 5 33 3004 1 — Dwg 3004 Sh — C

Ergon Energy Corporation Ltd
ABN 50 087 646 062



A	ORIGINAL ISSUE	
B	01.03.02	
C	2.12.11	

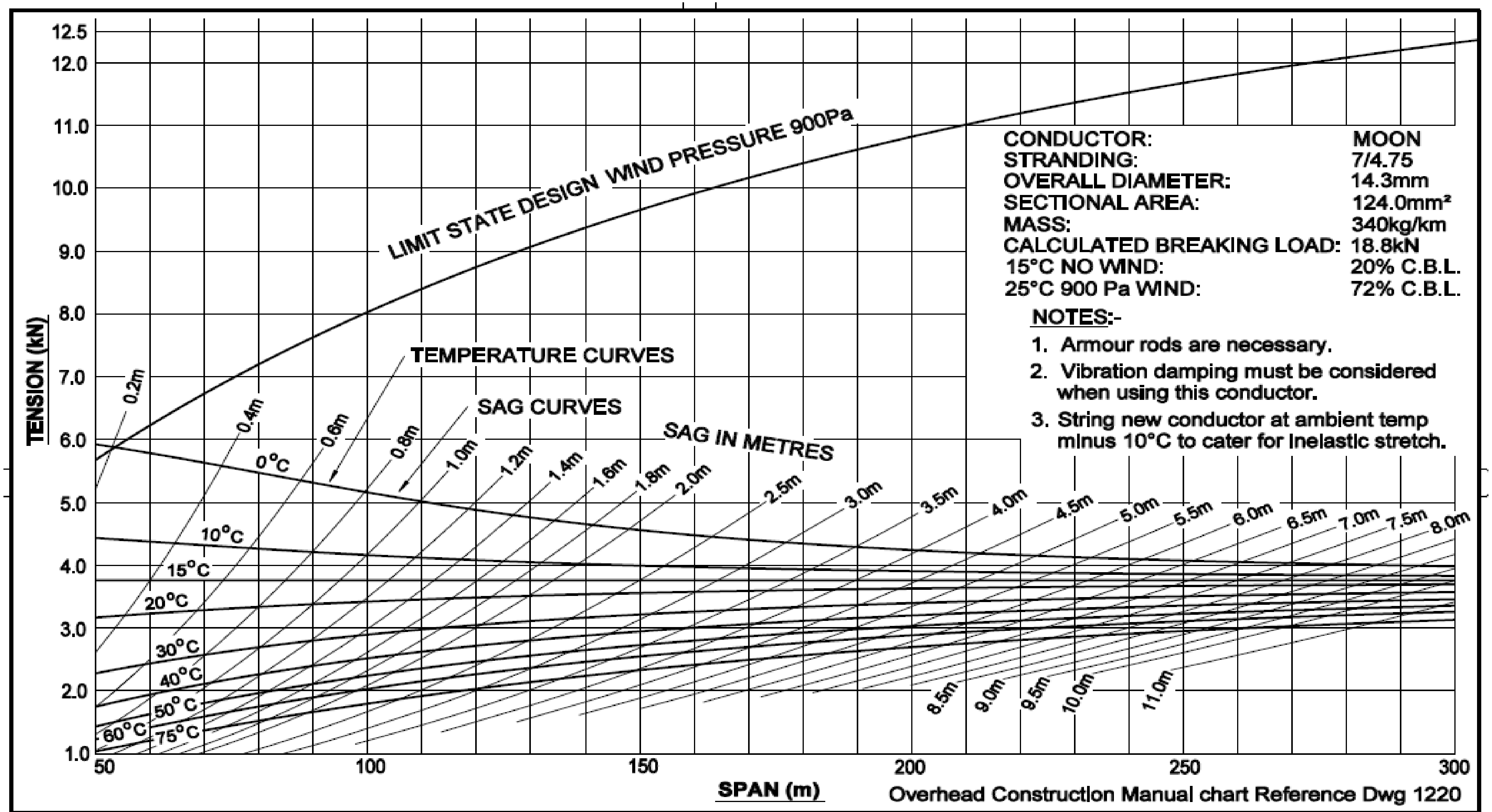
Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	7.3.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD

STRINGING CHARTS
RURAL 'MARS' 7/3.75 AAC
20% C.B.L. - 1200 Pa WIND

FILE: 5 33 3005 1 | Dwg 3005 Sh | C



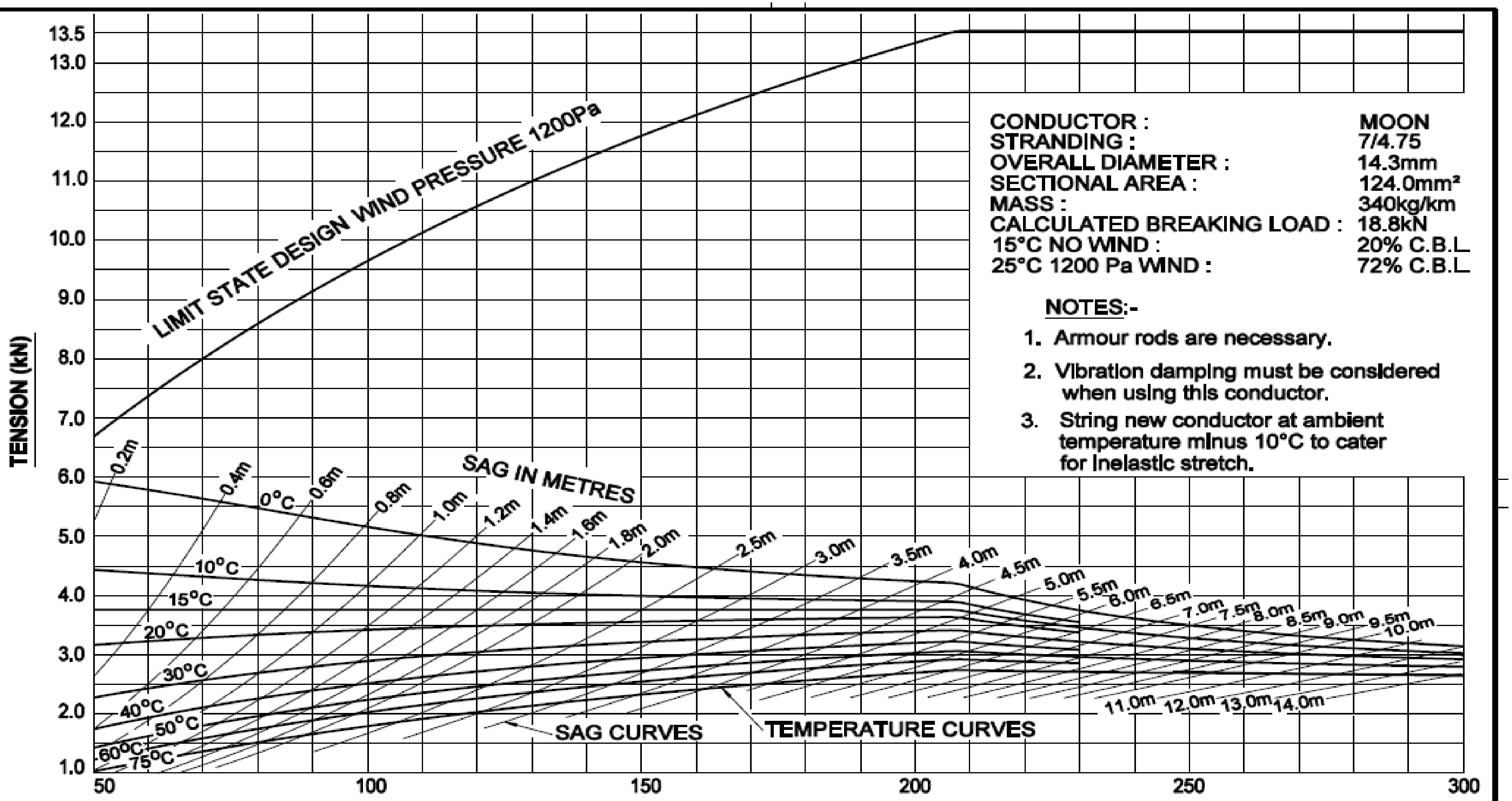
A	ORIGINAL ISSUE
B	01.03.02
C	2.12.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	20.3.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 'MOON' 7/4.75 AAC
20% C.B.L. - 900 Pa WIND

FILE: 5 33 3008 1 | Dwg 3008 Sh | C



CONDUCTOR :	MOON
STRANDING :	7/4.75
OVERALL DIAMETER :	14.3mm
SECTIONAL AREA :	124.0mm²
MASS :	340kg/km
CALCULATED BREAKING LOAD :	18.8kN
15°C NO WIND :	20% C.B.L.
25°C 1200 Pa WIND :	72% C.B.L.

NOTES:-

1. Armour rods are necessary.
2. Vibration damping must be considered when using this conductor.
3. String new conductor at ambient temperature minus 10°C to cater for inelastic stretch.

Overhead Construction Manual chart Reference Dwg 1221

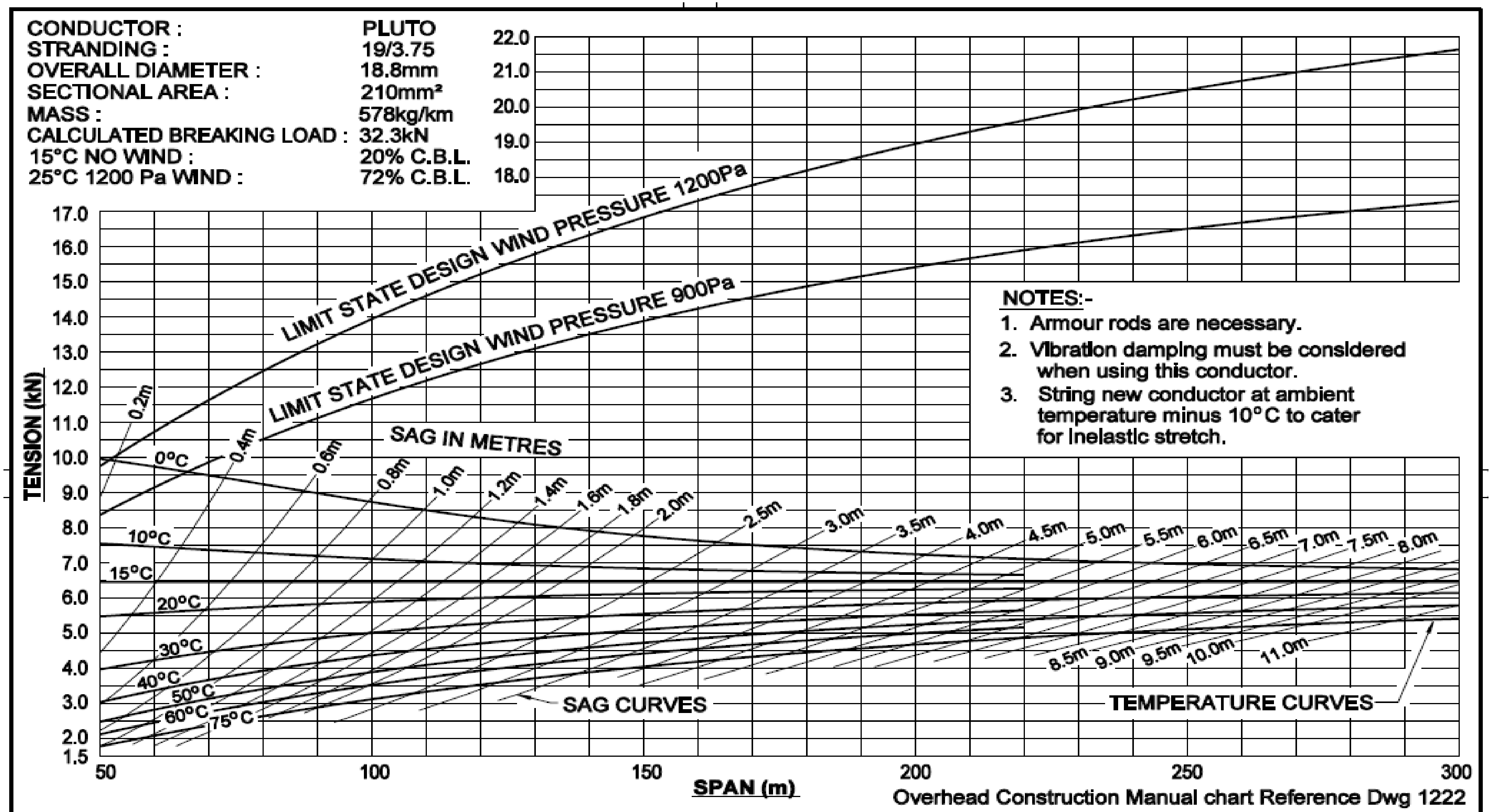
A	ORIGINAL ISSUE
B	01.03.02
C	30.11.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	17.4.01
PASSED	C. Avenell
DRAWN	L. Burton

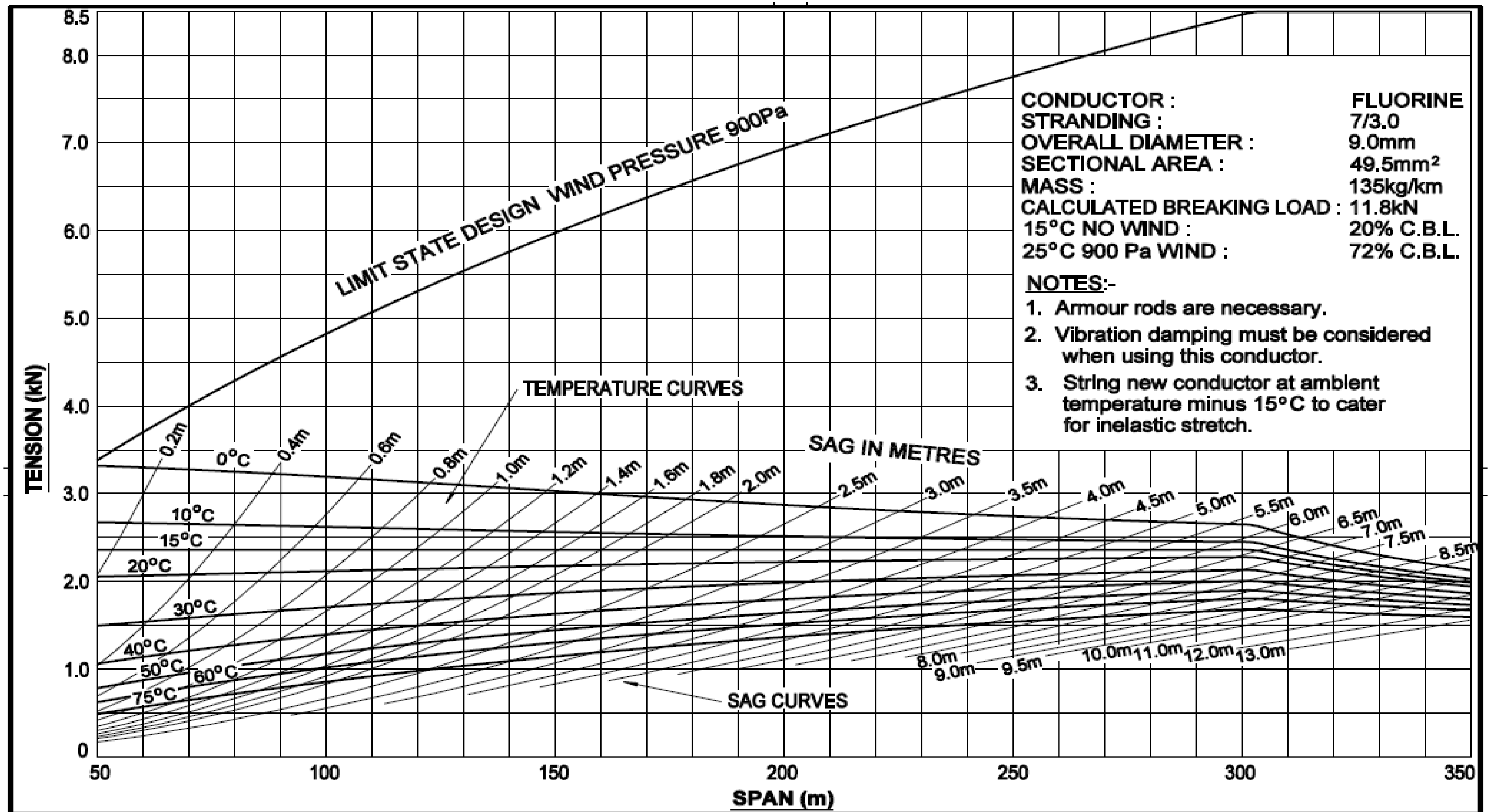
DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 'MOON' 7/4.75 AAC
20% C.B.L. - 1200 Pa WIND

FILE: 5 33 3009 1 | Dwg 3009 Sh | C

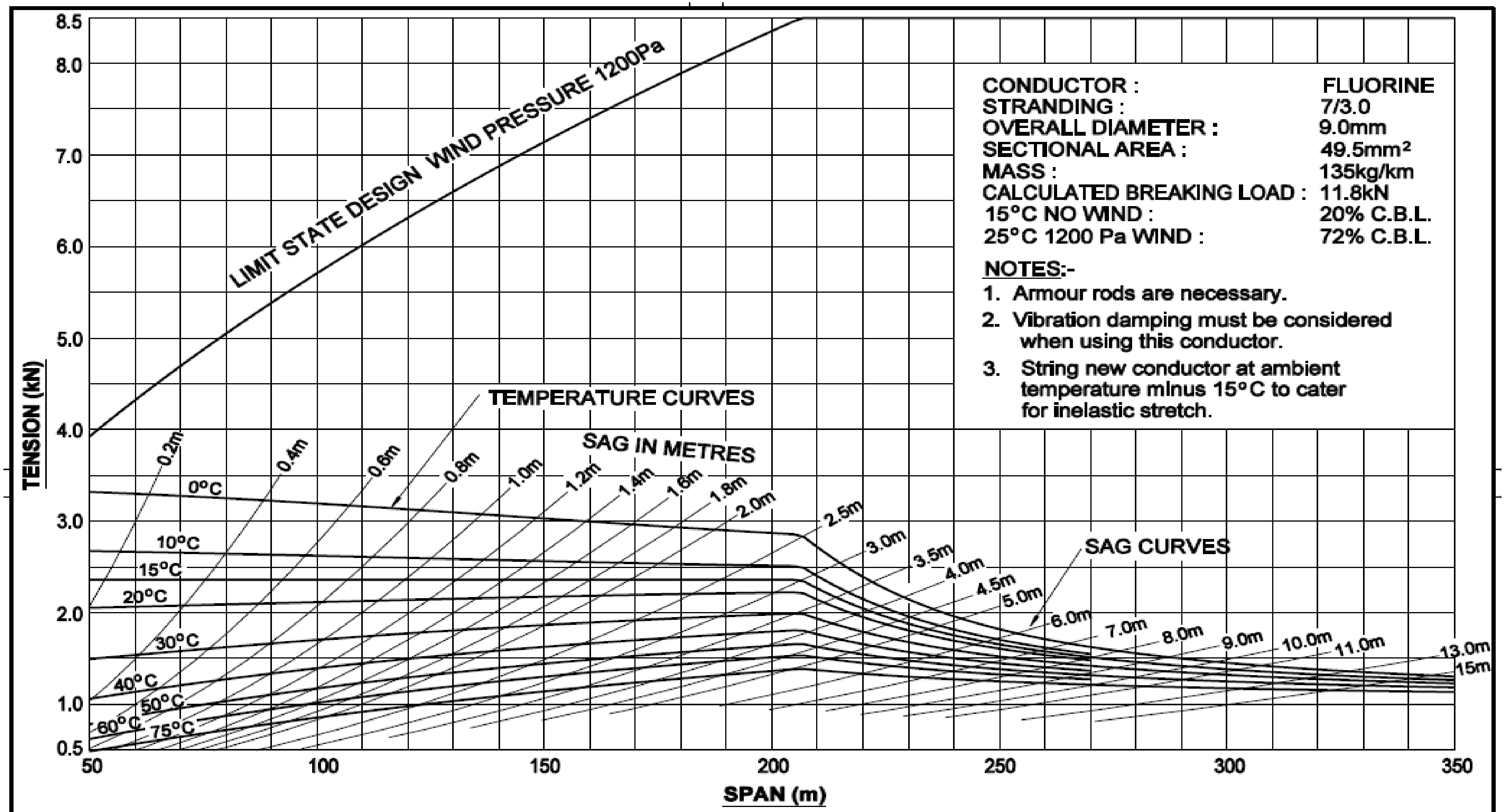


A	ORIGINAL ISSUE	APPROVED	C. Noel	**DISTRIBUTION DESIGN - OVERHEAD** STRINGING CHARTS RURAL 'PLUTO' 19/3.75 AAC 20% C.B.L. - 900 and 1200Pa WIND
B	01.03.02	DATE	17.05.01	
C	30.11.11	PASSED	C. Avenell	
		DRAWN	L. Burton	FILE: 5 33 3031 1 — Dwg 3031 Sh — C

Ergon Energy Corporation Ltd
ABN 50 087 646 062



A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED	C. Noel	**DISTRIBUTION DESIGN - OVERHEAD** STRINGING CHARTS RURAL 'FLUORINE' 7/3.0 AAAC 20% C.B.L. - 900 Pa WIND
B	17.09.04		DATE	13.2.03	
C	30.11.11		PASSED	C. Avenell	
			DRAWN	L. Burton	FILE: 5 33 3166 1 — Dwg 3166 Sh — C

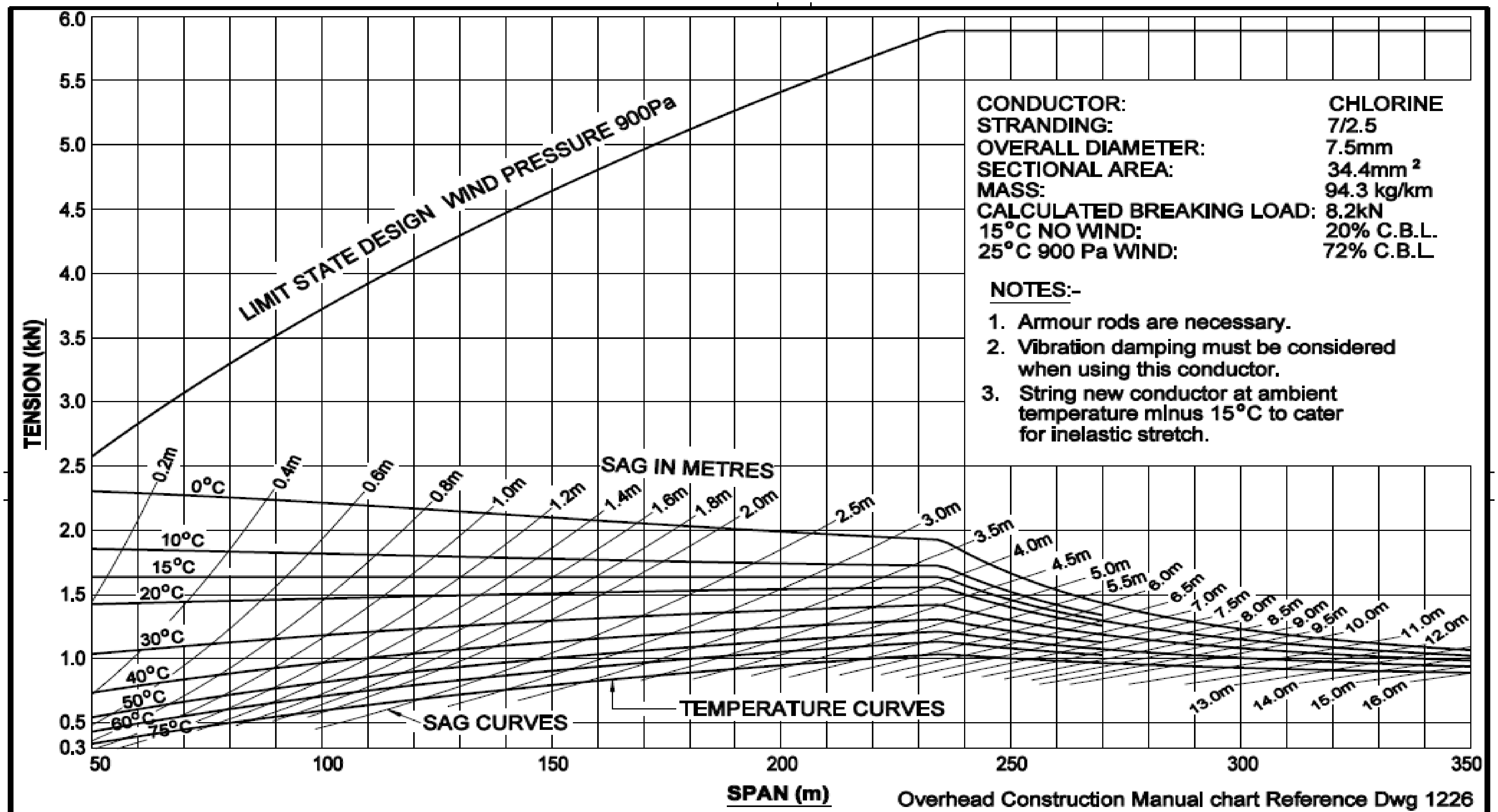


A	ORIGINAL ISSUE	APPROVED	C. Noel
B	30.11.11	DATE	6.2.03
		PASSED	C. Avenell
		DRAWN	L. Burton

