



positive energy



**Joint Ergon Energy/Energex**

**Technical Specification for  
Aluminium Conductor  
Underground Power Cables  
for Nominal System Voltages of  
11 and 33 kV**

**JTS04-01-09**

## Table of Contents

<b>1. Purpose and Scope</b> .....	<b>1</b>
1.1 General.....	1
1.2 Conforming Tenders.....	1
1.3 Alternatives.....	1
<b>2. Applicable Standards</b> .....	<b>2</b>
<b>3. Drawings</b> .....	<b>4</b>
<b>4. Service Conditions</b> .....	<b>4</b>
4.1 General Operating Conditions.....	4
4.2 Operating Conditions – Exposed Cable.....	5
4.3 Cable Application.....	5
<b>5. Design and Construction</b> .....	<b>5</b>
5.1 11kV and 33kV TRXLPE Insulated Cables.....	5
5.2 Option to Include Optical Fibres in the Cable Construction.....	9
5.3 Sealing of Cable Ends.....	12
5.4 Cable (Length) Markings.....	12
5.5 Drum Flange.....	12
5.6 Identification Printing.....	13
5.7 Laying.....	13
<b>6. Performance and Testing</b> .....	<b>13</b>
6.1 General.....	13
6.2 Water Penetration Tests.....	13
6.3 Type Testing.....	13
6.4 Routine Tests.....	14
6.5 Additional Tests.....	14
<b>7. Risk Assessment</b> .....	<b>15</b>
7.1 Legislation.....	15
7.2 Documentation.....	15
7.3 Tie Down Restraint.....	15
7.4 Cable Fastening.....	15
<b>8. Quality Assurance</b> .....	<b>15</b>
<b>9. Samples</b> .....	<b>16</b>
9.1 Production Samples.....	16
9.2 Delivery and Purchase.....	16

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



<b>10. Packaging and Marking .....</b>	<b>16</b>
10.1 General .....	16
10.2 Drum Sizes and Lengths .....	17
10.3 Drum Marking .....	17
10.4 Quarantine Requirements.....	18
<b>11. Service History .....</b>	<b>18</b>
<b>12. Reliability .....</b>	<b>19</b>
12.1 Guarantee.....	19
12.2 Service Life.....	19
<b>13. Traceability .....</b>	<b>19</b>
<b>14. Training .....</b>	<b>19</b>
<b>15. Environmental Considerations .....</b>	<b>19</b>
<b>16. Information to be Provided.....</b>	<b>20</b>
16.1 General.....	20
16.2 Drawings.....	20
16.3 Risk Assessment .....	20
16.4 Management Systems .....	20
16.5 Traceable Item Reliability Performance Guarantee .....	20
16.6 Technical Documentation Checklist.....	20
<b>17. Attachment 1 – Technical Details .....</b>	<b>21</b>
17.1 Technical Details – 11kV CABLE (Separate sheet for each item) .....	21
17.2 Technical Details – 33kV CABLE (Separate sheet for each item) .....	23
17.3 Technical Details – FIBRE OPTIC CABLE .....	25
<b>18. Attachment 2.....</b>	<b>26</b>
18.1 Underground Cable Current Rating .....	26
18.2 Underground Cable Current Rating (Continued) .....	27
18.3 Underground Cable Current Rating (Continued) .....	28
<b>19. Attachment 3.....</b>	<b>29</b>
19.1 Risk Assessment .....	29
<b>20. Attachment 4.....</b>	<b>30</b>
20.1 Management Systems Information Schedule .....	30
<b>21. Attachment 5.....</b>	<b>33</b>
21.1 Traceable Items Reliability Performance Guarantee .....	33
<b>22. Attachment 6.....</b>	<b>34</b>
22.1 Technical Documentation Checklist.....	34