Ergon Energy Corporation Ltd
ABN 50 087 646 062

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 'FLUORINE' 7/3.0 AAAC 1120
20% C.B.L. - 1200 Pa WIND

FILE: 5 33 3167 1 | Dwg 3167 Sh | B



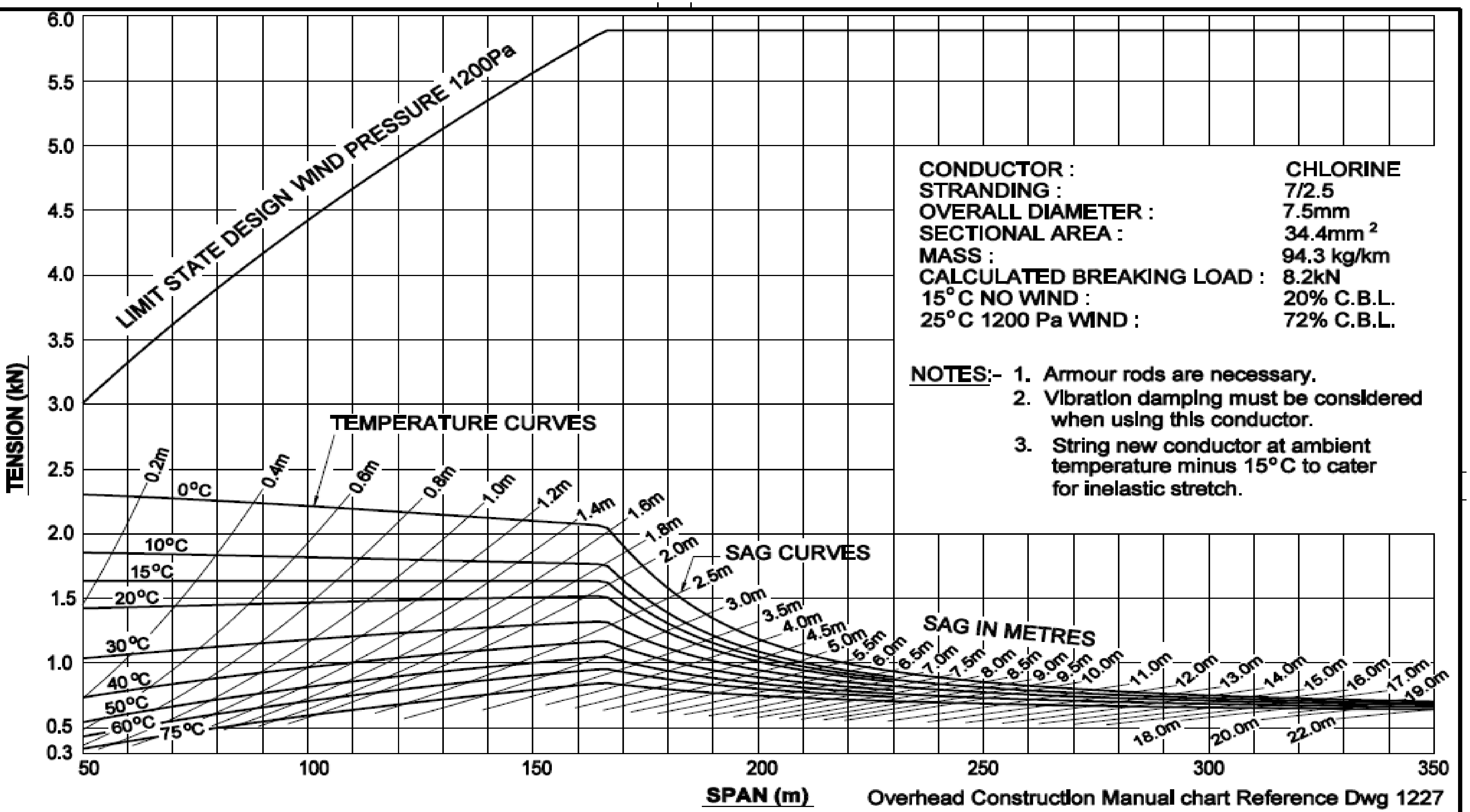
A	ORIGINAL ISSUE
B	01.03.02
C	6.12.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C. Noel
DATE	26.04.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 'CHLORINE' 7/2.5 AAAC
20% C.B.L. - 900 Pa WIND

FILE: 5 33 3012 1 | Dwg 3012 Sh | C



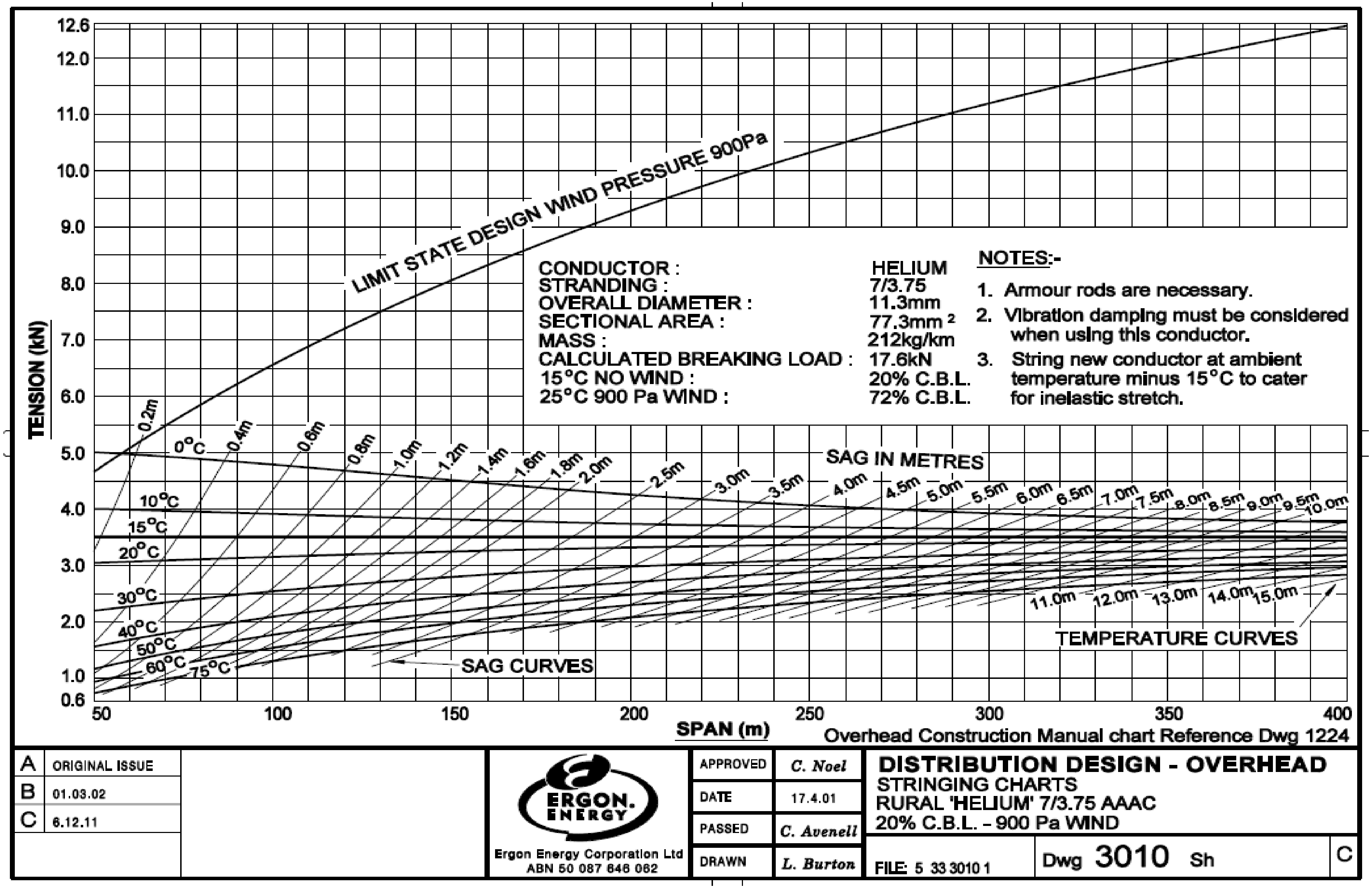
A	ORIGINAL ISSUE	
B	01.03.02	
C	6.12.11	

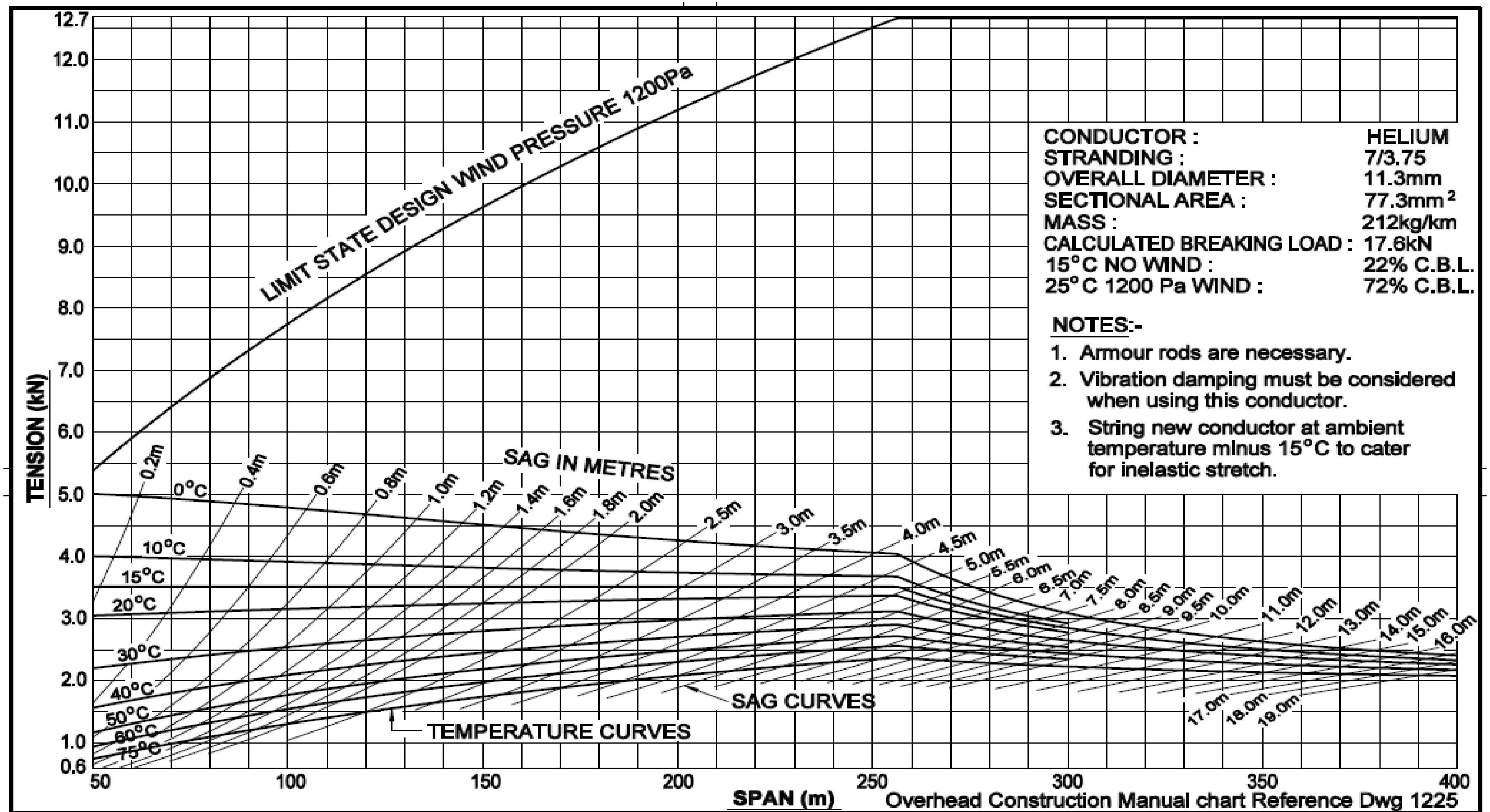
Ergon Energy Corporation Ltd ABN 50 087 646 062

APPROVED	C. Noel
DATE	26.4.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 'CHLORINE' 7/2.5 AAAC
20% C.B.L. - 1200 Pa WIND

FILE: 5 33 3013 1 | Dwg 3013 Sh | C


LIMIT STATE DESIGN WIND PRESSURE 900Pa
TENSION (kN)
12.6
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.6
50
100
150
200
250
300
350
400
SPAN (m)
CONDUCTOR : HELIUM
STRANDING : 7/3.75
OVERALL DIAMETER : 11.3mm
SECTIONAL AREA : 77.3mm 2
MASS : 212kg/km
CALCULATED BREAKING LOAD : 17.6kN
15°C NO WIND : 20% C.B.L.
25°C 900 Pa WIND : 72% C.B.L.
NOTES:-
1. Armour rods are necessary.
2. Vibration damping must be considered when using this conductor.
3. String new conductor at ambient temperature minus 15°C to cater for inelastic stretch.
SAG IN METRES
0.2m
0.4m
0.6m
0.8m
1.0m
1.2m
1.4m
1.6m
1.8m
2.0m
2.5m
3.0m
3.5m
4.0m
4.5m
5.0m
5.5m
6.0m
6.5m
7.0m
7.5m
8.0m
8.5m
9.0m
9.5m
10.0m
11.0m
12.0m
13.0m
14.0m
15.0m
0°C
10°C
15°C
20°C
30°C
40°C
50°C
60°C
75°C
SAG CURVES
TEMPERATURE CURVES
Overhead Construction Manual chart Reference Dwg 1224
A ORIGINAL ISSUE
B 01.03.02
C 6.12.11
ERGON. ENERGY
Ergon Energy Corporation Ltd
ABN 50 087 646 062
APPROVED C. Noel
DATE 17.4.01
PASSED C. Avenell
DRAWN L. Burton
DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 'HELIUM' 7/3.75 AAAC
20% C.B.L. - 900 Pa WIND
FILE: 5 33 3010 1
Dwg 3010 Sh
C

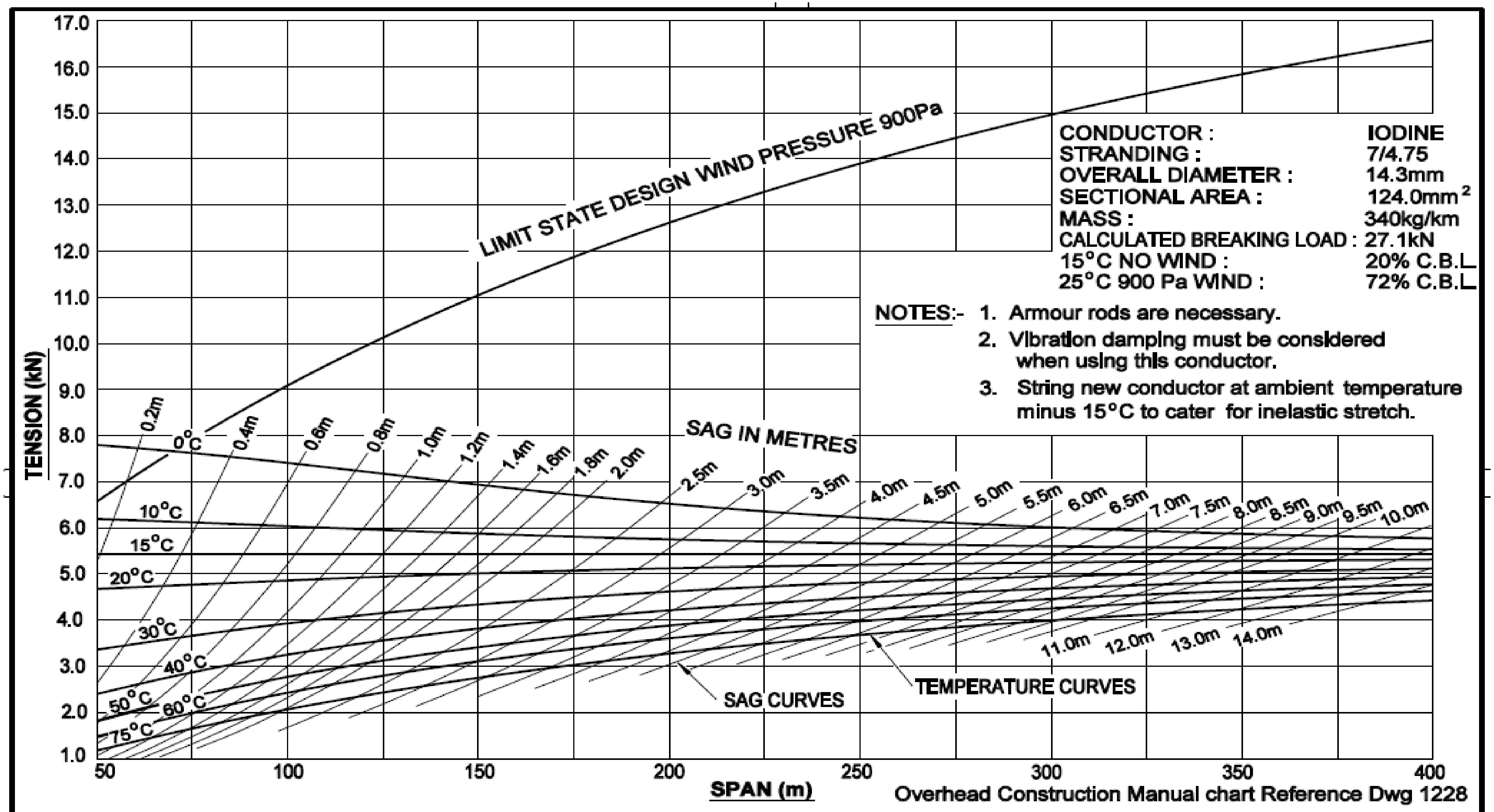


A	ORIGINAL ISSUE	APPROVED	C. Noel
B	01.03.02	DATE	17.4.01
C	6.12.11	PASSED	C. Avenell
		DRAWN	L. Burton

Ergon Energy Corporation Ltd
ABN 50 087 646 062

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 'HELIUM' 7/3.75 AAAC
20% C.B.L. - 1200 Pa WIND

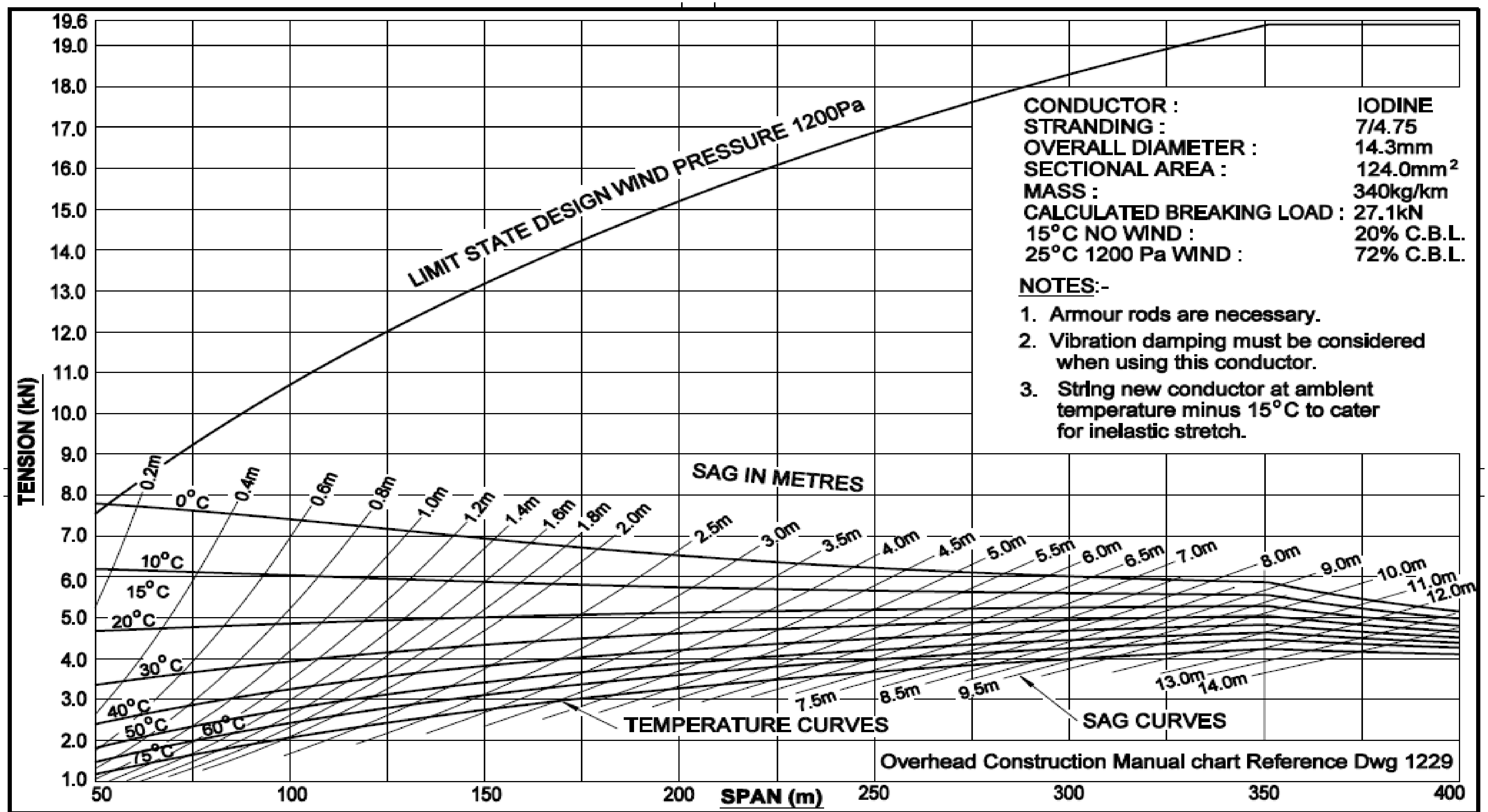
FILE: 5 33 3011 1 | Dwg 3011 Sh | C



A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED	C. Noel
B	01.03.02		DATE	28.02.01
C	6.12.11		PASSED	C. Avenell
			DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 'IODINE' 7/4.75 AAAC
20% C.B.L. - 900 Pa WIND

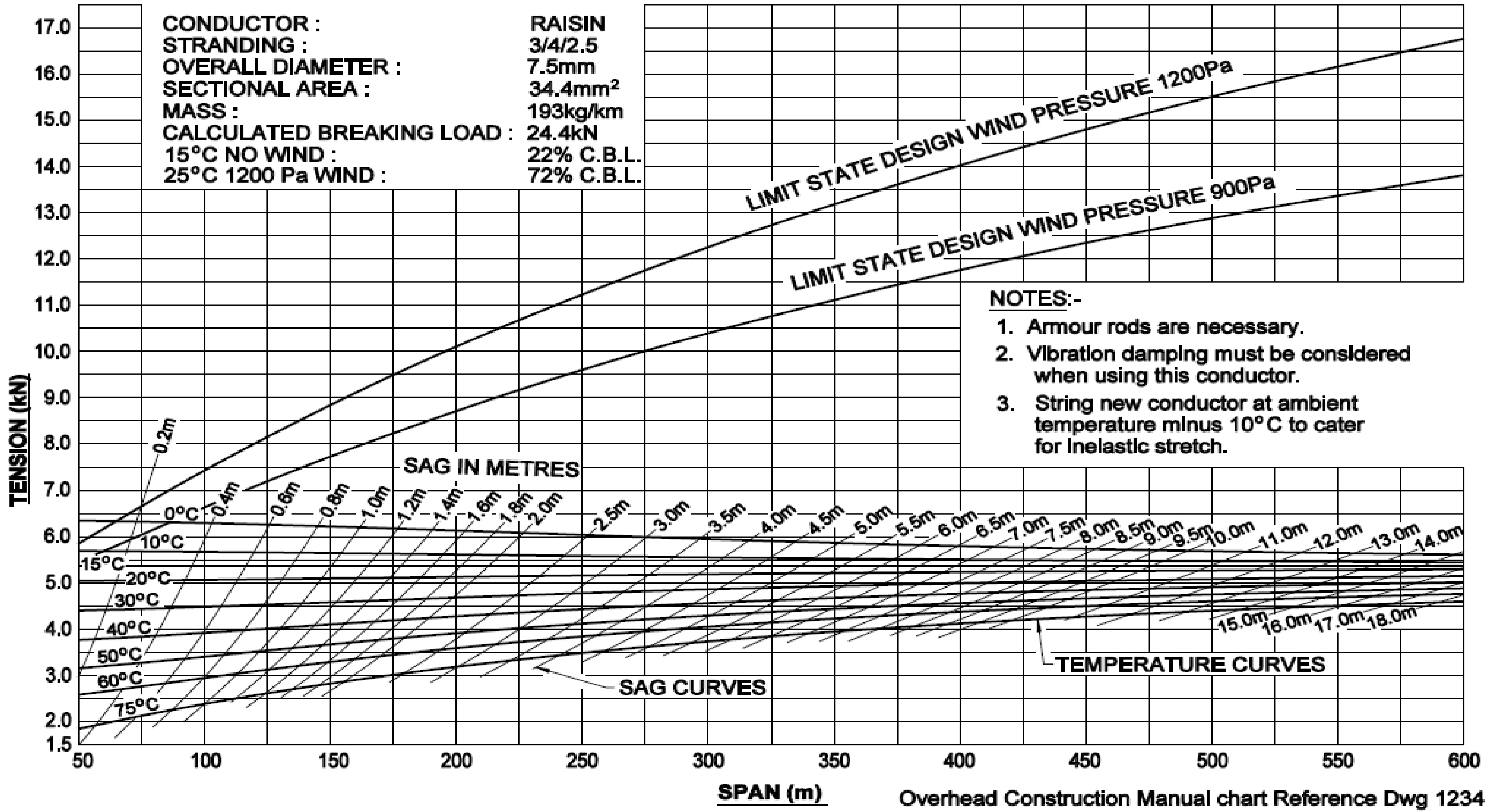
FILE: 5 33 3000 1 | Dwg 3000 Sh | C



A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED	C. Noel
B	01.03.02		DATE	1.3.01
C	6.12.11		PASSED	C. Avenell
			DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 'IODINE' 7/4.75 AAAC
20% C.B.L. - 1200 Pa WIND

FILE: 5 33 3001 1 | Dwg 3001 | Sh | C



Overhead Construction Manual chart Reference Dwg 1234

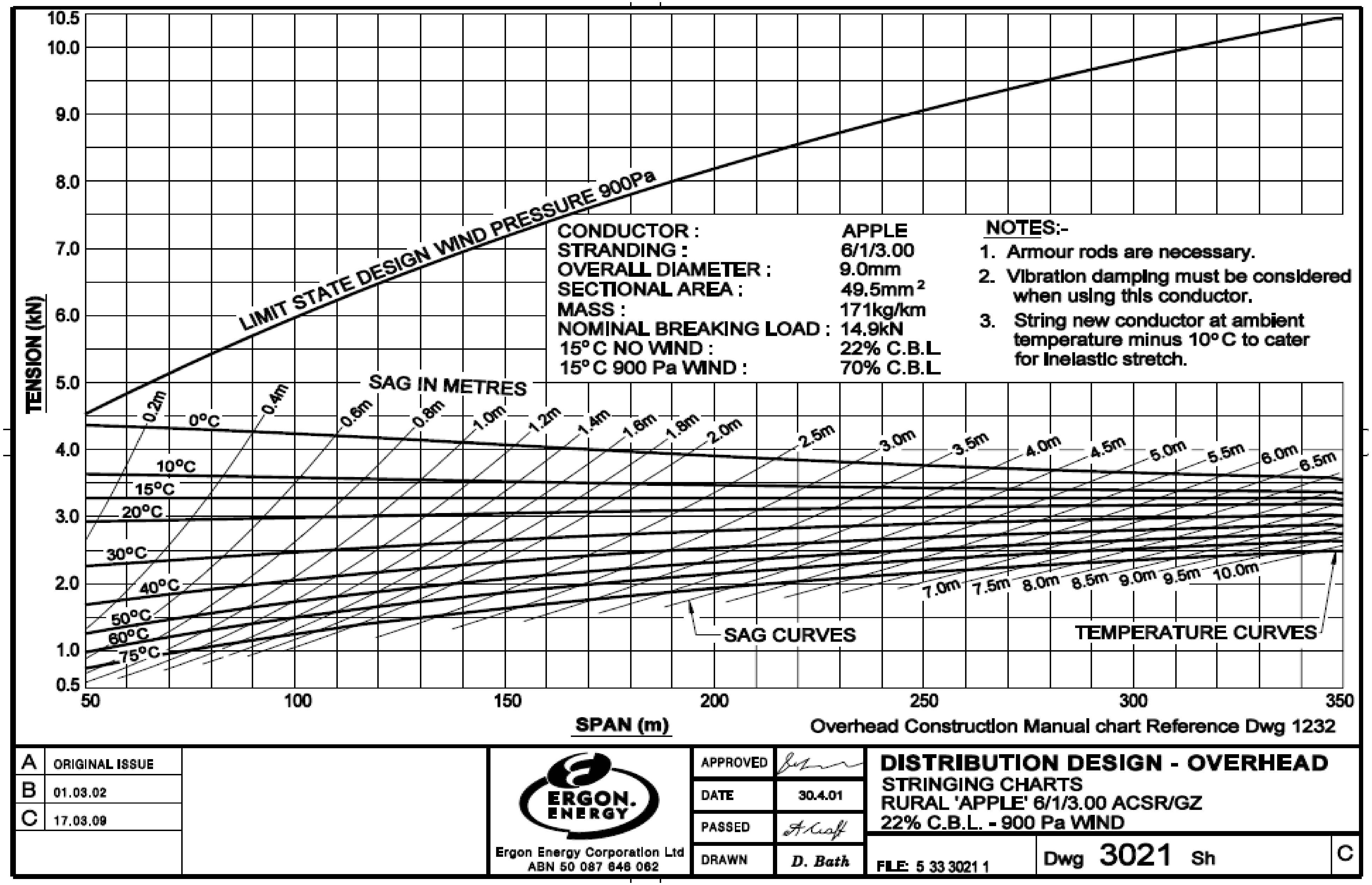
A	ORIGINAL ISSUE
B	01.03.02
C	12.12.11

Ergon Energy Corporation Ltd
ABN 50 087 646 062

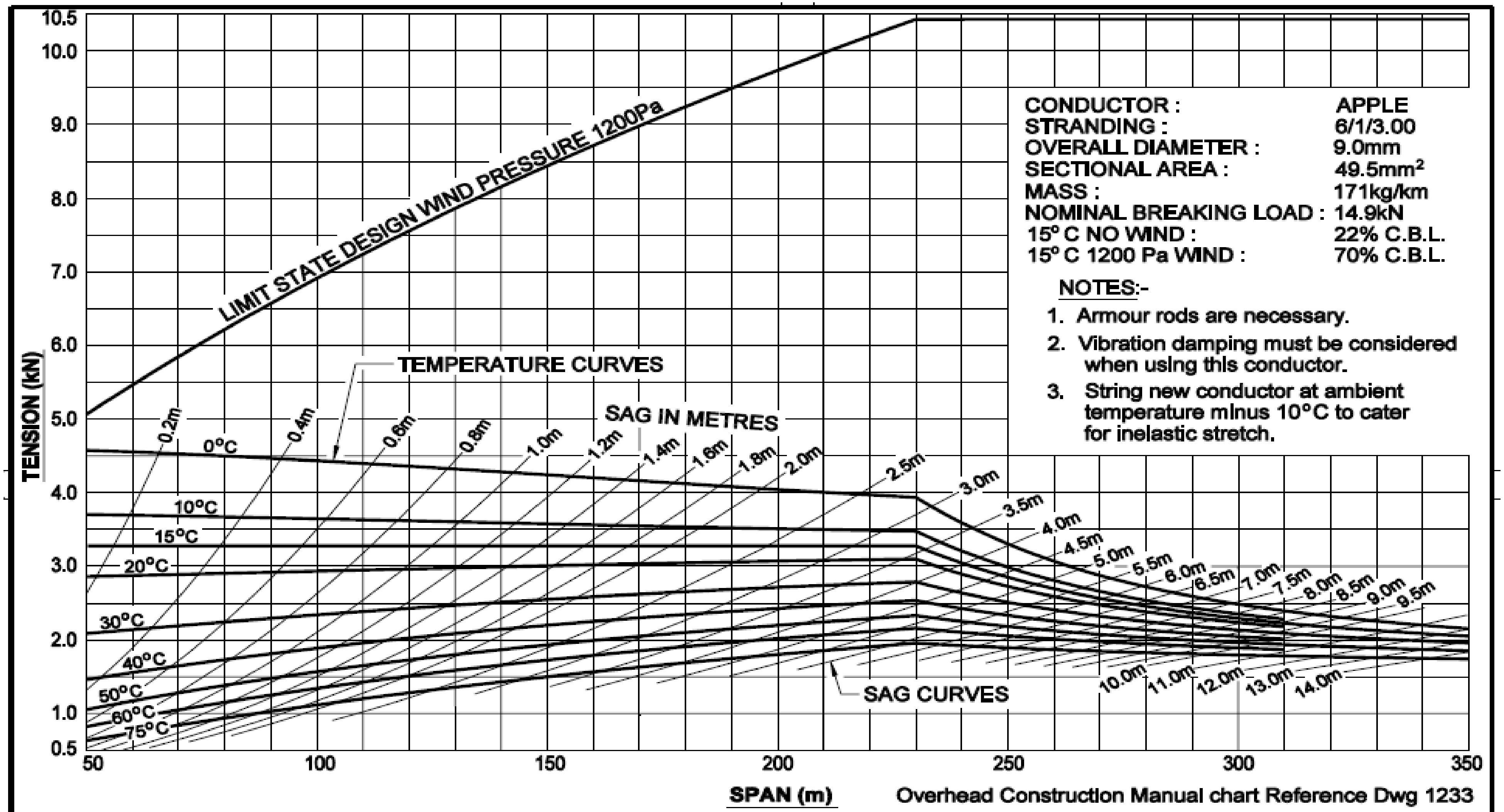
APPROVED	C. Noel
DATE	17.05.01
PASSED	C. Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 'RAISIN' 3/4/2.5 ACSR/GZ
22% C.B.L. - 900 AND 1200 Pa WIND

FILE: 5 33 3032 1 | Dwg 3032 Sh | C

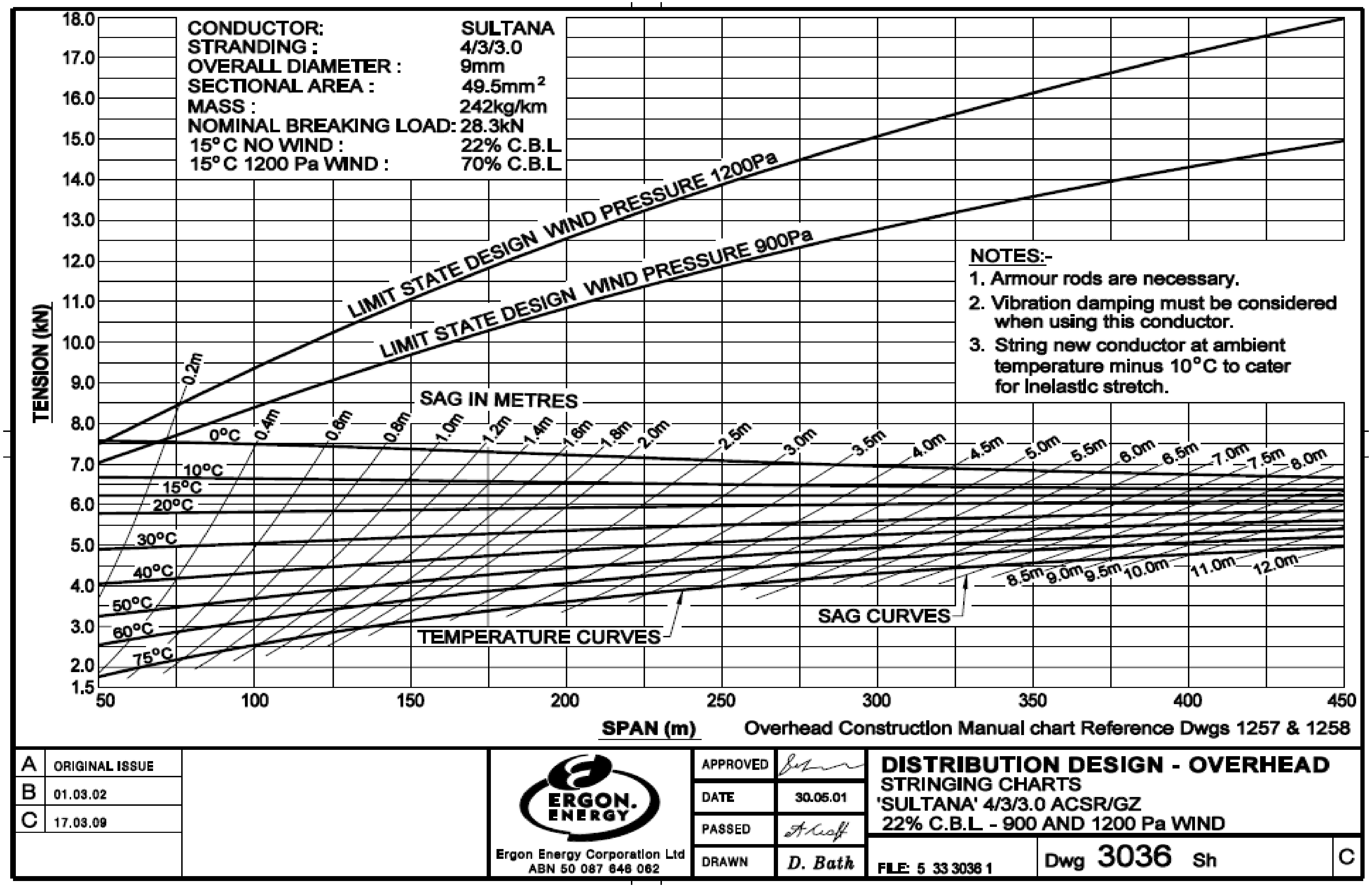


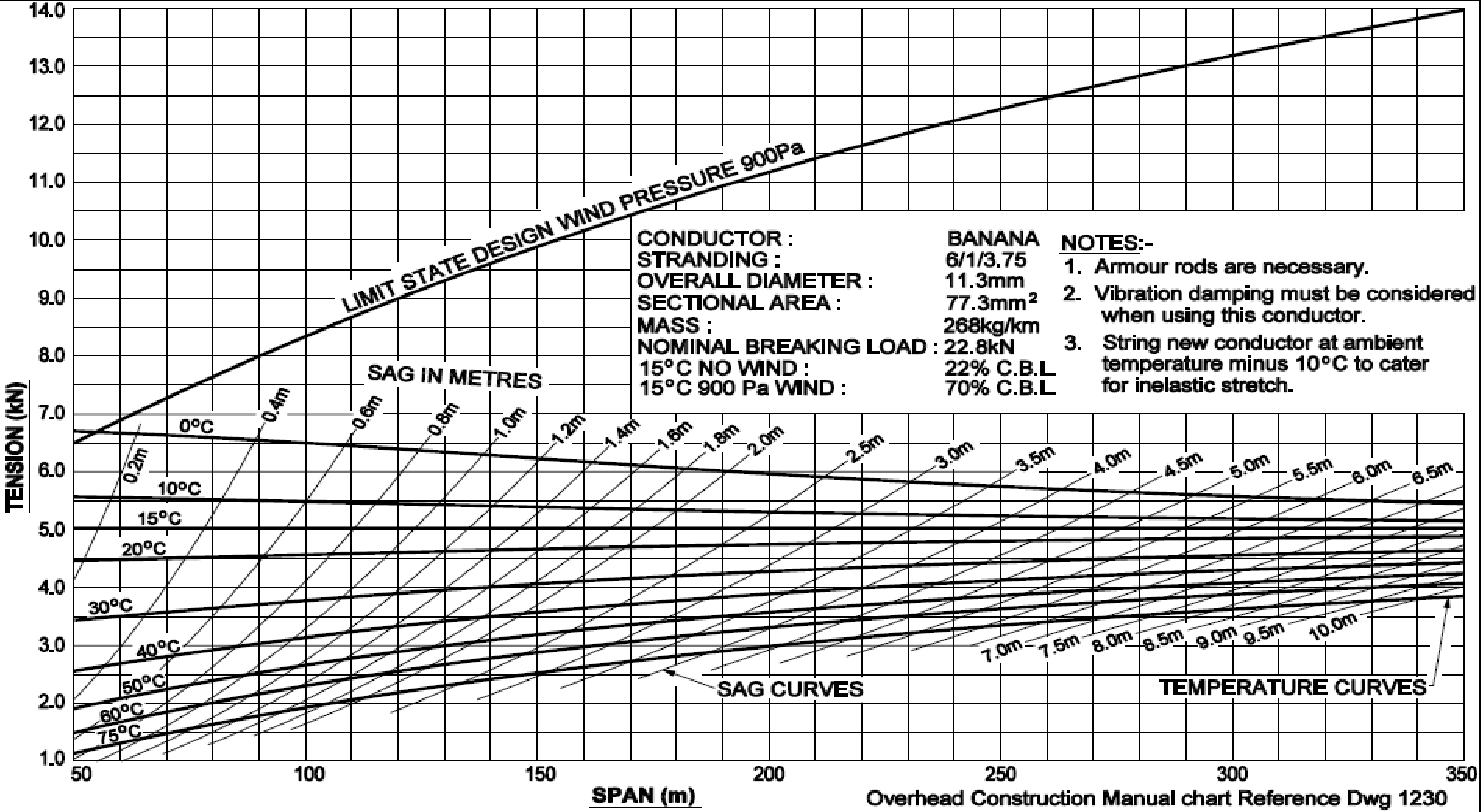
TENSION (kN)
SPAN (m)
LIMIT STATE DESIGN WIND PRESSURE 900Pa
SAG IN METRES
SAG CURVES
TEMPERATURE CURVES
CONDUCTOR : APPLE
STRANDING : 6/1/3.00
OVERALL DIAMETER : 9.0mm
SECTIONAL AREA : 49.5mm²
MASS : 171kg/km
NOMINAL BREAKING LOAD : 14.9kN
15°C NO WIND : 22% C.B.L.
15°C 900 Pa WIND : 70% C.B.L.
NOTES:-
1. Armour rods are necessary.
2. Vibration damping must be considered when using this conductor.
3. String new conductor at ambient temperature minus 10°C to cater for inelastic stretch.
Overhead Construction Manual chart Reference Dwg 1232
A ORIGINAL ISSUE
B 01.03.02
C 17.03.09
Ergon Energy Corporation Ltd
ABN 50 087 646 062
APPROVED
DATE 30.4.01
PASSED
DRAWN D. Bath
DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 'APPLE' 6/1/3.00 ACSR/GZ
22% C.B.L. - 900 Pa WIND
FILE: 5 33 3021 1
Dwg 3021 Sh C



A	ORIGINAL ISSUE	APPROVED		**DISTRIBUTION DESIGN - OVERHEAD** STRINGING CHARTS RURAL 'APPLE' 6/1/3.00 ACSR/GZ 22% C.B.L. - 1200 Pa WIND
B	01.03.02	DATE	30.4.01	
C	17.03.09	PASSED		
		DRAWN	D. Bath	FILE: 5 33 3022 1 — Dwg 3022 Sh — C

Ergon Energy Corporation Ltd
ABN 50 087 646 062


CONDUCTOR: SULTANA
STRANDING : 4/3/3.0
OVERALL DIAMETER : 9mm
SECTIONAL AREA : 49.5mm²
MASS : 242kg/km
NOMINAL BREAKING LOAD: 28.3kN
15°C NO WIND : 22% C.B.L
15°C 1200 Pa WIND : 70% C.B.L
LIMIT STATE DESIGN WIND PRESSURE 1200Pa
LIMIT STATE DESIGN WIND PRESSURE 900Pa
NOTES:-
1. Armour rods are necessary.
2. Vibration damping must be considered when using this conductor.
3. String new conductor at ambient temperature minus 10°C to cater for inelastic stretch.
SAG IN METRES
TENSION (kN)
SPAN (m)
TEMPERATURE CURVES
SAG CURVES
0°C
10°C
15°C
20°C
30°C
40°C
50°C
60°C
75°C
0.2m
0.4m
0.6m
0.8m
1.0m
1.2m
1.4m
1.6m
1.8m
2.0m
2.5m
3.0m
3.5m
4.0m
4.5m
5.0m
5.5m
6.0m
6.5m
7.0m
7.5m
8.0m
8.5m
9.0m
9.5m
10.0m
11.0m
12.0m
Overhead Construction Manual chart Reference Dwgs 1257 & 1258
A ORIGINAL ISSUE
B 01.03.02
C 17.03.09
ERGON. ENERGY
Ergon Energy Corporation Ltd
ABN 50 087 646 062
APPROVED
DATE 30.05.01
PASSED
DRAWN D. Bath
DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
'SULTANA' 4/3/3.0 ACSR/GZ
22% C.B.L. - 900 AND 1200 Pa WIND
FILE: 5 33 3036 1
Dwg 3036 Sh
C



Overhead Construction Manual chart Reference Dwg 1230

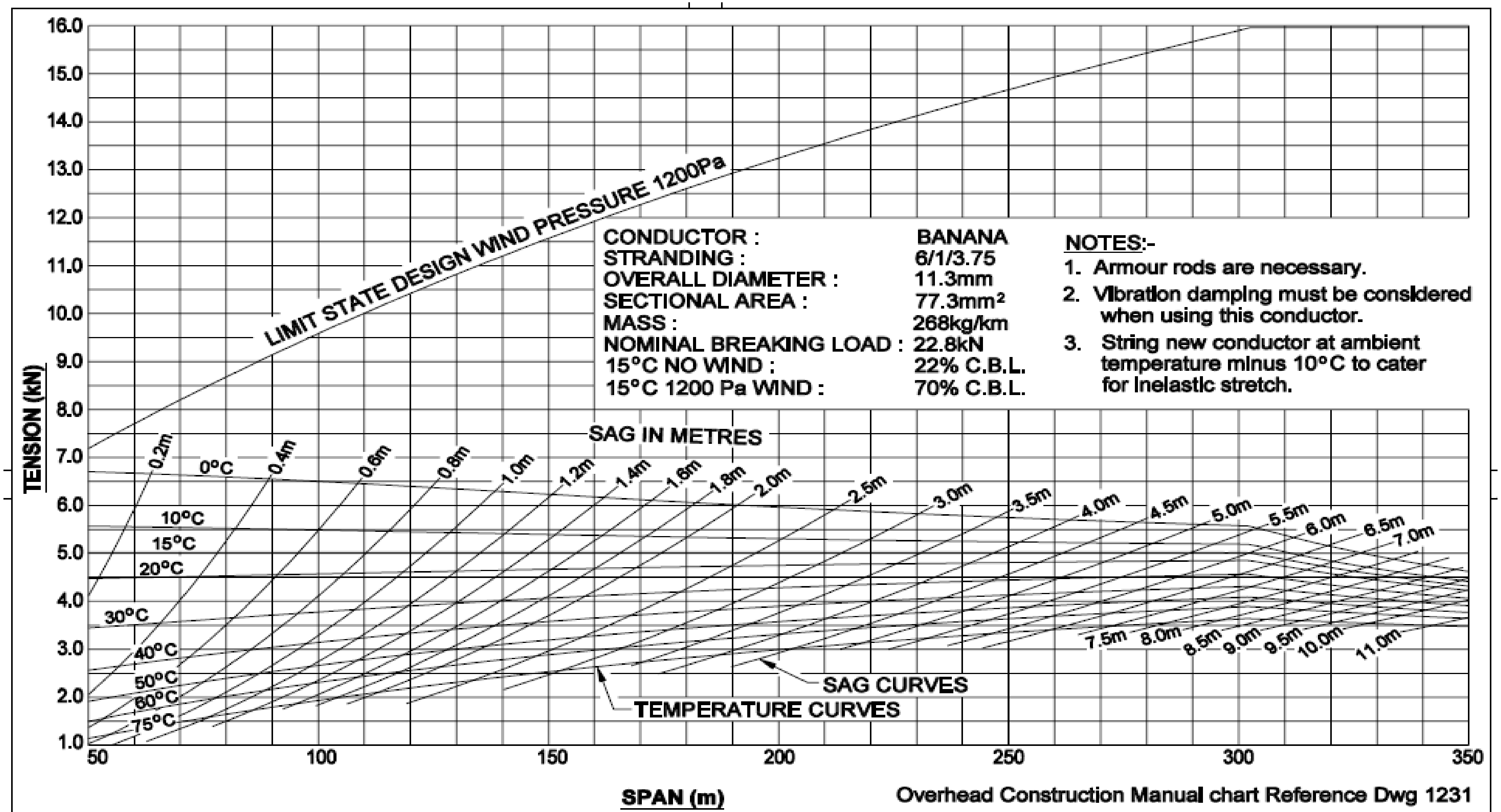
A	ORIGINAL ISSUE	
B	01.03.02	
C	17.03.09	

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	[signature]
DATE	30.4.01
PASSED	[signature]
DRAWN	D. Bath

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 'BANANA' 6/1/3.75 ACSR/GZ
22% C.B.L. - 900 Pa WIND