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



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<b>23. Attachment 7.....</b>	<b>35</b>
23.1 Additional Water Penetration Test .....	35
23.2 1. Scope .....	35
23.3 2. Principle .....	35
23.4 3. Preparation of Sample .....	35
23.5 4. Apparatus .....	35
23.6 5. Procedure .....	35
23.7 6. Report.....	36

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 1. Purpose and Scope

### 1.1 General

This specification sets out the Joint ENERGEX and Ergon Energy requirements for the manufacture, testing and delivery of Underground Power Cables with Aluminium Conductors for use in electricity sub-transmission and distribution networks at system voltages of 33 and 11kV. Specifically, the following are included:

- 33kV single core Tree Retardant Cross Linked Polyethylene (TRXLPE) underground cable
- 11kV triplex TRXLPE underground cable

### 1.2 Conforming Tenders

Offers strictly in accordance with the requirements of this specification as summarised below will be regarded as conforming tenders.

### 1.3 Alternatives

Tenderers are encouraged to submit alternative tenders based on their standard products provided that the cables so offered will provide current ratings and in-service performance equivalent to the cables conforming to this specification. Departures from this specification shall be fully documented in the tender. Alternative tenders may be submitted for consideration without a conforming tender being submitted.

The Tenderer is also required to offer a recommendation for the two classes of cable based purely on a performance outcome under the stated Service Conditions, including compliance with AS/NZS 1429.1 and considering Australian National and International best practice as well as AER requirements for best practice in terms of safety, technical, environmental and economic performance. Departures from AS/NZS 1429.1 should be noted.

The items covered by this technical specification are listed as follows:

ITEM	DESCRIPTION	STOCK CODE
<b>6.35/11 (12) kv CABLES:</b>		
1	3 x 1C 400mm <sup>2</sup> WB Aluminium / TRXLPE / WBT / Light Duty CWS / WBT / MDPE with Termite Repellent / Triplex	22339
2	3 x 1C 400mm <sup>2</sup> WB Aluminium / TRXLPE / WBT / Heavy Duty CWS / WBT / MDPE with Termite Repellent / Triplex	002433811
3	3 x 1C 400mm <sup>2</sup> WB Aluminium / TRXLPE / WBT / Heavy Duty CWS / WBT / PVC / NYLON / MDPE / Triplex / Insect Protected	002433829
<b>19/33 (36) KV CABLES:</b>		
4	1C 1,000mm <sup>2</sup> WB Aluminium / TRXLPE / WBT / Light Duty CWS / WBT / LAT / LLDPE / MDPE with Termite Repellent & Graphite Coating.	22338
5	1C 1,000mm <sup>2</sup> WB Aluminium / TRXLPE / WBT / Medium Duty CWS / WBT / LAT / LLDPE / MDPE with Termite Repellent & Graphite Coating.	002433860
6	1C 1,000mm <sup>2</sup> WB Aluminium / TRXLPE / WBT / Medium Duty CWS / WBT / LAT / LLDPE / NYLON / MDPE & Graphite Coating	002433886

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



ITEM	DESCRIPTION	STOCK CODE
	/ Insect Protected.	
7	1C 1,000mm <sup>2</sup> WB Aluminium / TRXLPE / WBT / Medium Duty CWS with OF / WBT / LAT / LLDPE / MDPE with Termite Repellent & Graphite Coating.	002433837
8	1C 1,000mm <sup>2</sup> WB Aluminium / TRXLPE / WBT / Medium Duty CWS with OF / WBT / LAT / LLDPE / NYLON / MDPE & Graphite Coating / Insect Protected.	002433852
9	1C 1,000mm <sup>2</sup> WB Aluminium / TRXLPE / WBT / Heavy Duty CWS / WBT / LAT / LLDPE / MDPE with Termite Repellent & Graphite Coating.	002433878
10	1C 1,000mm <sup>2</sup> WB Aluminium / TRXLPE / WBT / Heavy Duty CWS with OF / WBT / LAT / LLDPE / MDPE with Termite Repellent & Graphite Coating.	002433845