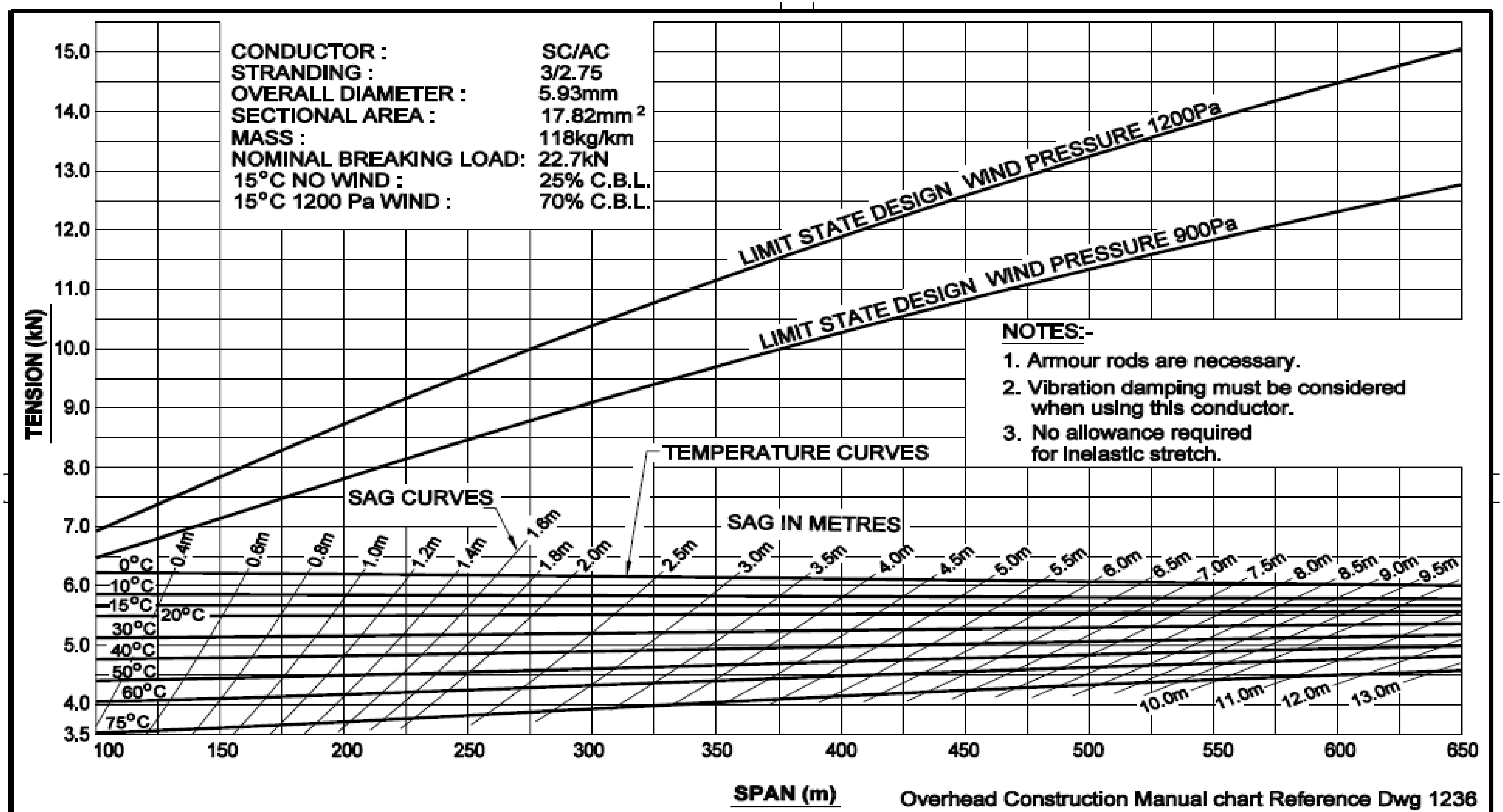
FILE: 5 33 3019 1 | Dwg 3019 Sh | C



Overhead Construction Manual chart Reference Dwg 1231

A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED	DISTRIBUTION DESIGN - OVERHEAD STRINGING CHARTS RURAL 'BANANA' 6/1/3.75 ACSR/GZ 22% C.B.L. - 1200 Pa WIND
B	01.03.02		DATE 30.4.01	
C	17.03.09		PASSED	
			DRAWN D. Bath	FILE: 5 33 3020 1 — Dwg 3020 Sh — C

STNW3361



Overhead Construction Manual chart Reference Dwg 1236

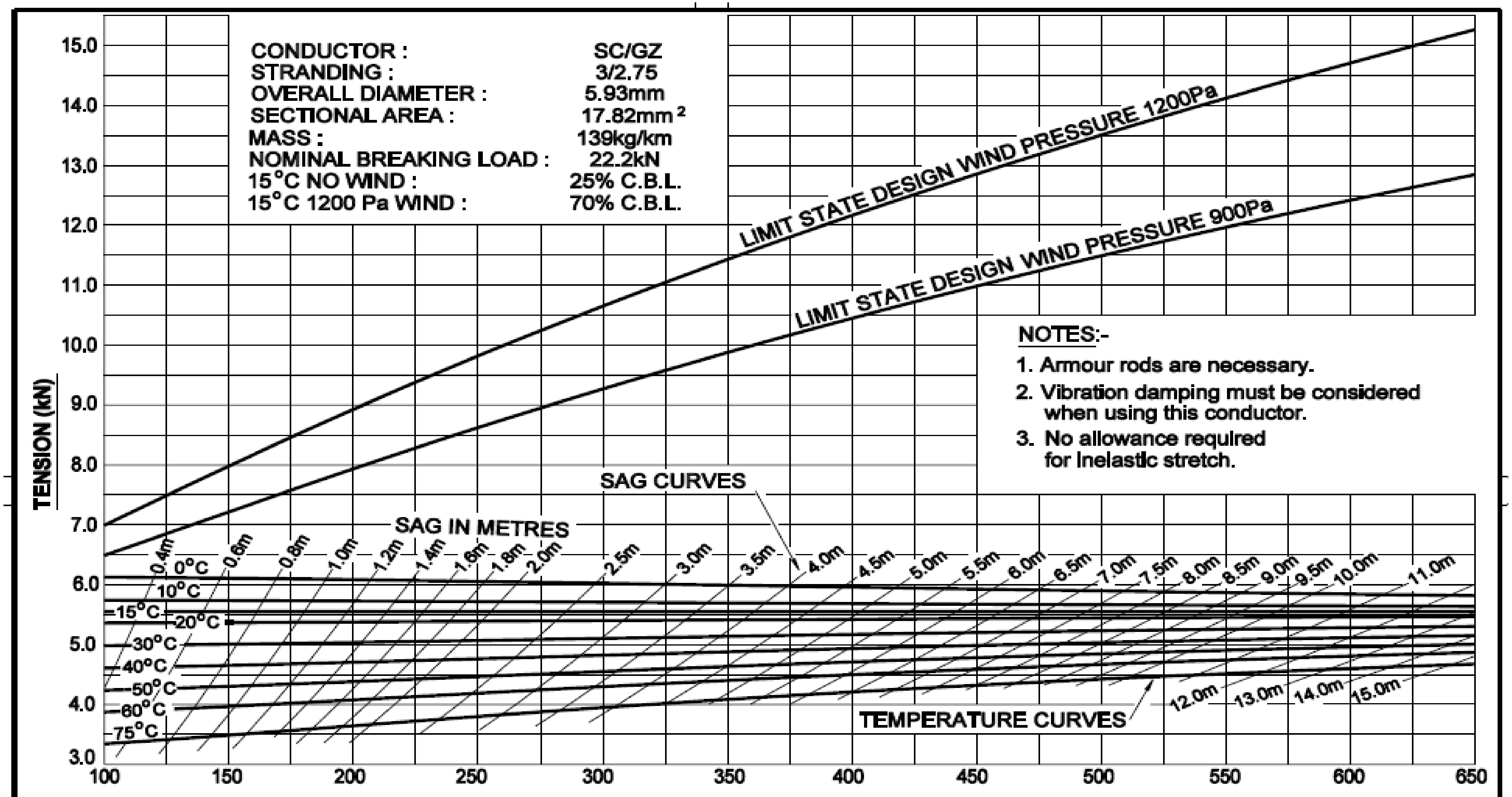
A	ORIGINAL ISSUE	
B	01.03.02	
C	17.03.09	

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	[signature]
DATE	24.5.01
PASSED	[signature]
DRAWN	D. Bath

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 3/2.75 SC/AC
25% C.B.L. - 900 AND 1200 Pa WIND

FILE: 5 33 3014 1 | Dwg 3014 Sh | C



Overhead Construction Manual chart Reference Dwg 1235

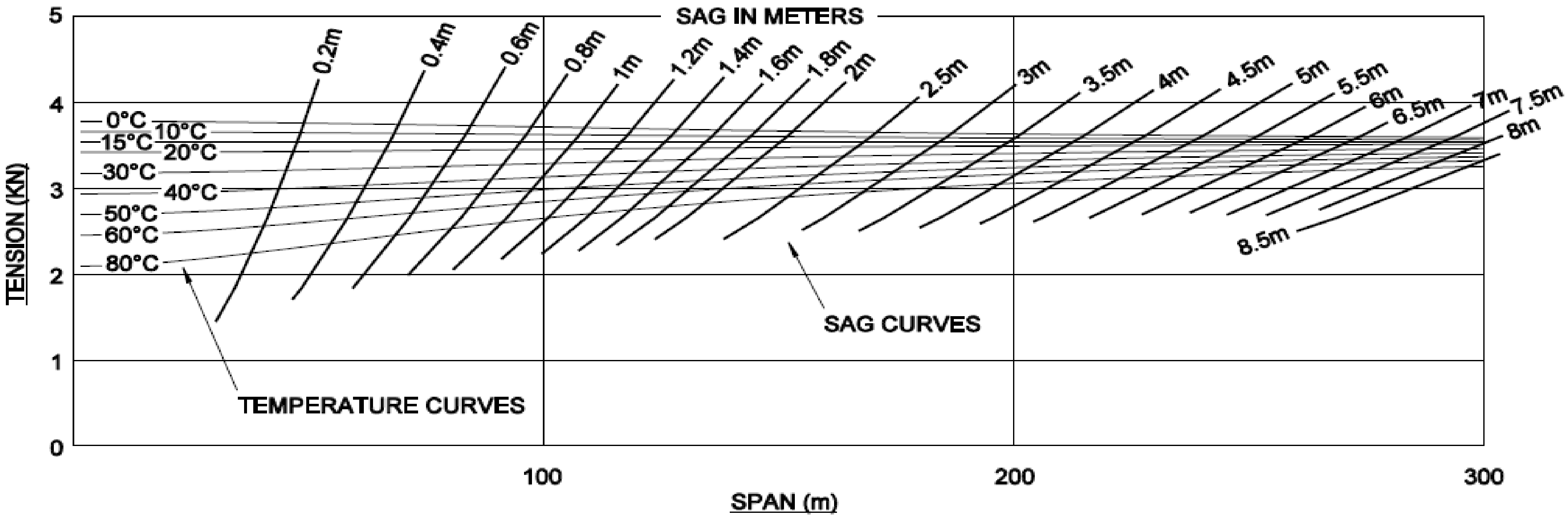
A	ORIGINAL ISSUE
B	01.03.02
C	17.03.09

Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	[signature]
DATE	23.5.01
PASSED	[signature]
DRAWN	D. Bath

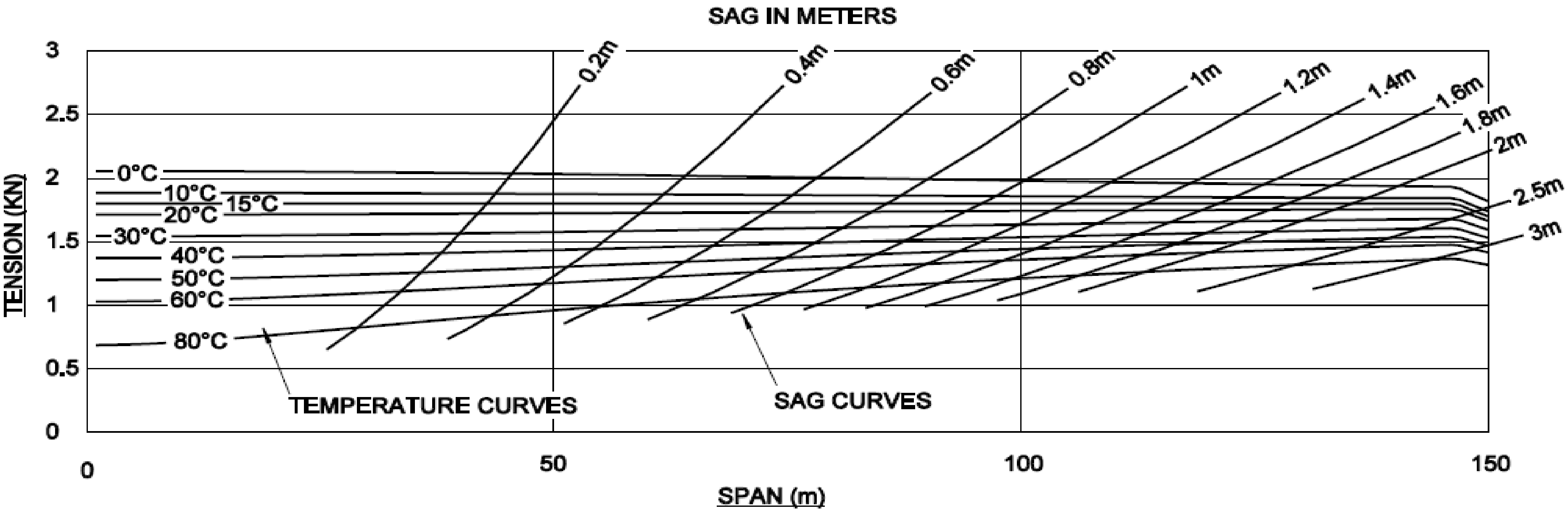
DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
RURAL 3/2.75 SC/GZ
25% C.B.L. - 900 AND 1200 Pa WIND

FILE: 5 33 3007 1 | Dwg 3007 Sh | C



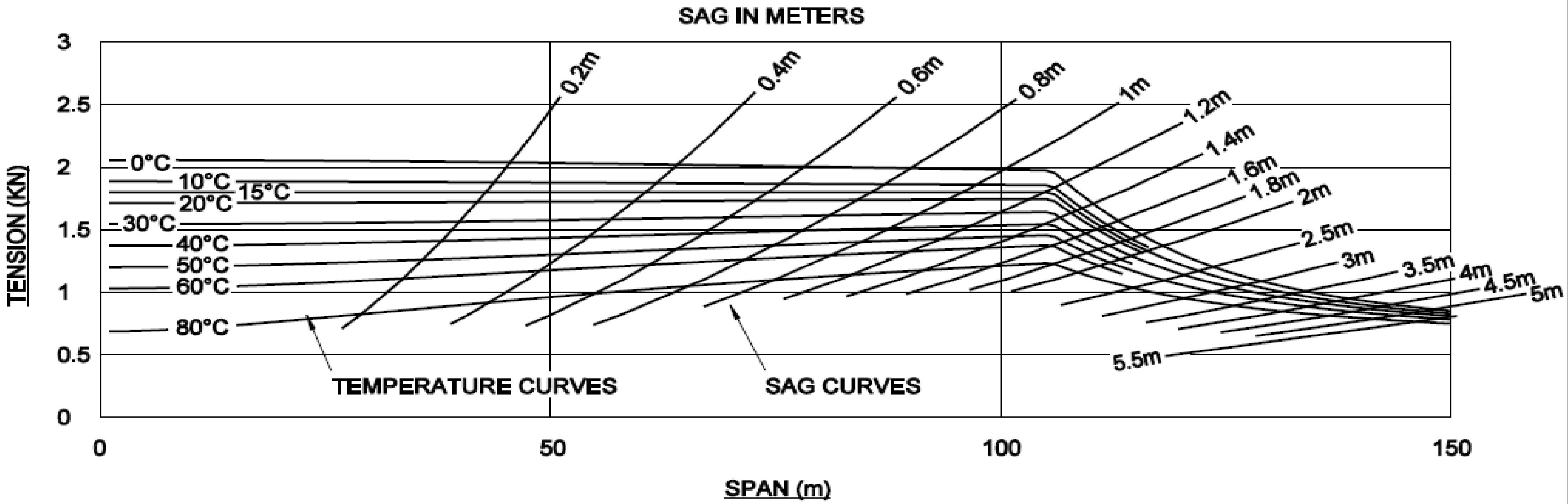
CONDUCTOR TYPE:	36-48 FIBRE ADSS CABLE - LONG SPAN
SECTIONAL AREA:	216.7 mm²
OVERALL DIAMETER:	18.4 mm
DISTRIBUTED MASS:	255 kg/km
FINAL MODULUS OF ELASTICITY:	15.9 GPa
COEFICIENT OF EXPANSION /°C:	7 x 10^-6
CALCULATED BREAKING LOAD:	59 kN
15°C NO WIND:	6% C.B.L
15°C 900Pa WIND:	34.4% C.B.L
15°C 1200Pa WIND:	34.4% C.B.L

A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED	DISTRIBUTION DESIGN - OVERHEAD
			DATE 30.6.09	STRINGING CHARTS
			PASSED	36-48 FIBRE ADSS CABLE - LONG SPAN
			DRAWN L. Burton	6% C.B.L - 900 AND 1200Pa WIND
				FILE: 5 33 3454 1 — Dwg 3454 Sh



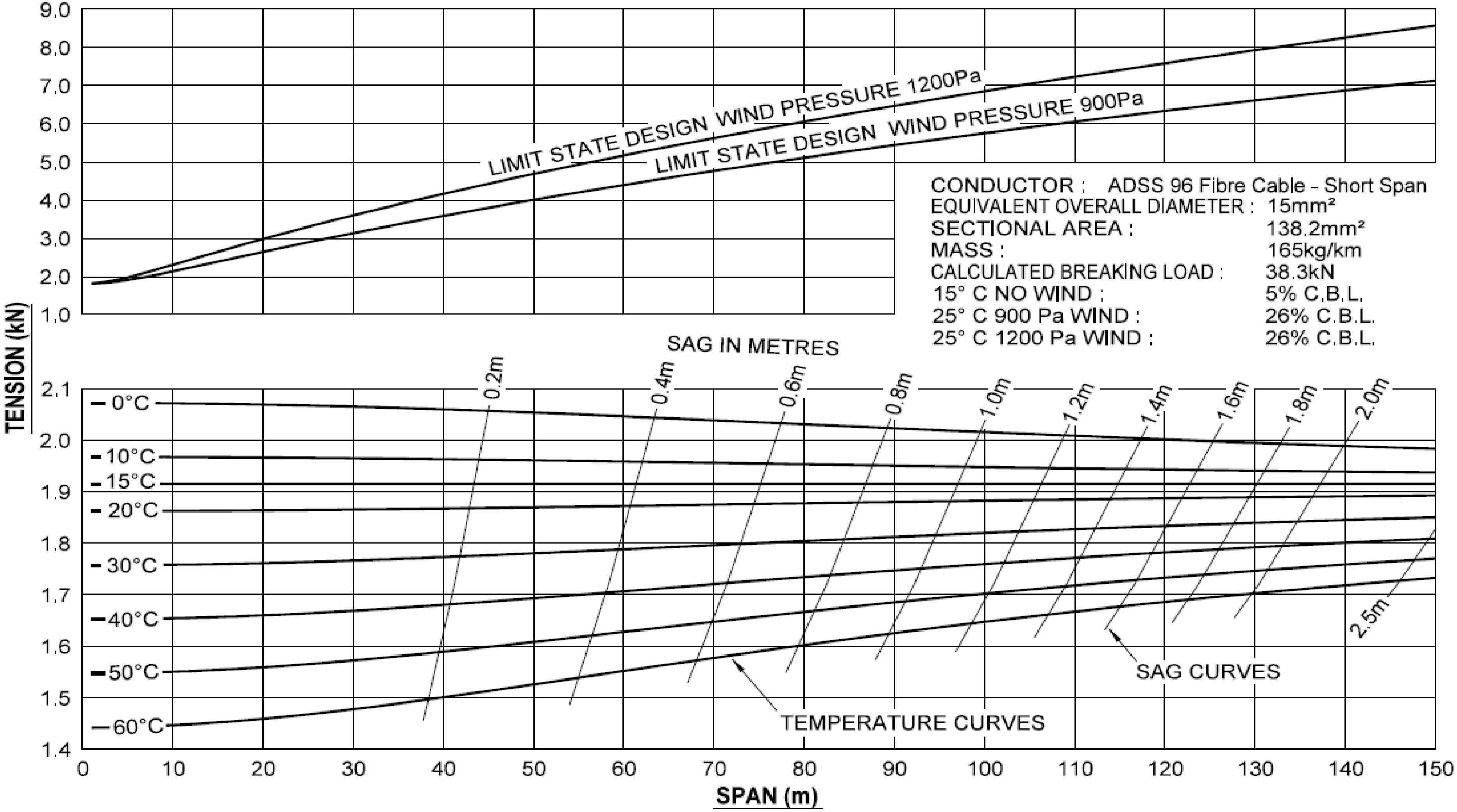
CONDUCTOR TYPE:	36-48 FIBRE ADSS CABLE - SHORT SPAN
SECTIONAL AREA:	124.3 mm²
OVERALL DIAMETER:	14.5 mm
DISTRIBUTED MASS:	160 kg/km
FINAL MODULUS OF ELASTICITY:	11.1 GPa
COEFICIENT OF EXPANSION /°C:	12.4 x 10^-6
CALCULATED BREAKING LOAD:	18 kN
15°C NO WIND:	10% C.B.L
25°C 900Pa WIND:	34.4% C.B.L

A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED	C. Noel	DISTRIBUTION DESIGN - OVERHEAD STRINGING CHARTS 36-48 FIBRE ADSS CABLE - SHORT SPAN 10% C.B.L - 900Pa WIND
			DATE	30.6.09	
			PASSED	C. Avenell	
			DRAWN	L. Burton	FILE: 5 33 3455 1 — Dwg 3455 Sh



CONDUCTOR TYPE:	36-48 FIBRE ADSS CABLE - SHORT SPAN
SECTIONAL AREA:	124.3 mm²
OVERALL DIAMETER:	14.5 mm
DISTRIBUTED MASS:	160 kg/km
FINAL MODULUS OF ELASTICITY:	11.1 GPa
COEFICIENT OF EXPANSION /°C:	12.4 x 10^-6
CALCULATED BREAKING LOAD:	18 kN
15°C NO WIND:	10% C.B.L
25°C 1200Pa WIND:	34.4% C.B.L

A ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED	C. Noel	DISTRIBUTION DESIGN - OVERHEAD STRINGING CHARTS 36-48 FIBRE ADSS CABLE - SHORT SPAN 10% C.B.L - 1200Pa WIND
		DATE	30.6.09	
		PASSED	C. Avenell	
		DRAWN	L. Burton	FILE: 5 33 3456 1 — Dwg 3456 Sh



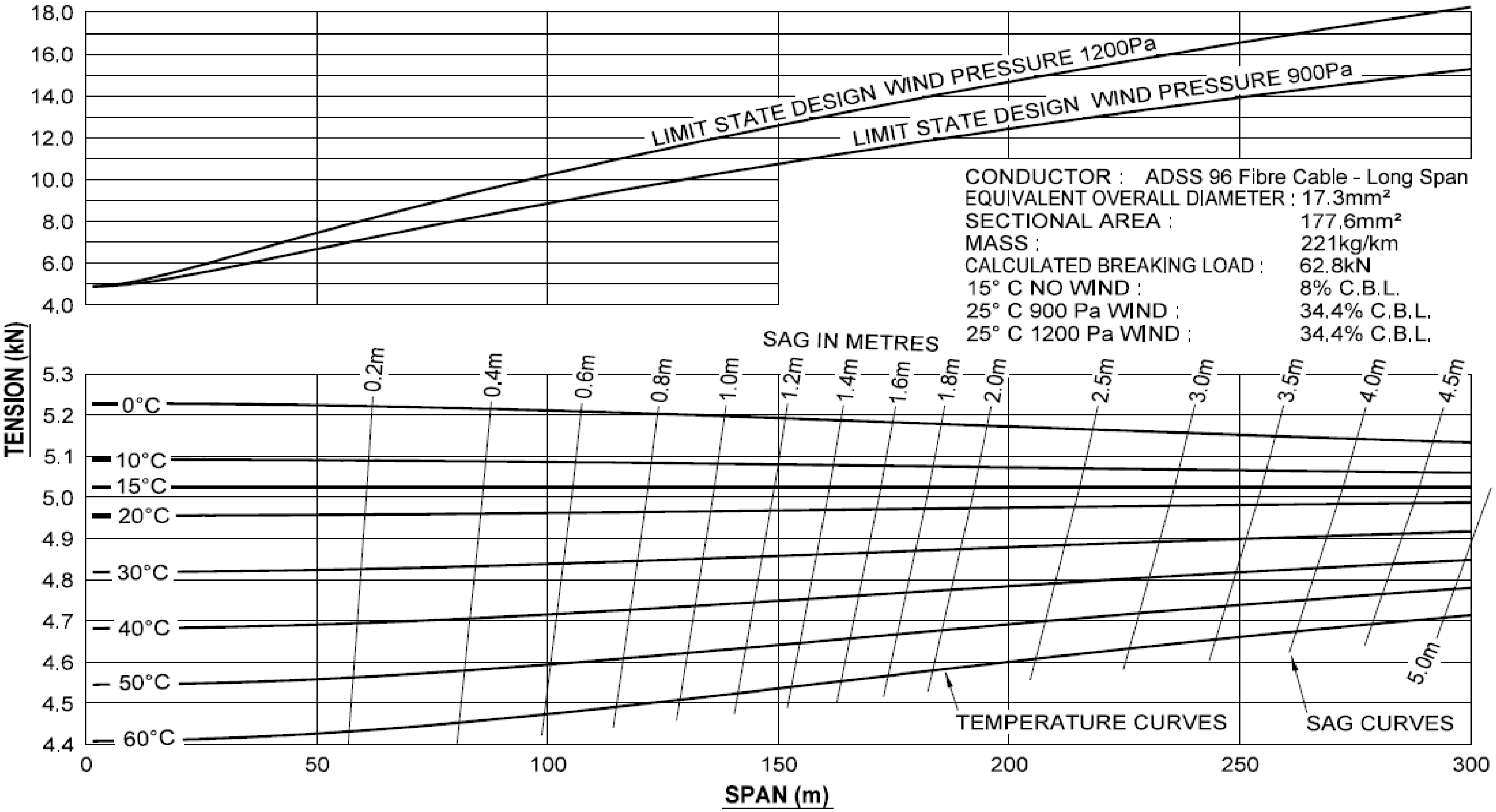
A	ORIGINAL ISSUE	HARD COPY UNCONTROLLED	APPROVED	C.Noel
			DATE	8/9/16
			PASSED	C.Avenell
			DRAWN	L. Burton

Ergon Energy Corporation Ltd
ABN 50 087 646 062

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
96 FIBRE ADSS CABLE - SHORT SPAN
5% C.B.L. - 900 & 1200 WIND

FILE: 5 33 3506 1 — Dwg 3506 Sh

STNW3361



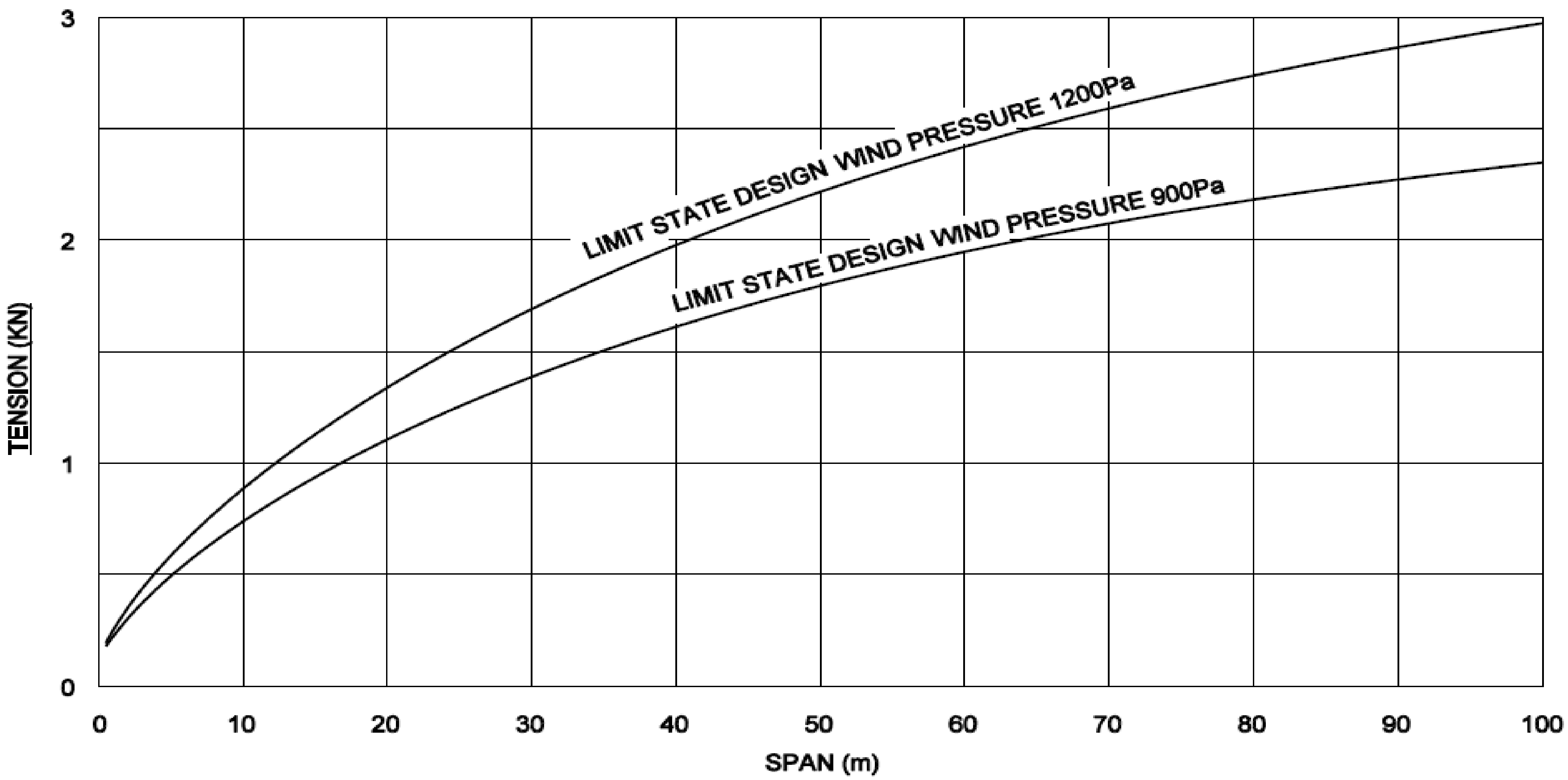
A	ORIGINAL ISSUE	APPROVED	C.Noel	**DISTRIBUTION DESIGN - OVERHEAD**
		DATE	8/9/16	STRINGING CHARTS
		PASSED	C.Avenell	96 FIBRE ADSS CABLE - LONG SPAN
		DRAWN	L. Burton	8% C.B.L. - 900 & 1200 WIND

HARD COPY UNCONTROLLED

Ergon Energy Corporation Ltd
ABN 50 087 646 062

FILE: 5 33 3507 1

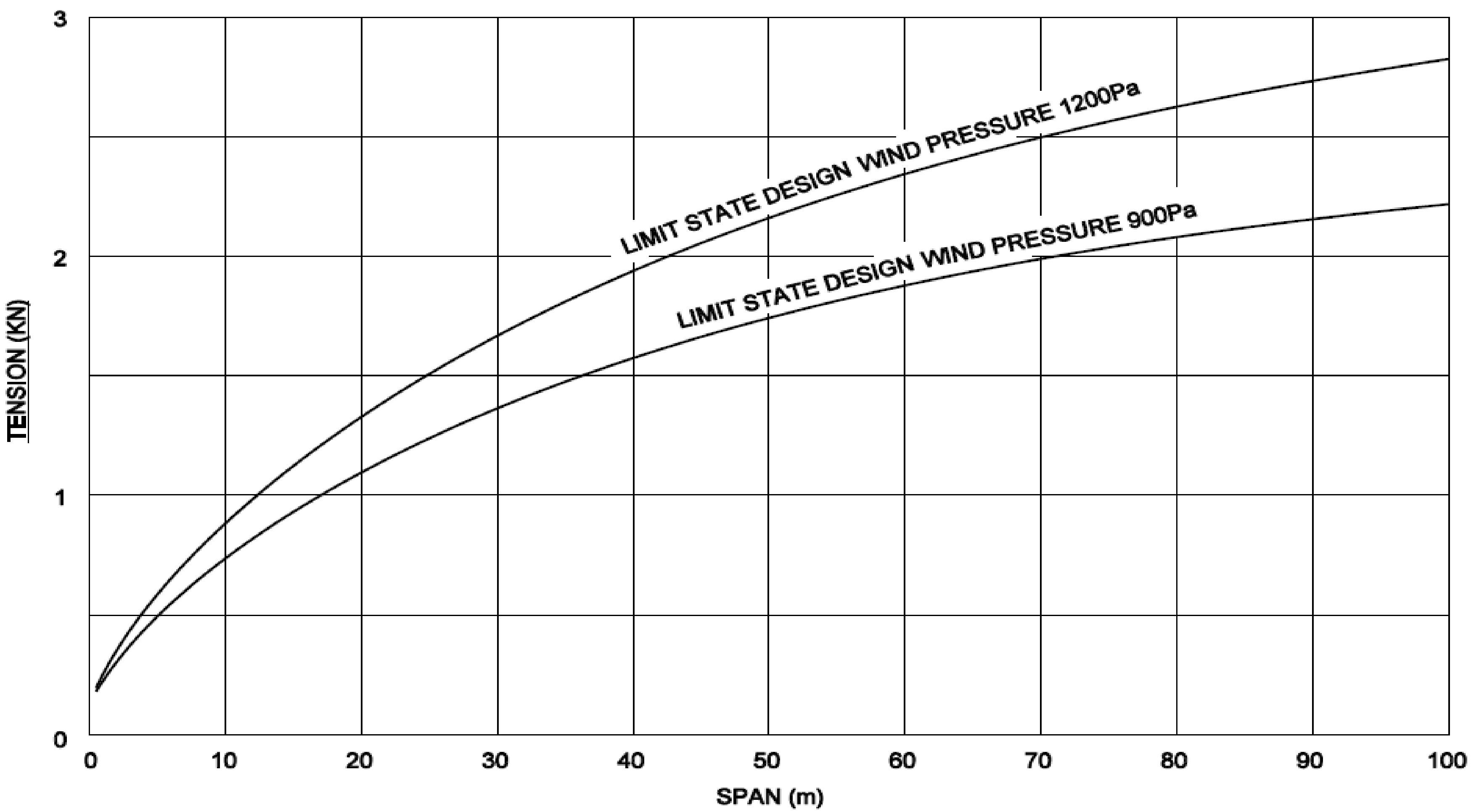
Dwg 3507 Sh



Refer dwg no. 1776 in the Stringing Charts folder of the O/H Constuction Manual for sag & temperature curves

A	ORIGINAL ISSUE	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED	C. Noel	DISTRIBUTION DESIGN - OVERHEAD STRINGING CHARTS NBN TYPE 2, 72 FIBRE 2% C.B.L - 900 & 1200 Pa WIND
			DATE	10/12/10	
			PASSED	C. Avenell	
			DRAWN	L. Burton	FILE: 5 33 3469 1 — Dwg 3469 Sh

STNW3361



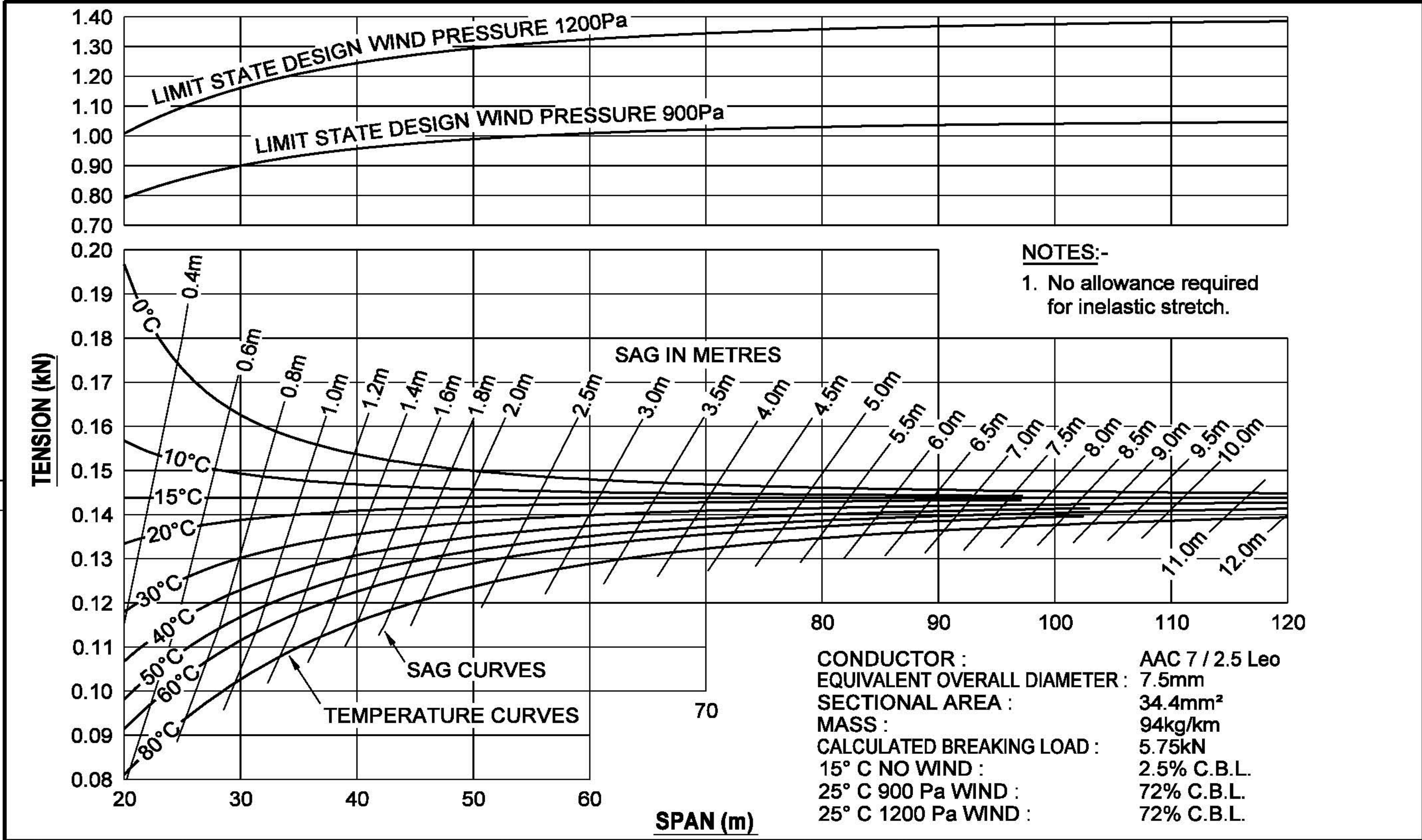
Refer dwg no. 1777 in the Stringing Charts folder of the O/H Constuction Manual for sag & temperature curves

A	ORIGINAL ISSUE	APPROVED	C. Noel
		DATE	10/12/10
		PASSED	C. Avenell
		DRAWN	L. Burton

Ergon Energy Corporation Ltd
ABN 50 087 646 062

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
NBN TYPE 2, 144 FIBRE
2% C.B.L - 900 & 1200 Pa WIND

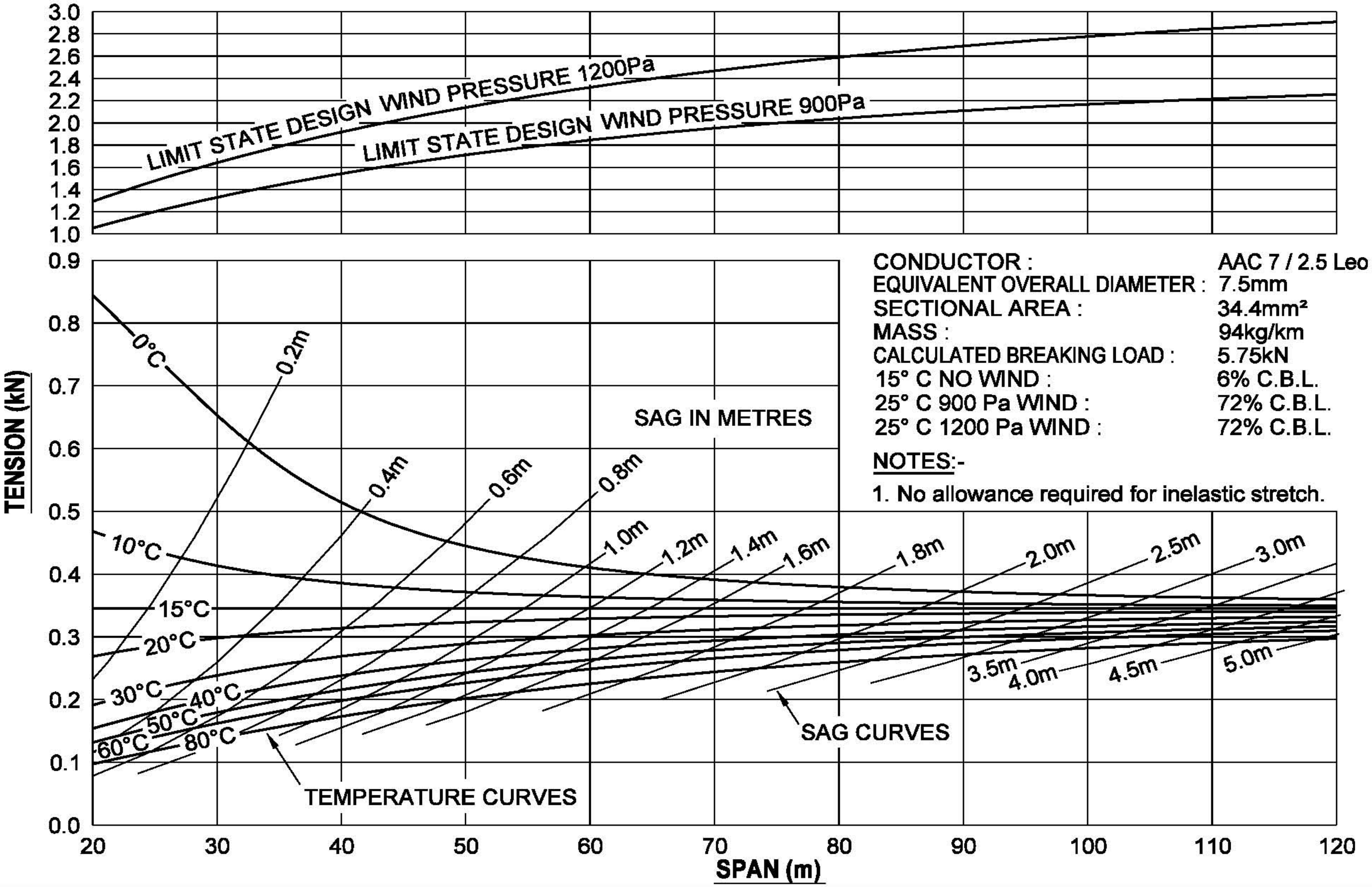
FILE: 5 33 3470 1 | Dwg 3470 Sh



A	ORIGINAL ISSUE	HARD COPY UNCONTROLLED	APPROVED	C.Noel
		Ergon Energy Corporation Ltd ABN 50 087 646 062	DATE	27/7/16
			PASSED	C.Avenell
			DRAWN	L. Burton

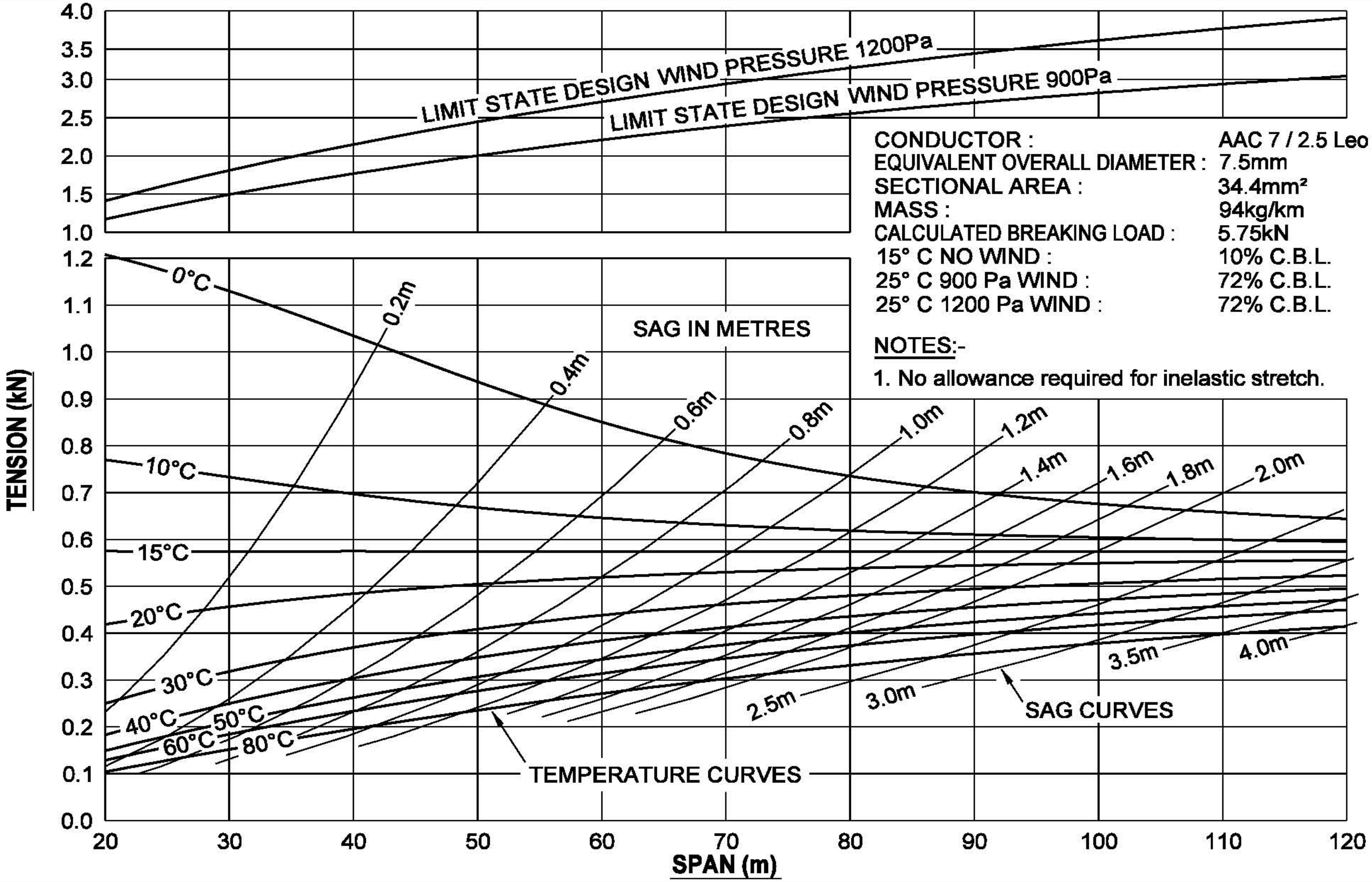
DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
'LEO' AAC 7/2.5 CONDUCTOR 2.5% C.B.L. - 900 Pa & 1200 Pa WIND - FOR 7/0.064" COPPER REPLACEMENT

FILE: 5 33 3502 1 | Dwg 3502 | Sh



A	ORIGINAL ISSUE	HARD COPY UNCONTROLLED	ERGON ENERGY Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED: C.Noel DATE: 27/7/16 PASSED: C.Avenell DRAWN: L. Burton	**DISTRIBUTION DESIGN - OVERHEAD** STRINGING CHARTS 'LEO' AAC 7/2.5 CONDUCTOR 6% C.B.L. - 900 Pa & 1200 Pa WIND - FOR 7/0.064" COPPER REPLACEMENT FILE: 5 33 3503 1	Dwg 3503	Sh

STNW3361



CONDUCTOR :	AAC 7 / 2.5 Leo
EQUIVALENT OVERALL DIAMETER :	7.5mm
SECTIONAL AREA :	34.4mm²
MASS :	94kg/km
CALCULATED BREAKING LOAD :	5.75kN
15° C NO WIND :	10% C.B.L.
25° C 900 Pa WIND :	72% C.B.L.
25° C 1200 Pa WIND :	72% C.B.L.