Abbreviations in above table:

CWS - Copper Wire Screen  
 LAT - Laminated Aluminium Tape  
 LLDPE - Linear Low Density Polyethylene  
 MDPE - Medium Density Polyethylene  
 OF - Optical Fibre  
 PVC - Polyvinyl Chloride  
 TRXLPE - Tree Retardant Cross linked Polyethylene  
 WB - Water Blocked Conductor  
 WBT - Water Blocking Tapes (and Yarns as required)

## 2. Applicable Standards

The cables must comply with the latest revision of all relevant Queensland Acts / Regulations and Australian Standards, and all amendments issued from time to time except where varied by this specification.

Should inconsistencies be identified between standards and/or this specification, the Tenderer shall immediately refer such inconsistencies to the Purchaser for resolution.

Standards that are applicable to this specification include the following:

Standard	Title
AS 1931	High-voltage test techniques
AS 60270	High-voltage test techniques - Partial discharge measurements
ASTM D1603	Carbon black in ethylene plastics
AS/NZS 1125	Conductors in insulated electrical cables and flexible cords
AS/NZS 1429.1	Electric cables - Polymeric insulated
AS/NZS 1660	Test methods for electric cables, cords and conductors
AS/NZS 2053.2:2001	Conduits and fittings for electrical installations Part 2: Rigid plain conduits and fittings of insulating material

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



Standard	Title
AS/NZS 2857 - 1986	Timber drums for insulated electric cables and bare conductors
AS/NZS 3808	Insulating and sheathing materials for electric cables
AS/NZS 3983	Metal drums for insulated electric cables and bare conductors
AS/NZS 60840:2006	Power Cables with extruded insulation and their accessories for rated voltages above 30kV ( $U_m = 36kV$ ) up to 150kV ( $U_m=170 kV$ ) – Test methods and requirements
CENELEC	Document HD 632 S2:2008.
Electricity Association Services Ltd. Engineering Recommendation C.55/4	Insulated Sheath Power Cable Systems
ELECTRA No. 24, Oct. 1972	Current Ratings of Cables for Cyclic and Emergency Loads (Part 1)
IEC 60228	Abbreviation of IEC 60684-3-228 Ed. 1.0 b... “heat shrinkable....sleeving”....
IEC 60229	Tests on cable over-sheaths which have a protective function and are applied by extrusion
IEC 60230	Impulse tests on cables and their accessories
IEC 60287-Parts 1 and 2	Electric cables – Calculation of the current rating – Part 1: Current rating equations and calculation of losses – Part 2: Thermal resistance
IEC 60684	Flexible insulating sleeving
IEC 60811-1-1	Common test methods for insulating and sheathing materials of electric cables – Part 1:Methods for general application – Section1: Measurement of thickness and overall dimensions – Tests for determining the mechanical properties
IEC 60811-1-2	Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section 2: Thermal ageing methods
IEC 60811-1-3	Insulating and sheathing materials of electric cables – Common test methods - Part 1: General application – Section 3:Methods for determining the density - Water absorption tests – Shrinkage test
IEC 60811-1-4	Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section Four: Tests at low temperature
IEC 60811-2-1	Insulating and sheathing materials of electric and optical cables – Common test methods - Part 2-1: Methods specific to elastomeric compounds –Ozone resistance, hot set and mineral oil immersion tests
IEC 60811-4-1	Common test methods for insulating and sheathing materials of electric cables – Part 4: Methods specific to polyethylene and polypropylene compounds –Section One: Resistance to environmental stress cracking – Wrapping test after thermal

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



Standard	Title
	ageing in air – Measurement of the melt flow index – Carbon black and/or mineral content measurement in PE
IEC 60885-3	Electrical test methods for electric cables – Part 3: Test methods for partial discharge measurements on lengths of extruded power cables
IEC 60287	Calculation of Continuous Current Rating of Cables (100% LF)
IEC 60793-2	Optical fibres – Part 2 – Product specification for multimode fibres
ISO 48	Rubber, vulcanised or thermoplastic – Determination of hardness (hardness between 10 IRHD and 100 IRHD)
ISO 9001	Quality systems - Model for quality assurance in production, installation and servicing
ITU-T G651 ITU-T G652	International Telecommunications Union –Telecommunications (ITU-T) Recommendations G651 and G652
TS008	Austel Technical Standard 008 – Requirements for Authorising Cabling Products

### 3. Drawings

No drawings are provided with this specification.

### 4. Service Conditions

#### 4.1 General Operating Conditions

- The conditions under which the cables will be required to operate are: Installed in a touching trefoil arrangement, either directly buried; or in a single way duct comprised of :
  - PVC conduit; or
  - polyethylene pressure pipe; or
  - fibre-cement conduit;

at a nominal depth of up to 1,200mm in a:

- fine grain bedding material; or
- in cement stabilised bedding and backfill; or
- flowable fill;
- Cable ends rising up concrete, timber, or metal poles and exposed to direct sunlight;
- Ambient air temperature not exceeding 50oC summer day time and -5oC winter night time as determined by a shaded thermometer;
- Ambient soil temperature not exceeding 35°C;
- An altitude not exceeding 1,000m above sea level;
- A high humidity (90%) combined with a high temperature (45°C); followed by a sudden drop in temperature of up to 10°C;



# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



- An area in which the cables may be installed is home to subterranean termite, *Mastotermes Darwinensis* and the coastal brown ant, *Pheidole Megacephala*.

## 4.2 Operating Conditions – Exposed Cable

Exposed sections of cable will be subject to the following additional service conditions:

- Solar radiation intensity of 1,000W/m<sup>2</sup>;
- Tropical summer storms with high winds above 160km/h and an annual rainfall in excess of 1,500mm;
- Areas of coastal salt spray and/or industrial pollution with equivalent salt deposits densities in the range of 2.0 - 3.0g/m<sup>2</sup>.

## 4.3 Cable Application

The power cables required are for use on 33kV and 11kV, three phase, 50Hz systems.

### 4.3.1 11kV Systems

The star point of the 11kV system is earthed either directly, or impedance earthed through a resistor, reactor, or via a neutral earthing transformer.

The maximum system voltage (phase to phase) is 12kV and the required impulse insulation levels are 95kV<sub>peak</sub>.

### 4.3.2 33kV Systems

The star point of the 33kV system is earthed either directly, or impedance earthed through a resistor or reactor.

The maximum system voltage (phase to phase) of both the ENERGEX and Ergon Energy networks is 36kV and the required impulse insulation levels are 200kV<sub>peak</sub>.

## 5. Design and Construction

### 5.1 11kV and 33kV TRXLPE Insulated Cables

#### 5.1.1 General

The 11kV and 33kV cables shall be designed, manufactured and tested in accordance with AS/NZS 1429.1.

During the contract period, the Tenderer shall not change the design, supplier, manufacturing process or compounding of the materials without the written approval of the Purchaser.

The location of manufacture and the Manufacturer as nominated in the tender in respect of any good or component of a good or basic processed material shall not be changed without the submission of relevant additional Quality Assurance documentation and without the prior approval in writing of ENERGEX/Ergon Energy.

The conductor screen, insulation and insulation screen shall be manufactured using a 3 in 1 extruder head with all three layers applied in the same extruder head.

It is desirable that the process has facilities at the point of extrusion to monitor and control the thickness of the extruded screens and the insulation and the concentricity of the cable (this may be done by X-Ray scanning and control or similar techniques).

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



The Tenderer must state in the tender submission how they will control the concentricity of the cable and the thickness of the extruded cable screens and the cable insulation. This will be considered in assessing tenders.

The cable cores shall be dry nitrogen cured and de-gassed to the manufacturer's recommendations, but in any case as a minimum, at ambient temperature for 1 day per millimetre of insulation thickness prior to further laying up of the cable core.