NOTES:-

1. No allowance required for inelastic stretch.

A	ORIGINAL ISSUE

HARD COPY UNCONTROLLED

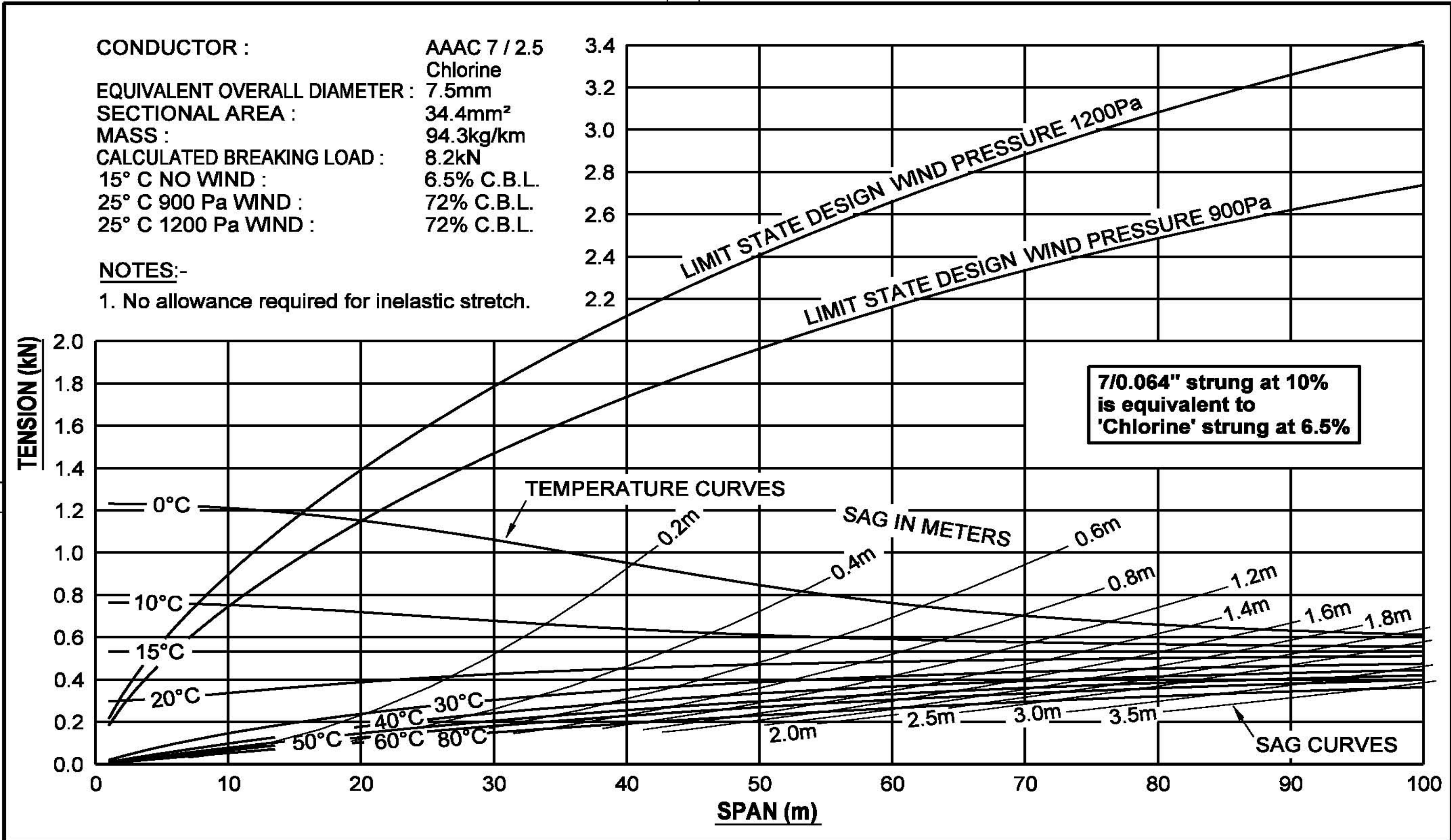
Ergon Energy Corporation Ltd
ABN 50 087 646 062

APPROVED	C.Noel
DATE	27/7/16
PASSED	C.Avenell
DRAWN	L. Burton

DISTRIBUTION DESIGN - OVERHEAD
STRINGING CHARTS
'LEO' AAC 7/2.5 CONDUCTOR 10% C.B.L. - 900 Pa & 1200 Pa WIND - FOR 7/0.064" COPPER REPLACEMENT

FILE: 5 33 3504 1 | Dwg 3504 | Sh

STNW3361



A ORIGINAL ISSUE	HARD COPY UNCONTROLLED	Ergon Energy Corporation Ltd ABN 50 087 646 062	APPROVED: C.Noel; DATE: 27/7/16; PASSED: C.Avenell; DRAWN: L. Burton	**DISTRIBUTION DESIGN - OVERHEAD** STRINGING CHARTS 'CHLORINE' AAAC 1120 7/2.5 CONDUCTOR 6.5% C.B.L. - 900 & 1200 Pa WIND - FOR 7/0.064" COPPER REPLACEMENT; FILE: 5 33 3505 1; Dwg 3505 Sh

Table B-1 – V.P.I. Wood Poles Net Allowable Pole Tip Loads (Non-Cyclonic Regions)

Pole Description				POOR SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 2)					MEDIUM SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 2)					GOOD SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 2)			
						Stabilised Backfill					Stabilised Backfill					Stabilised Backfill	
Length (m)	Nominal Pole Strength Rating (kN) (Note 1)	Standard Setting Depth (m)	Limit State Load Rating (kN)	STD Depth +300	STD Depth +450	STD Depth +300	STD Depth +450	STD Depth +600	STD Depth +150	STD Depth +300	STD Depth +150	STD Depth +300	STD Depth +450	STD Depth	STD Depth +150	STD Depth	STD Depth +150
8	3	1.40	5.4	2.165	2.969	3.624	4.858	4.874	3.550	4.843	4.828	4.843	4.858	4.812	4.828	4.812	4.828
	5		9	2.559	3.521	4.019	5.411	7.050	4.209	5.806	6.411	8.313	8.332	6.510	8.294	8.276	8.294
	8		14.4	2.954	4.072	4.413	5.963	7.787	4.869	6.725	7.070	9.644	12.720	7.538	10.577	10.766	13.561
	12		21.6	3.322	4.594	4.781	6.484	8.490	5.493	7.603	7.694	10.522	13.903	8.518	11.971	11.746	16.374
9.5	3	1.55	5.4	2.438	3.288	4.014	4.701	4.717	4.159	4.685	4.669	4.685	4.701	4.652	4.669	4.652	4.669
	5		9	2.844	3.847	4.420	5.847	7.506	4.869	6.560	7.305	8.127	8.147	7.814	8.108	8.088	8.108
	8		14.4	3.303	4.481	4.879	6.481	8.344	5.676	7.661	7.112	10.814	13.368	9.125	12.431	12.803	13.321
	12		21.6	3.708	5.040	5.285	7.040	9.082	6.387	8.629	8.823	11.782	15.267	10.278	14.013	13.956	18.885
11	3	1.70	5.4	2.723	3.609	4.437	4.559	4.576	4.525	4.542	4.525	4.542	4.559	4.508	4.525	4.508	4.525
	5		9	3.233	4.295	4.947	6.432	7.988	5.706	7.518	7.926	7.947	7.967	7.906	7.926	7.906	7.926
	8		14.4	3.713	4.950	5.428	7.087	8.995	6.586	8.694	9.290	12.123	13.157	10.899	13.108	13.084	13.108
	12		21.6	4.194	5.605	5.908	7.742	9.851	7.465	9.870	10.169	13.299	16.938	12.376	16.441	16.558	20.090
12.5	3	1.85	5.4	3.127	4.081	4.360	4.378	4.396	4.342	4.360	4.342	4.360	4.378	4.324	4.342	4.324	4.342
	5		9	3.608	4.716	5.477	7.011	7.812	6.534	7.770	7.749	7.770	7.791	7.728	7.749	7.728	7.749
	8		14.4	4.208	5.514	6.077	7.810	9.783	7.651	9.903	10.651	12.912	12.937	12.862	12.887	12.862	12.887
	12		21.6	4.748	6.230	6.617	8.526	10.700	8.652	11.208	11.652	14.946	18.735	14.671	19.045	19.405	19.860
14	3	2.00	5.4	3.405	4.207	4.189	4.207	4.226	4.170	4.189	4.170	4.189	4.207	4.152	4.170	4.152	4.170
	5		9	4.046	5.230	6.085	7.520	7.543	7.476	7.498	7.476	7.498	7.520	7.453	7.476	7.453	7.476
	8		14.4	4.689	6.052	6.728	8.524	10.552	8.710	11.082	12.032	12.696	12.722	12.645	12.671	12.645	12.671
	12		21.6	5.363	6.927	7.402	9.398	11.653	9.974	12.695	13.296	16.774	19.661	17.239	19.602	19.572	19.602
15.5	5	2.15	9	4.552	5.798	6.775	7.323	7.346	7.277	7.300	7.277	7.300	7.323	7.254	7.277	7.254	7.277
	8		14.4	5.276	6.725	7.499	9.388	11.509	10.005	12.404	12.377	12.404	12.431	12.350	12.377	12.350	12.377
	12		21.6	5.965	7.617	8.187	10.280	12.629	11.351	14.249	15.019	18.695	19.311	19.218	19.249	19.218	19.249
	20		36	7.032	9.001	9.255	11.664	14.367	13.439	16.892	17.108	21.337	26.118	23.716	29.744	29.694	33.135
17	5	2.30	9	5.087	6.401	7.064	7.088	7.112	7.041	7.064	7.041	7.064	7.088	7.017	7.041	7.017	7.041
	8		14.4	5.867	7.388	8.268	10.256	12.194	11.309	12.139	12.111	12.139	12.166	12.083	12.111	12.083	12.111
	12		21.6	6.721	8.472	9.140	11.340	13.793	12.982	16.076	17.020	18.966	18.998	18.902	18.934	18.902	18.934
	20		36	7.909	9.982	10.327	12.850	15.663	15.317	18.979	19.355	23.817	28.825	27.368	32.800	32.762	32.800

GENERAL NOTES:

1. The Nominal Pole Strength Rating is the allowable pole tip load due to the more severe of
(a) maximum wind at 15°C,
(b) minimum temperature at no wind.

2. The Net Allowable Limit State Pole Tip Load is the pole element strength less the wind load on the pole referred to the pole tip.

3. Shading indicates that the foundation allows for full pole strength utilisation.

DESIGN CRITERIA - POOR SOIL

1. Soil Description:
Soft clay, poorly compacted sand and soil that tends to absorb large amounts of water (excluding slush).

2. Passive Soil Reaction per unit depth - 150kPa/m.

3. Pole wind pressure - 1300kPa.

DESIGN CRITERIA - MEDIUM SOIL

1. Soil Description:
Compact medium clay, well bonded sandy loam, bonded sand and gravel with reasonable water drainage.

2. Passive Soil Reaction per unit depth - 300kPa/m.

3. Pole wind pressure - 1300kPa.

DESIGN CRITERIA - GOOD SOIL

1. Soil Description:
Well compacted rock soil, hard clay and well bonded sand and gravel with good surface water drainage.

2. Passive Soil Reaction per unit depth - 600kPa/m.

3. Pole wind pressure - 1300kPa.

Table B-2 – V.P.I. Wood Poles Net Allowable Pole Tip Loads (Cyclonic Regions)

Pole Description				POOR SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 2)					MEDIUM SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 2)					GOOD SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 2)			
						Stabilised Backfill					Stabilised Backfill					Stabilised Backfill	
Length (m)	Nominal Pole Strength Rating (kN) (Note 1)	Standard Setting Depth (m)	Limit State Load Rating (kN)	STD Depth +300	STD Depth +450	STD Depth +300	STD Depth +450	STD Depth +600	STD Depth +150	STD Depth +300	STD Depth +150	STD Depth +300	STD Depth +450	STD Depth	STD Depth +150	STD Depth	STD Depth +150
8	3	1.40	5.4	1.993	2.802	3.453	4.692	4.712	3.374	4.672	4.652	4.672	4.692	4.631	4.652	4.631	4.652
	5		9	2.348	3.315	3.807	5.205	6.850	3.992	5.594	6.194	8.102	8.126	6.287	8.077	8.053	8.077
	8		14.4	2.703	3.828	4.162	5.718	7.549	4.611	6.474	6.812	9.392	12.476	7.273	10.319	10.501	13.303
	12		21.6	3.026	4.306	4.485	6.196	8.210	5.189	7.308	7.931	10.227	13.616	8.207	11.668	11.435	16.070
9.5	3	1.55	5.4	2.218	3.073	3.794	4.486	4.507	3.934	4.465	4.444	4.465	4.486	4.422	4.444	4.422	4.444
	5		9	2.575	5.584	4.151	5.584	7.249	4.595	6.291	7.031	7.859	7.884	7.533	7.833	7.807	7.833
	8		14.4	2.978	4.164	4.555	6.164	8.043	5.344	7.336	7.781	10.489	13.051	8.786	12.099	12.464	12.990
	12		21.6	3.335	4.675	4.911	6.675	8.725	6.005	8.256	8.441	11.409	14.902	9.889	13.631	13.566	18.504
11	3	1.70	5.4	2.459	3.350	4.173	4.300	4.322	4.256	4.278	4.256	4.278	4.300	4.234	4.256	4.234	4.256
	5		9	2.909	3.977	4.623	6.114	7.676	5.376	7.194	7.596	7.623	7.650	7.569	7.596	7.569	7.596
	8		14.4	3.323	4.567	5.038	6.704	8.620	6.188	8.304	8.892	11.733	12.774	10.494	12.711	12.679	12.711
	12		21.6	3.738	5.157	5.452	7.295	9.412	7.001	9.414	9.705	12.843	16.491	11.903	15.976	16.084	19.625
12.5	3	1.85	5.4	2.807	3.767	4.040	4.064	4.087	4.017	4.040	4.017	4.040	4.064	3.993	4.017	3.993	4.017
	5		9	3.229	4.344	5.098	6.639	7.446	6.149	7.391	7.364	7.391	7.419	7.336	7.364	7.336	7.364
	8		14.4	3.750	5.064	5.619	7.360	9.341	7.186	9.446	10.186	12.454	12.487	12.389	12.422	12.389	12.422
	12		21.6	4.221	5.713	6.091	8.008	10.191	8.117	10.681	11.117	14.420	18.217	14.127	18.510	18.861	19.324
14	3	2.00	5.4	3.032	3.840	3.816	3.840	3.864	3.792	3.816	3.792	3.816	3.840	3.768	3.792	3.768	3.792
	5		9	3.584	4.775	5.623	7.065	7.094	7.006	7.036	7.006	7.036	7.065	6.977	7.006	6.977	7.006
	8		14.4	4.165	5.536	6.204	8.007	10.044	8.178	10.558	11.500	12.172	12.206	12.105	12.139	12.105	12.139
	12		21.6	4.758	6.330	6.797	8.802	11.066	9.360	12.090	12.682	16.168	19.064	16.615	18.987	18.948	18.987
15.5	5	2.15	9	4.029	5.282	6.252	6.807	6.837	6.746	6.777	6.746	6.777	6.807	6.716	6.746	6.716	6.746
	8		14.4	4.662	6.120	6.885	8.783	10.911	9.383	11.790	11.755	11.790	11.825	11.720	11.755	11.720	11.755
	12		21.6	5.251	6.913	7.473	9.576	11.934	10.627	13.536	14.296	17.981	18.607	18.485	18.526	18.485	18.526
	20		36	6.162	8.142	8.385	10.805	13.520	12.558	16.022	16.226	20.467	25.260	22.823	28.862	28.801	32.254
17	5	2.30	9	4.492	5.813	6.469	6.500	6.531	6.438	6.469	6.438	6.469	6.500	6.406	6.438	6.406	6.438
	8		14.4	5.171	6.700	7.590	9.569	11.515	10.604	11.443	11.407	11.443	11.479	11.370	11.407	11.370	11.407
	12		21.6	5.910	7.671	8.329	10.450	13.003	12.162	15.265	16.200	18.156	18.197	18.072	18.114	18.072	18.114
	20		36	6.936	9.021	9.355	11.889	14.713	14.332	18.006	18.370	22.844	27.863	26.390	31.815	31.765	31.815

GENERAL NOTES:

1. The Nominal Pole Strength Rating is the allowable pole tip load due to the more severe of
(a) maximum wind at 15°C,
(b) minimum temperature at no wind.

2. The Net Allowable Limit State Pole Tip Load is the pole element strength less the wind load on the pole referred to the pole tip.

3. Shading indicates that the foundation allows for full pole strength utilisation.

DESIGN CRITERIA - POOR SOIL

1. Soil Description:
Soft clay, poorly compacted sand and soil that tends to absorb large amounts of water (excluding slush).

2. Passive Soil Reaction per unit depth - 150kPa/m.

3. Pole wind pressure - 1700kPa.

DESIGN CRITERIA - MEDIUM SOIL

1. Soil Description:
Compact medium clay, well bonded sandy loam, bonded sand and gravel with reasonable water drainage.

2. Passive Soil Reaction per unit depth - 300kPa/m.

3. Pole wind pressure - 1700kPa.

DESIGN CRITERIA - GOOD SOIL

1. Soil Description:
Well compacted rock soil, hard clay and well bonded sand and gravel with good surface water drainage.

2. Passive Soil Reaction per unit depth - 600kPa/m.

3. Pole wind pressure - 1700kPa.

Table B-3 – V.P.I. Wood Poles Net Allowable Pole Tip Loads (Sustained Loads)

Pole Description				POOR SOIL - NET ALLOWABLE SUSTAINED POLE TIP LOADS (kN) (Note 2)					MEDIUM SOIL - NET ALLOWABLE SUSTAINED POLE TIP LOADS (kN) (Note 2)					GOOD SOIL - NET ALLOWABLE SUSTAINED POLE TIP LOADS (kN) (Note 2)			
Length (m)	Nominal Pole Strength Rating (kN) (Note 1)	Standard Setting Depth (m)	Sustained Load Rating (kN)	STD Depth +300	STD Depth +450	Stabilised Backfill STD Depth +300	Stabilised Backfill STD Depth +450	Stabilised Backfill STD Depth +600	STD Depth +150	STD Depth +300	Stabilised Backfill STD Depth +150	Stabilised Backfill STD Depth +300	Stabilised Backfill STD Depth +450	STD Depth	STD Depth +150	Stabilised Backfill STD Depth	Stabilised Backfill STD Depth +150
8	3	1.40	1.5	0.756	0.975	1.161	1.500	1.500	1.145	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500
	5		2.5	0.902	1.164	1.307	1.689	2.139	1.365	1.804	1.977	2.500	2.500	2.009	2.500	2.500	2.500
	8		4	1.048	1.352	1.453	1.877	2.378	1.586	2.095	2.197	2.906	3.754	2.333	3.171	3.230	4.000
	12		6	1.189	1.536	1.595	2.061	2.611	1.800	2.379	2.411	3.190	4.122	2.647	3.599	3.544	4.822
9.5	3	1.55	1.5	0.876	1.107	1.314	1.500	1.500	1.358	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500
	5		2.5	1.032	1.306	1.470	1.861	2.317	1.600	2.065	2.277	2.500	2.500	2.424	2.500	2.500	2.500
	8		4	1.211	1.531	1.648	2.087	2.598	1.876	2.421	2.553	3.297	4.000	2.841	3.753	3.862	4.000
	12		6	1.367	1.730	1.805	2.285	2.845	2.118	2.734	2.795	3.610	4.570	3.207	4.237	4.228	5.590
11	3	1.70	1.5	0.995	1.236	1.471	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500
	5		2.5	1.190	1.480	1.667	2.073	2.500	1.883	2.381	2.500	2.500	2.500	2.500	2.500	2.500	2.500
	8		4	1.384	1.720	1.860	2.314	2.837	2.188	2.767	2.939	3.720	4.000	3.393	4.000	4.000	4.000
	12		6	1.577	1.961	2.053	2.555	3.133	2.496	3.153	3.244	4.106	5.109	3.865	4.986	5.027	6.000
12.5	3	1.85	1.5	1.158	1.417	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500
	5		2.5	1.344	1.646	1.863	2.284	2.500	2.163	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500
	8		4	1.582	1.938	2.101	2.576	3.117	2.546	3.164	3.379	4.000	4.000	4.000	4.000	4.000	4.000
	12		6	1.794	2.198	2.314	2.836	3.432	2.877	3.589	3.720	4.627	5.672	4.567	5.774	5.882	6.000
14	3	2.00	1.5	1.282	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500
	5		2.5	1.541	1.864	2.108	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500
	8		4	1.776	2.147	2.342	2.834	3.390	2.900	3.552	3.823	4.000	4.000	4.000	4.000	4.000	4.000
	12		6	2.037	2.463	2.603	3.149	3.768	3.326	4.073	4.249	5.206	6.000	5.352	6.000	6.000	6.000
15.5	5	2.15	2.5	1.737	2.076	2.354	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500
	8		4	2.020	2.415	2.637	3.155	3.736	3.341	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
	12		6	2.301	2.752	2.919	3.492	4.135	3.806	4.603	4.825	5.837	6.000	6.000	6.000	6.000	6.000
	20		10	2.739	3.275	3.356	4.015	4.756	4.529	5.478	5.548	6.712	8.030	7.394	9.058	9.055	10.000
17	5	2.30	2.5	1.951	2.309	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500
	8		4	2.258	2.673	2.930	3.469	4.000	3.777	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
	12		6	2.599	3.076	3.270	3.873	4.545	4.347	5.197	5.468	6.000	6.000	6.000	6.000	6.000	6.000
	20		10	3.075	3.640	3.747	4.437	5.208	5.143	6.150	6.265	7.494	8.875	8.507	10.000	10.000	10.000

GENERAL NOTES:

1. The Nominal Pole Strength Rating is the allowable pole tip load due to the more severe of
(a) maximum wind at 15°C,
(b) minimum temperature at no wind.

2. The Net Allowable Sustained Pole Tip Load is the pole element strength under sustained loading conditions.

3. Shading indicates that the foundation allows for full pole strength utilisation.

DESIGN CRITERIA - POOR SOIL

1. Soil Description:
Soft clay, poorly compacted sand and soil that tends to absorb large amounts of water (excluding slush).

2. Passive Soil Reaction per unit depth - 150kPa/m.

DESIGN CRITERIA - MEDIUM SOIL

1. Soil Description:
Compact medium clay, well bonded sandy loam, bonded sand and gravel with reasonable water drainage.

2. Passive Soil Reaction per unit depth - 300kPa/m.

DESIGN CRITERIA - GOOD SOIL

1. Soil Description:
Well compacted rock soil, hard clay and well bonded sand and gravel with good surface water drainage.

2. Passive Soil Reaction per unit depth - 600kPa/m.

Table B-4 – Steel Poles Net Allowable Pole Tip Loads (Non-Cyclonic Regions)

Pole Description			POOR SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)			MEDIUM SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)			GOOD SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)	
Length (m)	Limit State Pole Strength Rating (kN) (Note 1)	Standard Setting Depth (m)	Stabilised Backfill			Stabilised Backfill			Stabilised Backfill	
			STD Depth +300	STD Depth +450	STD Depth +600	STD Depth +150	STD Depth +300	STD Depth +450	STD Depth	STD Depth +150
12.5	10.8	1.85	5.136	6.753	8.559	13.363	14.038	14.072	13.971	14.005
	14.4		5.734	7.569	9.664	14.058	18.056	21.873	21.763	21.800
14	12.15	2.00	5.530	7.170	9.026	10.047	10.074	10.100	10.021	10.047
	14.4		6.169	8.030	10.137	11.564	11.944	11.975	11.881	11.912

GENERAL NOTES:

1. The Net Allowable Limit State Pole Tip Load is the pole element strength less the wind load on the pole referred to the pole tip.

2. Shading indicates that the foundation allows for full pole strength utilisation.

DESIGN CRITERIA - POOR SOIL

1. Soil Description:
Soft clay, poorly compacted sand and soil that tends to absorb large amounts of water (excluding slush).

2. Passive Soil Reaction per unit depth - 150kPa/m.

3. Pole wind pressure - 1300kPa.

DESIGN CRITERIA - MEDIUM SOIL

1. Soil Description:
Compact medium clay, well bonded sandy loam, bonded sand and gravel with reasonable water drainage.

2. Passive Soil Reaction per unit depth - 300kPa/m.

3. Pole wind pressure - 1300kPa.

DESIGN CRITERIA - GOOD SOIL

1. Soil Description:
Well compacted rock soil, hard clay and well bonded sand and gravel with good surface water drainage.

2. Passive Soil Reaction per unit depth - 600kPa/m.

3. Pole wind pressure - 1300kPa.

Table B-5 – Steel Poles Net Allowable Pole Tip Loads (Cyclonic Regions)

Pole Description			POOR SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)			MEDIUM SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)			GOOD SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)	
Length (m)	Limit State Pole Strength Rating (kN) (Note 1)	Standard Setting Depth (m)	Stabilised Backfill			Stabilised Backfill			Stabilised Backfill	
			STD Depth +300	STD Depth +450	STD Depth +600	STD Depth +150	STD Depth +300	STD Depth +450	STD Depth	STD Depth +150
12.5	10.8	1.85	4.571	6.696	8.050	8.363	8.398	8.433	8.329	8.363
	14.4		5.065	6.910	9.015	9.807	11.558	11.600	11.476	11.517
14	12.15	2.00	4.891	6.539	8.155	9.400	9.435	9.470	9.365	9.400
	14.4		5.413	7.284	9.400	10.799	11.188	11.229	11.105	11.147

GENERAL NOTES:

1. The Net Allowable Limit State Pole Tip Load is the pole element strength less the wind load on the pole referred to the pole tip.

2. Shading indicates that the foundation allows for full pole strength utilisation.

DESIGN CRITERIA - POOR SOIL

1. Soil Description:
Soft clay, poorly compacted sand and soil that tends to absorb large amounts of water (excluding slush).

2. Passive Soil Reaction per unit depth - 150kPa/m.

3. Pole wind pressure - 1700kPa.

DESIGN CRITERIA - MEDIUM SOIL

1. Soil Description:
Compact medium clay, well bonded sandy loam, bonded sand and gravel with reasonable water drainage.

2. Passive Soil Reaction per unit depth - 300kPa/m.

3. Pole wind pressure - 1700kPa.

DESIGN CRITERIA - GOOD SOIL

1. Soil Description:
Well compacted rock soil, hard clay and well bonded sand and gravel with good surface water drainage.