## 5.1.2 Conductors

The 11kV conductors will have a nominal cross-sectional area of 400mm<sup>2</sup> (items 1 to 3) and shall be stranded circular compacted aluminium in accordance with Section 3 of AS/NZS 1125.

The 33kV conductors will have a nominal cross-sectional area of 1000mm<sup>2</sup> aluminium (items 4 to 10). To provide for greater conductor flexibility, the conductors shall be alternative Class 2 (refer to AS/NZS1125 and IEC60228) Milliken stranding construction, fully water blocked, including water blocking tapes between sectors of the conductor instead of insulating barriers.

(Note the conductor cross sectional areas are indicative only and the Tenderer is encouraged to offer standard alternatives of comparable ratings.)

The individual wires shall be of the same nominal diameter before stranding into the compacted circular formation. Successive layers of wires shall have opposite directions of lay.

Any lubricants used during compaction of the conductor shall be removed from the conductors prior to application of the core screen. Greasing of the conductors is not permitted.

## 5.1.3 Water Blocking of 11kV and 33kV Conductors

Water blocking of the conductor stranding shall be provided by the use of non-biodegradable water swellable yarns and tapes to preclude the longitudinal migration of moisture along the conductor.

Non-conductive water blocking yarns and/or non-conductive water blocking tapes are acceptable for use inside conductors. Water blocking yarns used inside conductors must be spun yarns containing super-absorbent staple fibre and suitable strength elements. Water blocking tapes used internally in conductors must be less than 0.20mm thick and consist of a single polyester web and a suitable super-absorbent powder mixture. The water blocking material shall not affect the performance of the conductor and conductor connections in terms of the ratings calculated in accordance with IEC 60287.

Water blocking tapes used peripherally around conductors must be semi-conductive, readily removable and consist of one or two webs, a suitable super-absorbent powder mixture and carbon black.

All water blocking materials must have proven long term thermal stability at power cable operating conditions.

Water absorbent materials in a class of polymers described as "neutralised cross-linked polyacrylate acid" and also known by the generic term "polyacrylate absorbents" are acceptable.

Water absorbent materials in a free powder form are not acceptable.

Mastic type water blocking materials are not acceptable.

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



The Tenderer shall provide details of the proportion of the cross-sectional area of the free space within the conductor envelope occupied by the water blocking tapes and/or yarns.

The Tenderer shall submit with their tender submission the results of tests carried out in accordance with Appendix C of AS/NZS 1429.1 demonstrating the effectiveness of water-blocking method and materials proposed.

## 5.1.4 Conductor Screen

11kV and 33kV cables shall have an extruded, cross-linked, semi-conductive conductor screen applied in accordance with clause 2.2 of AS/NZS 1429.1.

## 5.1.5 Insulation

The insulation for both 11kV and 33kV cables shall be TRXLPE suitable for conductor temperatures described in Table 1.2 of AS/NZS 1429.1 for XLPE. The dry cure process shall be used. Full technical details of the TRXLPE insulation offered shall be included in the tender submission. The Tenderer shall provide information on how the Tree Retardant requirement is achieved including the source and type of XLPE material, and the percentage and type of Tree Retardant compound in the XLPE (i.e. Technical paper discussing the assurance of how ongoing measurable TRXLPE quality is maintained and test results validating what is the overall impact on cable life over non TRXLPE.) This will form part of the tender assessment.

The Tenderer shall provide sample test results of shrinkage tests carried out on the TRXLPE insulation using the test procedure and meeting the requirements of Clause 12.4.13 of CENELEC Document HD 632 S2:2008 Part 1, in particular the maximum permissible shrinkage of 4%.

The expected service life of the cable under the specified environmental conditions with TRXLPE insulation offered shall also be stated.