2. Passive Soil Reaction per unit depth - 600kPa/m.

3. Pole wind pressure - 1700kPa.

Table B-6 – Steel Poles Net Allowable Pole Tip Loads (Sustained Loads)

Pole Description			POOR SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)			MEDIUM SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)			GOOD SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)	
Length (m)	Limit State Pole Strength Rating (kN) (Note 1)	Standard Setting Depth (m)	Stabilised Backfill			Stabilised Backfill			Stabilised Backfill	
			STD Depth +300	STD Depth +450	STD Depth +600	STD Depth +150	STD Depth +300	STD Depth +450	STD Depth	STD Depth +150
12.5	10.8	1.85	2.700	2.700	2.700	2.700	2.700	2.700	2.700	2.700
	14.4		3.600	3.600	3.600	3.600	3.600	3.600	3.600	3.600
14	12.15	2.00	2.113	2.561	3.038	3.038	3.038	3.038	3.038	3.038
	14.4		2.396	2.904	3.481	3.600	3.600	3.600	3.600	3.600

GENERAL NOTES:

1. The Net Allowable Limit State Pole Tip Load is the pole element strength less the wind load on the pole referred to the pole tip.

2. Shading indicates that the foundation allows for full pole strength utilisation.

DESIGN CRITERIA - POOR SOIL

1. Soil Description:
Soft clay, poorly compacted sand and soil that tends to absorb large amounts of water (excluding slush).

2. Passive Soil Reaction per unit depth - 150kPa/m.

3. Pole wind pressure - 0Pa.

DESIGN CRITERIA - MEDIUM SOIL

1. Soil Description:
Compact medium clay, well bonded sandy loam, bonded sand and gravel with reasonable water drainage.

2. Passive Soil Reaction per unit depth - 300kPa/m.

3. Pole wind pressure - 0Pa.

DESIGN CRITERIA - GOOD SOIL

1. Soil Description:
Well compacted rock soil, hard clay and well bonded sand and gravel with good surface water drainage.

2. Passive Soil Reaction per unit depth - 600kPa/m.

3. Pole wind pressure - 0Pa.

Table B-7 – Concrete Poles Net Allowable Pole Tip Loads (Non-Cyclonic Regions)

Pole Description			POOR SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)					MEDIUM SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)					GOOD SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)			
Length (m)	Limit State Pole Strength Rating (kN) (Note 1)	Standard Setting Depth (m)	STD Depth +300	STD Depth +450	Stabilised Backfill			STD Depth +150	STD Depth +300	Stabilised Backfill			STD Depth	STD Depth +150	Stabilised Backfill	
					STD Depth +300	STD Depth +450	STD Depth +600			STD Depth +150	STD Depth +300	STD Depth +450			STD Depth	STD Depth +150
11	16	1.70	5.018	6.676	6.733	8.814	11.205	8.876	11.704	11.580	14.333	14.365	14.268	14.301	14.268	14.301
	24		5.357	7.145	7.072	9.282	11.823	9.509	12.557	12.213	15.986	20.373	15.742	20.896	19.923	22.122
	32		5.865	7.848	7.580	9.985	12.750	10.458	13.837	13.162	17.265	22.037	17.352	23.062	21.533	28.469
12.5	16	1.85	5.718	7.477	7.587	9.773	12.262	10.363	13.398	13.363	14.038	14.072	13.971	14.005	13.971	14.005
	24		6.077	7.967	7.946	10.263	12.901	11.059	14.317	14.058	18.056	21.873	18.738	21.800	21.763	21.800
	32		6.615	8.702	8.485	10.997	13.859	12.102	15.697	15.102	19.436	24.420	20.557	26.770	25.291	29.493
14	16	2.00	6.554	8.433	8.594	10.904	13.514	12.108	13.730	13.695	13.730	13.765	13.660	13.695	13.660	13.695
	24		6.938	8.949	8.977	11.421	14.180	12.874	16.374	16.196	20.453	21.539	21.426	21.464	21.426	21.464
	32		7.513	9.723	9.553	12.195	15.108	14.022	17.867	17.344	21.946	27.188	24.275	29.117	29.075	29.117
15.5	16	2.15	7.494	9.498	9.716	12.161	13.484	13.376	13.412	13.376	13.412	13.448	13.340	13.376	13.340	13.376
	24		7.906	10.045	10.129	12.708	15.600	14.900	18.654	18.569	21.158	21.197	21.079	21.119	21.079	21.119
	32		8.524	10.866	10.747	13.529	16.649	16.165	20.273	19.833	24.718	28.819	28.422	28.732	28.689	28.732
17	16	2.30	8.581	10.725	10.999	13.117	13.154	13.042	13.080	13.042	13.080	13.117	13.005	10.042	13.005	10.042
	24		9.025	11.307	11.444	14.176	17.219	17.217	20.799	20.758	20.799	20.839	20.718	20.758	20.718	20.758
	32		9.179	11.562	11.598	14.430	17.586	18.609	23.008	22.647	27.845	28.422	28.288	28.333	28.288	28.333
18.5	16	2.45	9.778	12.066	12.405	12.777	12.816	12.700	12.738	12.700	12.738	12.777	12.661	12.700	12.661	12.700
	24		10.259	12.688	12.886	15.775	18.976	19.762	20.431	20.390	20.431	20.473	20.348	20.390	20.348	20.390
	32		10.980	13.621	13.607	16.708	20.144	21.291	25.989	25.722	27.971	28.017	27.878	27.925	27.878	27.925

GENERAL NOTES:

1. The Net Allowable Limit State Pole Tip Load is the pole element strength less the wind load on the pole referred to the pole tip.

2. Shading indicates that the foundation allows for full pole strength utilisation.

DESIGN CRITERIA - POOR SOIL

1. Soil Description:
Soft clay, poorly compacted sand and soil that tends to absorb large amounts of water (excluding slush).

2. Passive Soil Reaction per unit depth - 150kPa/m.

3. Pole wind pressure - 1300kPa.

DESIGN CRITERIA - MEDIUM SOIL

1. Soil Description:
Compact medium clay, well bonded sandy loam, bonded sand and gravel with reasonable water drainage.

2. Passive Soil Reaction per unit depth - 300kPa/m.

3. Pole wind pressure - 1300kPa.

DESIGN CRITERIA - GOOD SOIL

1. Soil Description:
Well compacted rock soil, hard clay and well bonded sand and gravel with good surface water drainage.

2. Passive Soil Reaction per unit depth - 600kPa/m.

3. Pole wind pressure - 1300kPa.

Table B-8 – Concrete Poles Net Allowable Pole Tip Loads (Cyclonic Regions)

Pole Description			POOR SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)					MEDIUM SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)					GOOD SOIL - NET ALLOWABLE LIMIT STATE POLE TIP LOADS (kN) (Note 1)			
Length (m)	Limit State Pole Strength Rating (kN) (Note 1)	Standard Setting Depth (m)	STD Depth +300	STD Depth +450	Stabilised Backfill			STD Depth +150	STD Depth +300	Stabilised Backfill			STD Depth	STD Depth +150	Stabilised Backfill	
					STD Depth +300	STD Depth +450	STD Depth +600			STD Depth +150	STD Depth +300	STD Depth +450			STD Depth	STD Depth +150
11	16	1.70	4.505	6.137	6.220	8.310	10.712	8.353	11.191	11.057	13.820	13.862	13.735	13.778	13.773	13.778
	24		4.790	6.589	6.505	8.726	11.278	8.931	11.990	11.635	15.419	19.816	15.154	20.318	19.335	21.544
	32		5.217	7.202	6.932	9.349	12.127	9.798	13.189	12.502	16.617	21.401	16.679	22.401	20.861	27.809
12.5	16	1.85	5.114	6.884	6.984	9.180	11.678	9.749	12.794	12.749	13.435	13.478	13.347	13.391	13.347	13.391
	24		5.411	7.313	7.281	9.608	12.257	10.382	13.652	13.382	17.390	21.218	18.050	21.123	21.075	21.123
	32		5.857	7.955	7.726	10.251	13.125	11.330	14.938	14.330	18.671	23.674	18.692	24.558	23.426	28.787
14	16	2.00	5.857	7.745	7.895	10.217	12.837	11.399	13.031	12.986	13.031	13.077	12.940	12.986	12.940	12.986
	24		6.169	8.192	8.208	10.664	13.435	12.094	15.606	15.416	19.684	20.782	20.634	20.684	20.634	20.684
	32		6.639	8.862	8.679	11.334	11.369	12.389	16.063	15.711	20.141	25.190	23.375	28.230	28.175	28.230
15.5	16	2.15	6.697	8.712	8.920	11.375	12.710	12.569	12.616	12.569	12.616	12.663	12.603	12.649	12.603	12.649
	24		7.031	9.182	9.254	11.845	14.750	14.014	17.780	17.682	20.283	20.334	20.181	20.232	20.181	20.232
	32		7.532	9.887	9.735	12.550	15.684	15.159	19.281	18.828	23.726	27.841	27.403	27.727	27.670	27.727
17	16	2.30	7.190	9.239	9.609	12.107	12.365	12.132	12.181	12.132	12.181	12.230	12.083	12.132	12.083	12.132
	24		8.041	10.335	10.459	13.203	16.259	16.220	19.814	19.761	19.814	19.867	19.708	19.761	19.708	19.761
	32		8.578	11.081	10.997	13.949	17.237	17.481	21.893	21.519	26.731	27.322	27.146	27.205	27.146	27.205
18.5	16	2.45	8.774	11.074	11.401	11.785	11.836	11.684	11.735	11.684	11.735	11.785	11.633	11.684	11.633	11.684
	24		9.160	11.603	11.787	14.690	17.904	18.651	19.333	19.279	19.333	19.388	19.224	19.279	19.224	19.279
	32		9.740	12.395	12.367	15.482	18.933	20.037	24.750	24.268	26.731	26.791	26.610	26.671	26.610	26.671

GENERAL NOTES:

1.The Net Allowable Limit State Pole Tip Load is the pole element strength less the wind load on the pole referred to the pole tip.

2. Shading indicates that the foundation allows for full pole strength utilisation.

DESIGN CRITERIA - POOR SOIL

1. Soil Description:
Soft clay, poorly compacted sand and soil that tends to absorb large amounts of water (excluding slush).

2. Passive Soil Reaction per unit depth - 150kPa/m.

3. Pole wind pressure - 1700kPa.

DESIGN CRITERIA - MEDIUM SOIL

1. Soil Description:
Compact medium clay, well bonded sandy loam, bonded sand and gravel with reasonable water drainage.

2. Passive Soil Reaction per unit depth - 300kPa/m.

3. Pole wind pressure - 1700kPa.

DESIGN CRITERIA - GOOD SOIL

1. Soil Description:
Well compacted rock soil, hard clay and well bonded sand and gravel with good surface water drainage.

2. Passive Soil Reaction per unit depth - 600kPa/m.

3. Pole wind pressure - 1700kPa.

Table B-9 – Concrete Poles Net Allowable Pole Tip Loads (Sustained Loads)

Pole Description			POOR SOIL - NET ALLOWABLE SUSTAINED POLE TIP LOADS (kN) (Note 1)					MEDIUM SOIL - NET ALLOWABLE SUSTAINED POLE TIP LOADS (kN) (Note 1)					GOOD SOIL - NET ALLOWABLE SUSTAINED POLE TIP LOADS (kN) (Note			
Length (m)	Limit State Pole Strength Rating (kN) (Note 1)	Standard Setting Depth (m)	STD Depth +300	STD Depth +450	Stabilised Backfill			STD Depth +150	STD Depth +300	Stabilised Backfill			STD Depth	STD Depth +150	Stabilised Backfill	
					STD Depth +300	STD Depth +450	STD Depth +600			STD Depth +150	STD Depth +300	STD Depth +450			STD Depth	STD Depth +150
11	16	1.70	1.857	2.309	2.333	2.902	3.558	2.938	3.714	3.689	4.000	4.000	4.000	4.000	4.000	4.000
	24		2.000	2.487	2.476	3.081	3.777	3.163	4.000	3.914	4.952	6.000	4.904	6.000	6.000	6.000
	32		2.214	2.754	2.690	3.348	4.105	3.501	4.429	4.252	5.381	6.695	5.427	7.002	6.588	8.000
12.5	16	1.85	2.133	2.613	2.652	3.250	3.932	3.433	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
	24		2.289	2.804	2.808	3.442	4.164	3.683	4.578	4.516	5.616	6.000	5.826	6.000	6.000	6.000
	32		2.523	3.091	3.042	3.729	4.512	4.058	5.045	4.891	6.084	7.457	6.099	7.714	7.414	8.000
14	16	2.00	2.451	2.963	3.048	3.650	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
	24		2.621	3.169	3.188	3.856	4.612	4.281	5.242	5.203	6.000	6.000	6.000	6.000	6.000	6.000
	32		2.876	3.478	3.443	4.165	4.159	4.467	5.473	5.390	6.606	7.993	7.556	8.000	8.000	8.000
15.5	16	2.15	2.800	3.347	3.418	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
	24		2.986	3.569	3.603	4.309	5.101	4.939	5.971	5.958	6.000	6.000	6.000	6.000	6.000	6.000
	32		3.263	3.902	3.881	4.642	5.496	5.398	6.527	6.417	7.762	8.000	8.000	8.000	8.000	8.000
17	16	2.30	3.033	3.589	3.705	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
	24		3.396	4.019	4.068	4.816	5.650	5.683	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
	32		3.699	4.378	4.370	5.174	6.071	6.188	7.397	7.310	8.000	8.000	8.000	8.000	8.000	8.000
18.5	16	2.45	3.622	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
	24		3.841	4.504	4.571	5.362	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
	32		4.169	4.890	4.899	5.748	8.000	7.046	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000

GENERAL NOTES:

1. The Net Allowable Limit State Pole Tip Load is the pole element strength less the wind load on the pole referred to the pole tip.

2. Shading indicates that the foundation allows for full pole strength utilisation.

DESIGN CRITERIA - POOR SOIL

1. Soil Description:
Soft clay, poorly compacted sand and soil that tends to absorb large amounts of water (excluding slush).

2. Passive Soil Reaction per unit depth - 150kPa/m.

3. Pole wind pressure - 1300kPa.

DESIGN CRITERIA - MEDIUM SOIL

1. Soil Description:
Compact medium clay, well bonded sandy loam, bonded sand and gravel with reasonable water drainage.

2. Passive Soil Reaction per unit depth - 300kPa/m.

3. Pole wind pressure - 1300kPa.

DESIGN CRITERIA - GOOD SOIL

1. Soil Description:
Well compacted rock soil, hard clay and well bonded sand and gravel with good surface water drainage.

2. Passive Soil Reaction per unit depth - 600kPa/m.

3. Pole wind pressure - 1300kPa.

Appendix C

Informative

Waterways Crossing Signage

Figure C-1 – Waterways Crossing Sign – Large Overhead Powerline Warning Label

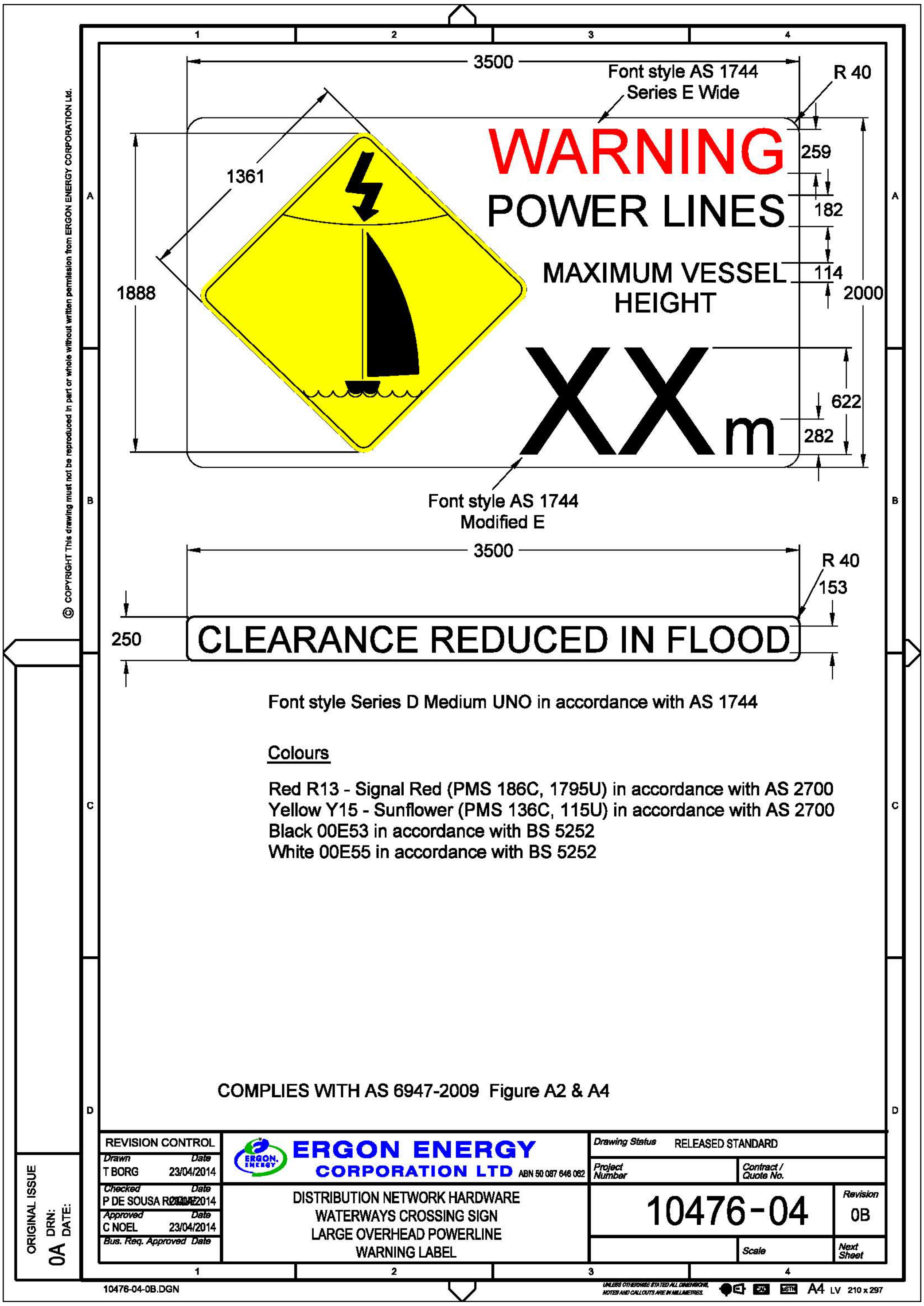


Figure C-2 – Waterways Crossing Sign – Small Overhead Powerline Warning Label

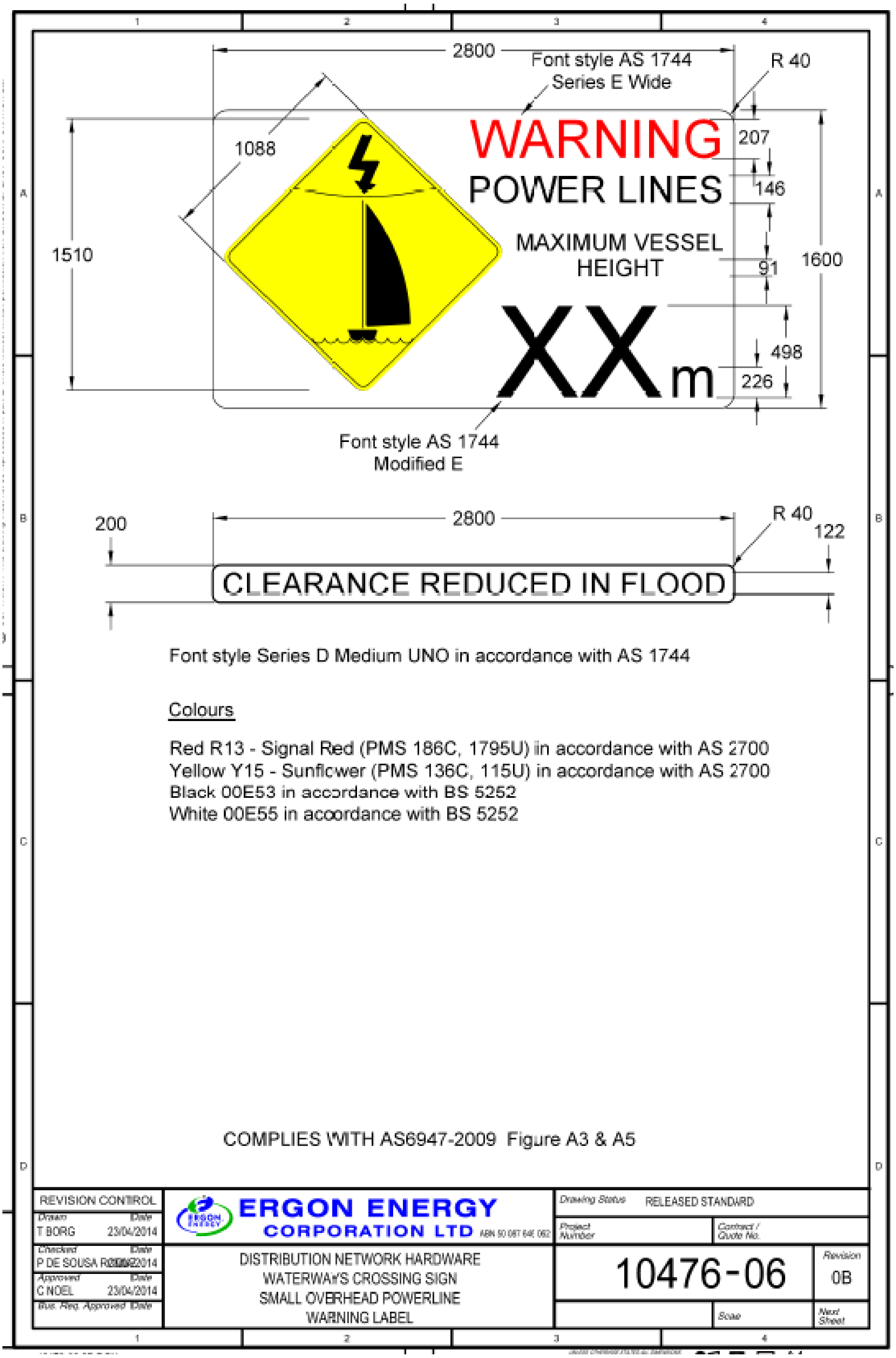


Figure C-3 – Waterways Crossing Sign – Crossing Awareness

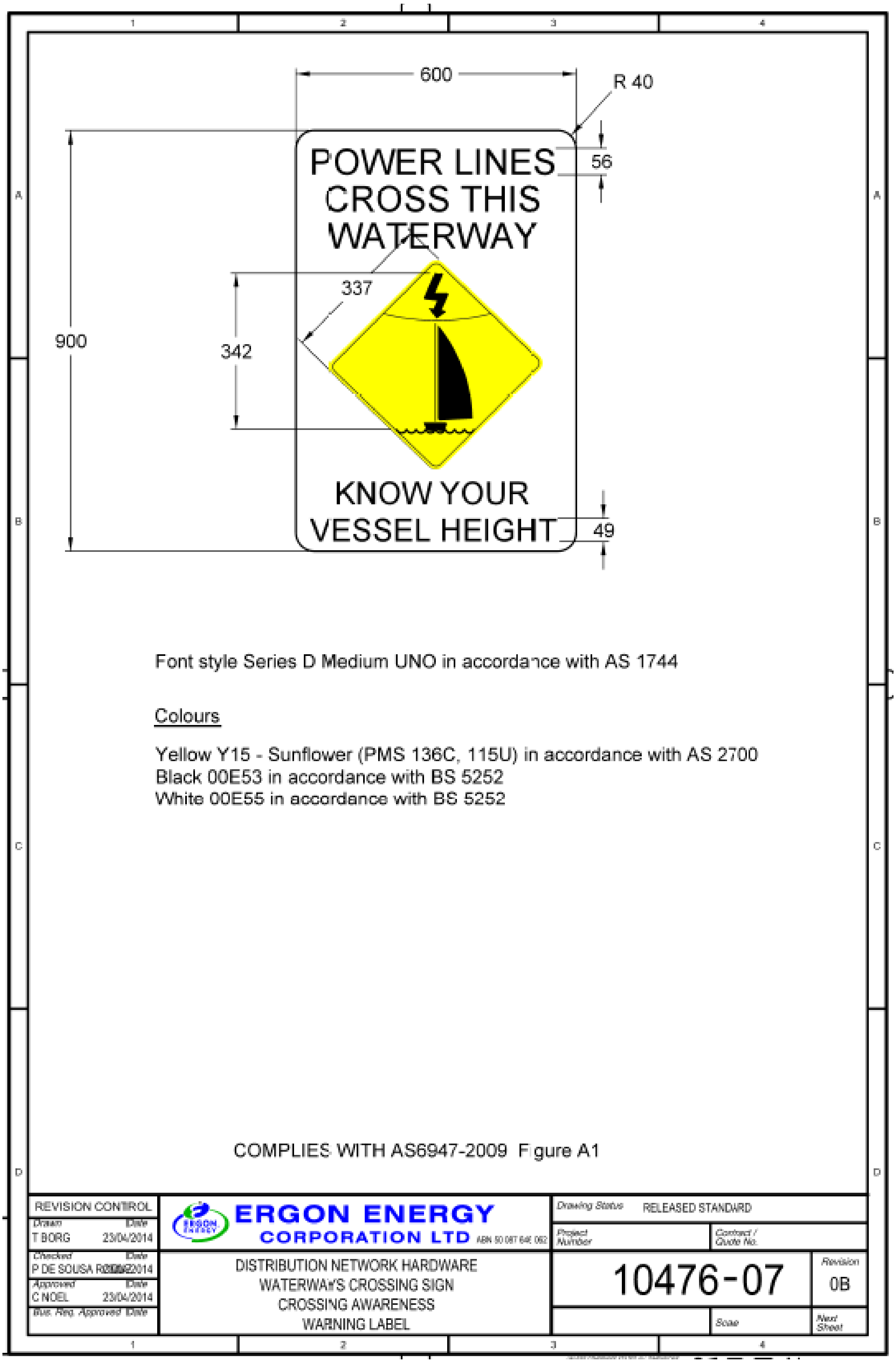


Figure C-4– Waterways Crossing Sign – Submarine Cable Warning Sign

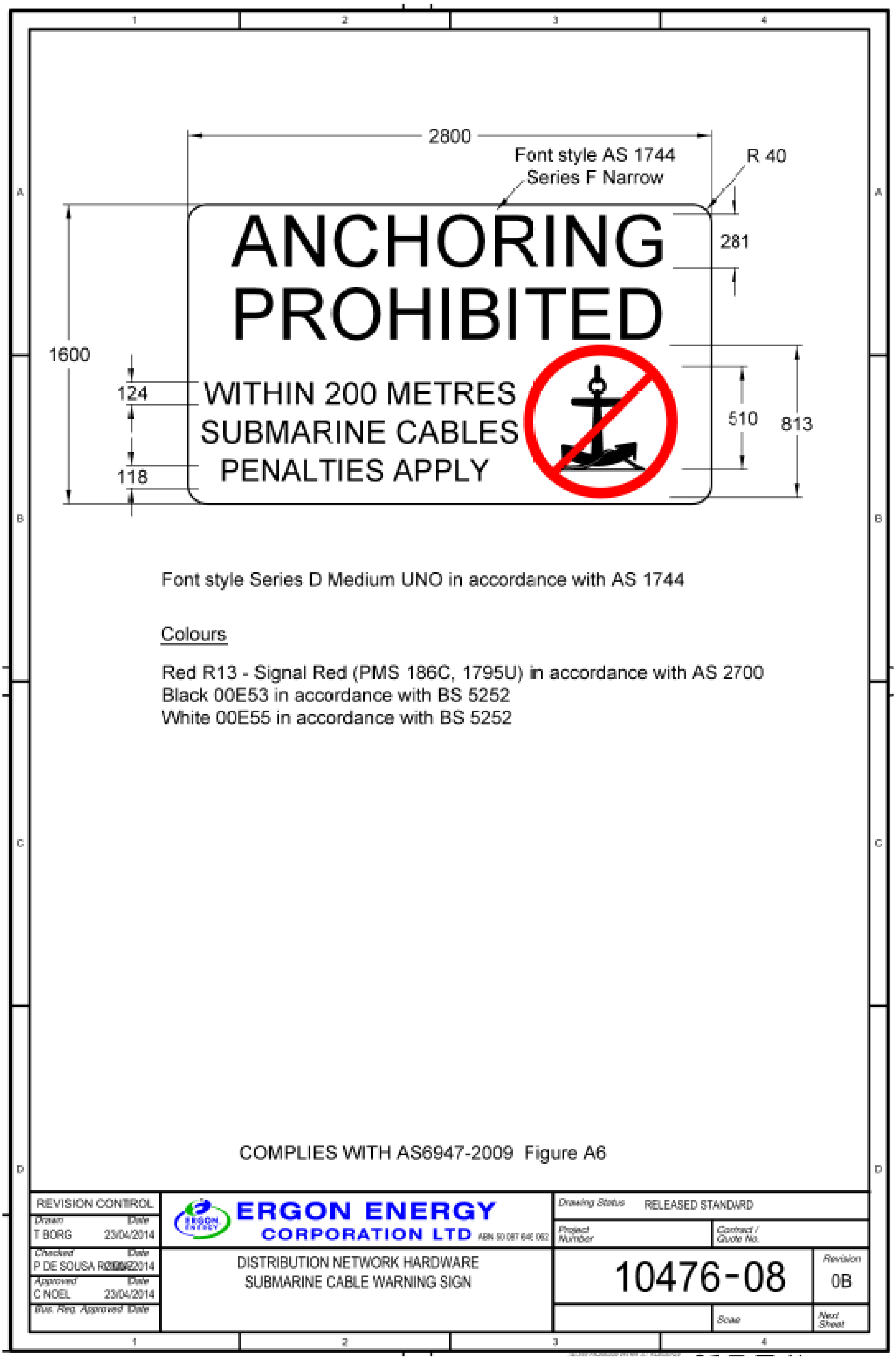


Figure C-5 – Waterways Crossing Sign – Signage Placement - Sample Plan

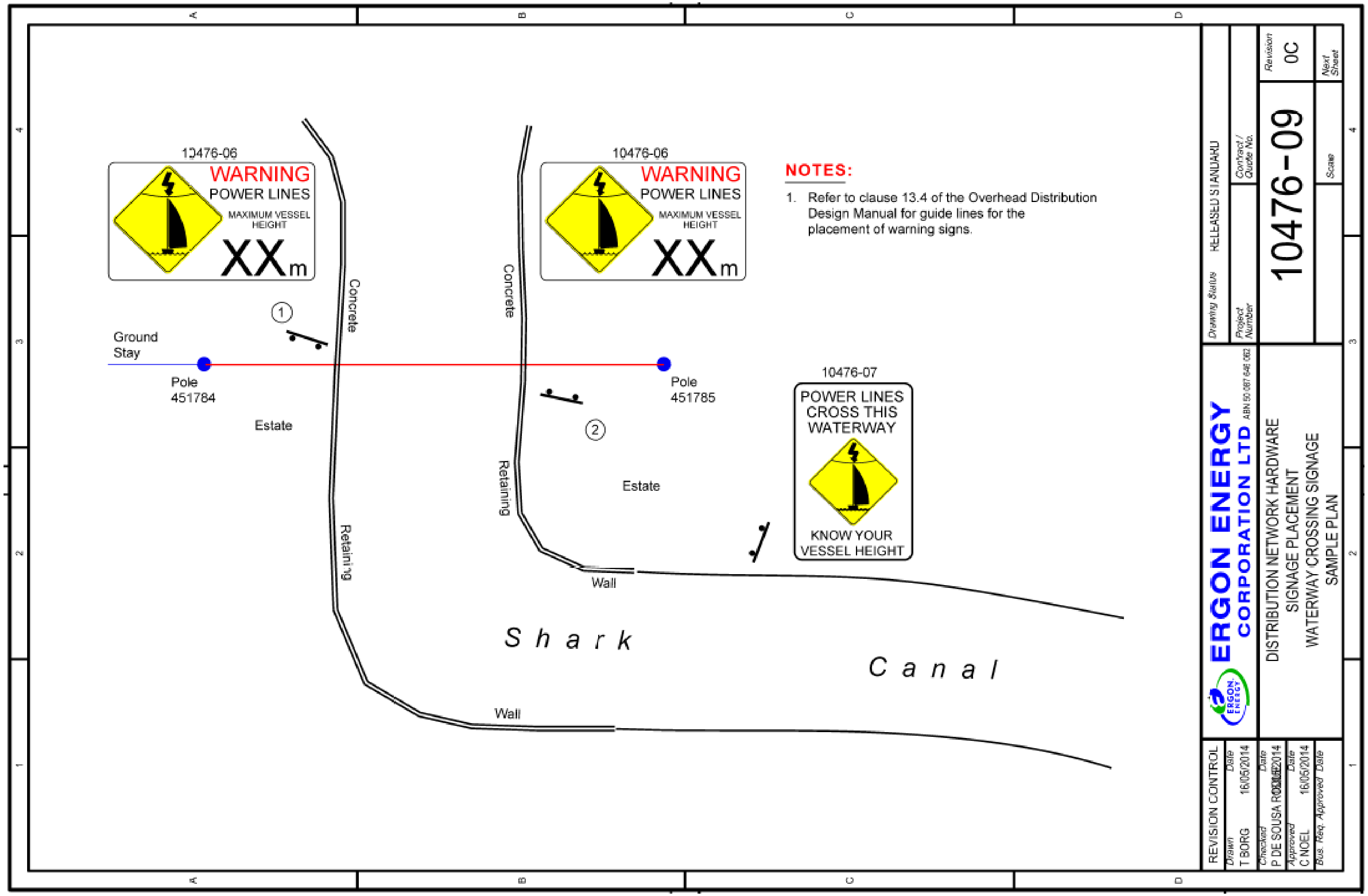


Figure C-6 - Waterways Crossing Sign – Conductor Heighting – Sample Plan

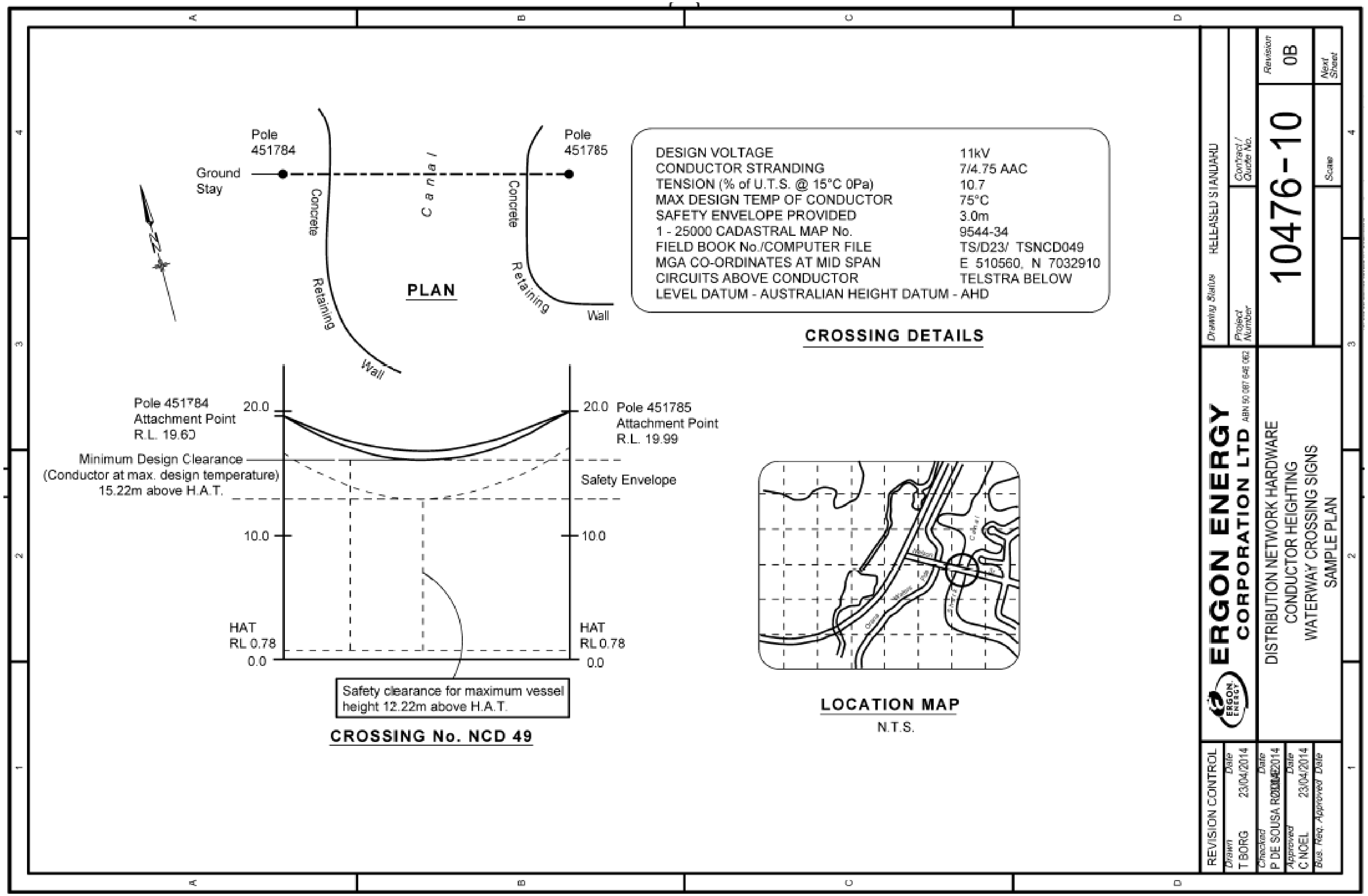


Figure C-7 - Waterways Crossing Sign – Sign Assembly

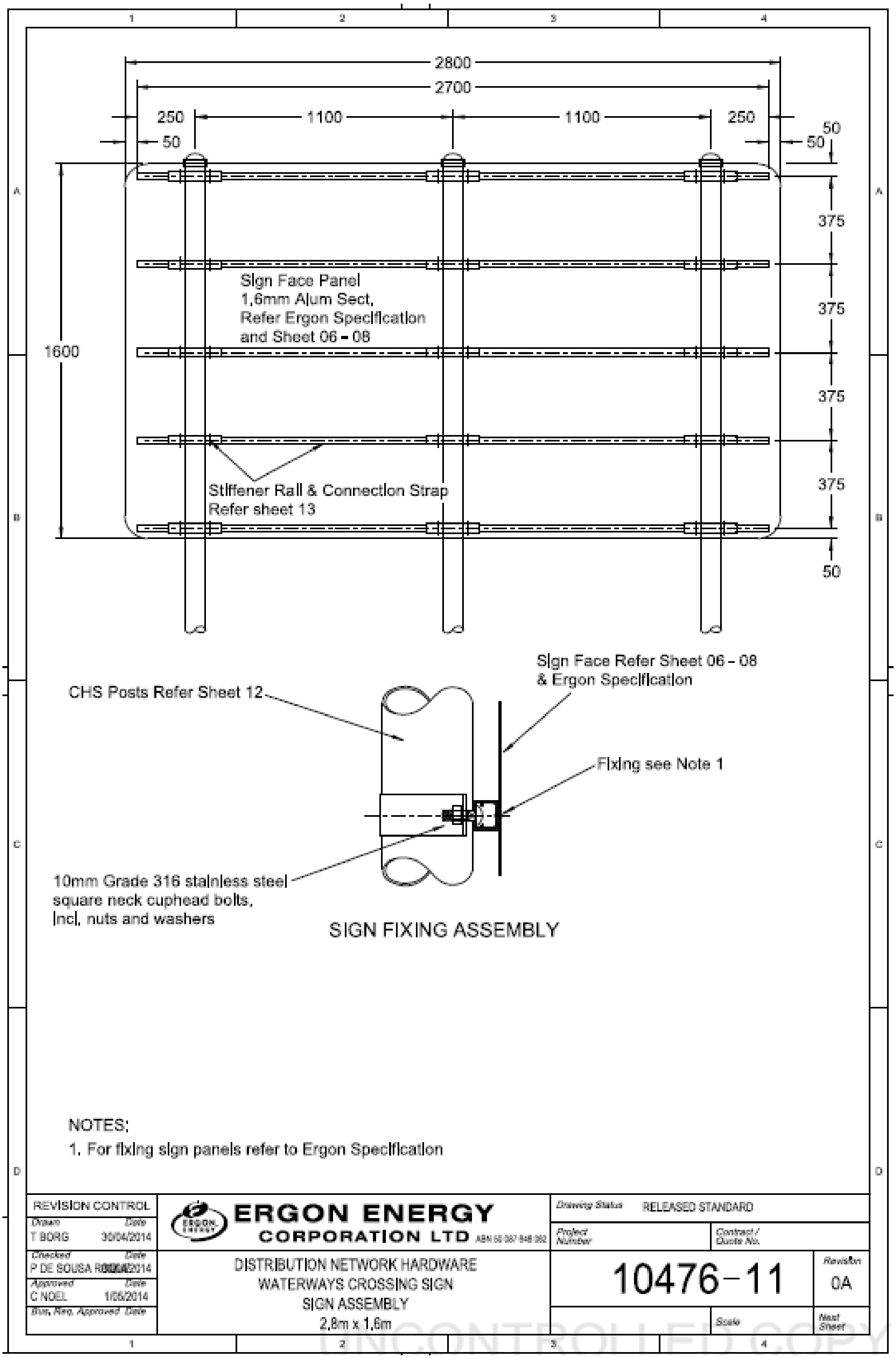


Figure C-8 - Waterways Crossing Sign – Support Post

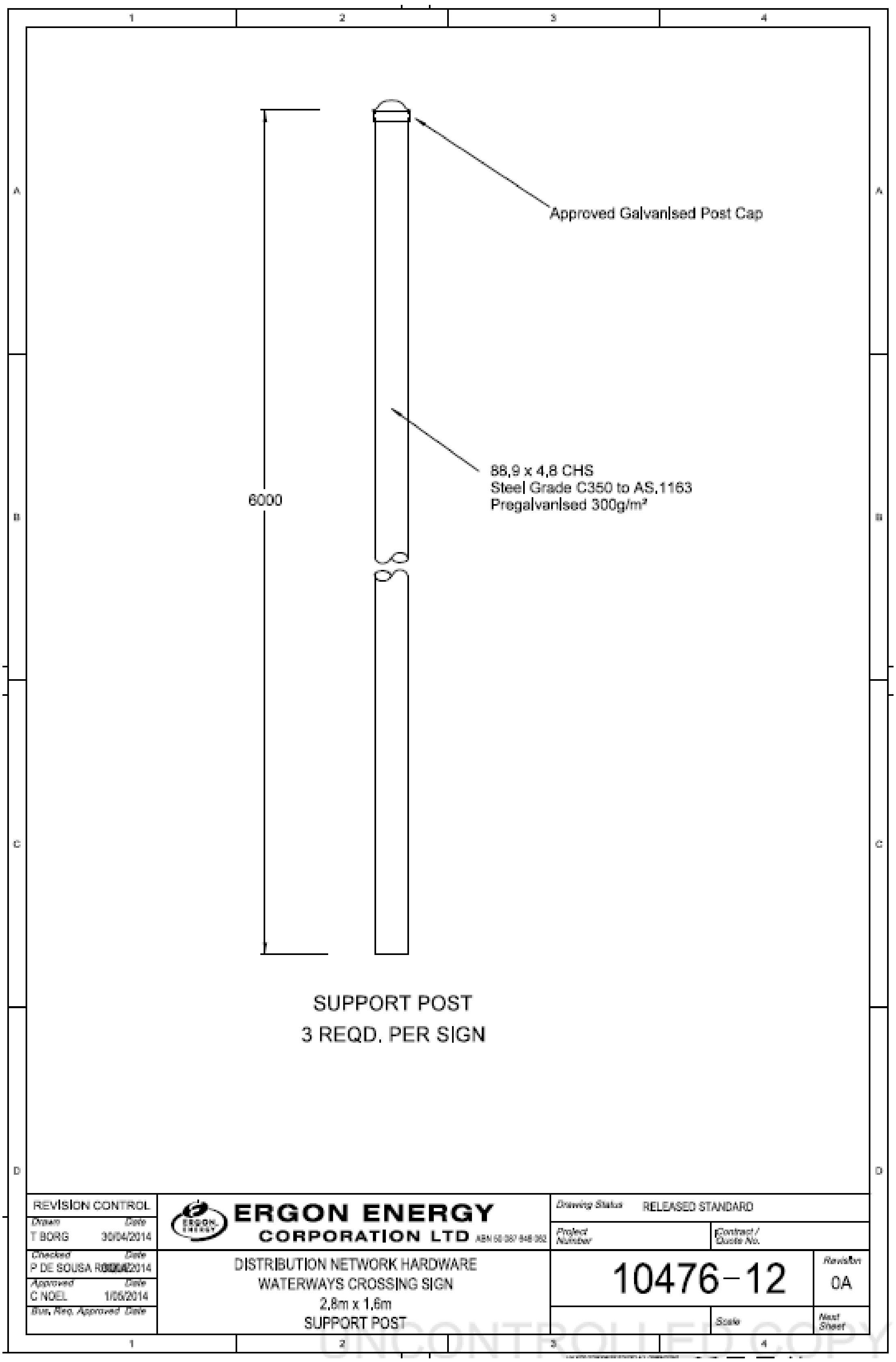
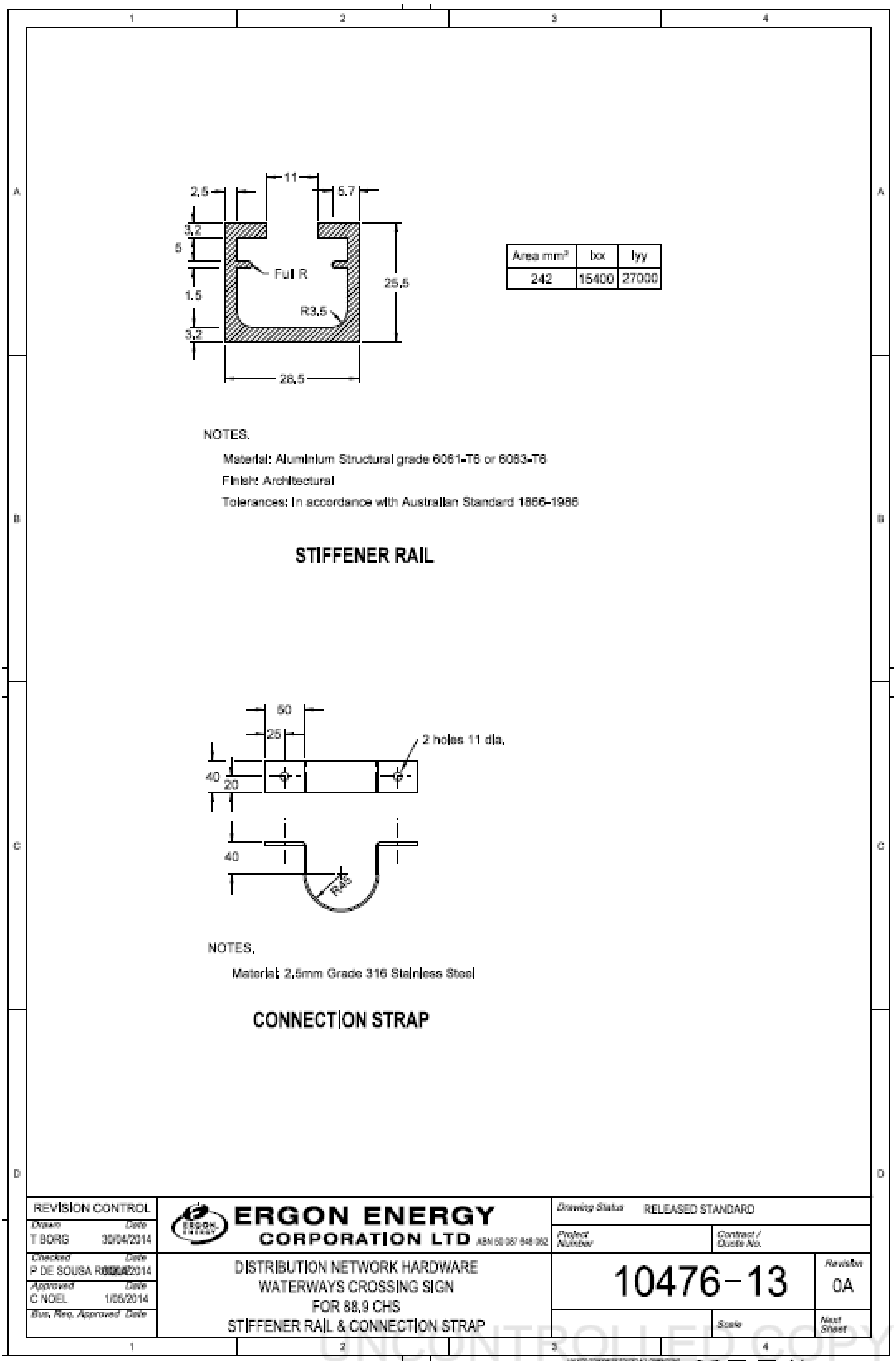


Figure C-9– Waterways Crossing Sign – Stiffener Rail and Connection Strap



Appendix D

Informative

Revision History

Revision date	Version number	Author	Description of change/revision
19/05/2014	1.0	Carmelo Noel	Original Issue
06/06/2016	2.0	Rao Margani Carmelo Noel	Aircraft Warning Marker details added Composite crossarm application
17/06/2020	3.0	Leon Burton	Updated Clearance to structure / ground. 7.5.3 & 7.5.4 Pole use criteria updated.
06/10/2022	4.0	Craig Avenell	Included Number of HV Switch Points
22/05/2023	5.0	Marcella Huismans	Updated Branding & Footnote
07/07/2023	6.0	Marcella Huismans Craig Avenell	Updated Hyperlinks
14/07/2023	7.0	Sandy Meikle	Header, Footer and formatting correction
20/07/2023	8.0	Sandy Meikle Marcella Huismans	References updated
04/11/2025	9.0	Fabio Zaini	Updates to the following sections: 1.2. 6.4, 6.5, 6.6, 7.2, 8.1, 12.2 and Appendix A. Fig 9.1 - updated