De-gassing of the insulation shall be effected before the LAT is applied to 33kV cables. The Tenderer shall provide details with the tender documentation of the de-gassing process, stating the temperatures and periods of time that manufactured core material of the cable is exposed to allow gasses to ventilate.

At the end of the de-gassing process the residual gases shall be identified and quantified by measuring the cross-linking by-product concentration in cable samples using the tests conducted in a thermogravimetric analyser (TGA) in accordance with the procedure and meeting the requirements of Clause 2.4.15 of CENELEC Document HD 632 S2:2008 Part 2.

## 5.1.6 Insulation Screen

The screen shall consist of a layer of extruded, cross-linked, semi-conductive compound applied directly over the insulation. The insulation screen shall be designed to be hand-stripped in accordance with clause 2.4.3 of AS/NZS 1429.1, and it shall meet the strippability and adhesion tests of tests 4(b) and (c) of Table 3.1 of AS/NZS 1429.1.

## 5.1.7 Metallic Screen

The individual 11kV triplex cable cores and 33kV cable shall be screened using helically applied plain annealed copper wires complying with AS/NZS 1125. Each screen shall have a gross cross-sectional area not less than that required to ensure that under the maximum prospective fault conditions the transient temperature of the screen does not exceed 250°C.

The minimum screen strand size shall be 1.35mm.

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



The metallic screens shall be designed and constructed for system fault levels specified in Section 5.1.9. The fault rating of the cable screen based on an initial core conductor temperature of 90°C shall be stated in Attachments 1.1 and 1.2.

The metallic screens shall be designed and constructed for system fault levels described in 5.1.9.

For both 11kV and 33kV cables the screen wires shall be applied over the bedding of semi-conductive water blocking tapes.

## 5.1.8 Protective Layers, Over-Sheaths and Outer-Sheaths

For both the 11kV and 33kV cable cores shall have water-swellable tapes applied under and over the screen wires in accordance with Clause 2.14 of AS/NZS 1429.1.

For 33 kV cables the cable cores will be further enclosed by an extruded water barrier comprised of an Aluminium / PE laminate tape (LAT) bonded to a LLDPE over-sheath sheath.

The seam of the LAT shall be continuous without any puckering and be capable of accommodating the bending and others stresses applied to cable cores during installation, without any disturbance to the seal.

The LAT shall be strippable from the LLDPE and shall have adhesion and peel strength in accordance with AS/NZS 60840 Annex G.

Full details of the LAT shall be included with the tender.

The LLDPE over-sheath shall comply with AS/NZS 3808.

Where a nylon jacket is specified for insect protection, a 5V-90 PVC sheath (colour orange) shall be applied either over the water swellable tapes for 11kV cables or the LAT over-sheath for 33kV cables, in accordance with Clause 2.13 of AS/NZS 1429.1. The nylon jacket shall be applied over the PVC sheath and must be capable of being removed without damage to the PVC sheath.

The nylon jacket shall consist of continuously UV stabilised black nylon (polyamide 12) with a radial thickness of not less than 0.8mm. It must have a smooth glossy surface, free from defects or scratches. Full details of the nylon jacket shall be included with the tender.

For both 11kV and 33kV cables an extruded outer-sheath of black MDPE shall be applied as the final protective over-sheath of the cable.

The Tenderer shall provide sample test results of shrinkage tests carried out on the MDPE outer sheath insulation using the test procedure and meeting the requirements of Clause 12.4.13 of CENELEC Document HD 632 S2:2008 Part 1, in particular the maximum permissible shrinkage of 4%

The black MDPE over-sheath shall be in accordance with Clause 2.13 of AS/NZS 1429.1 and UV stabilized by the addition of a minimum of 2% carbon black evenly distributed throughout the MDPE.

For the purposes of this specification the term MDPE refers to an over sheath that shall have the following properties:

Table 5.1.8	
Property	Value for MDPE
Density	0.930 – 0.950 g/cm <sup>3</sup>

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



Hardness Shore D	54 – 58
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Where termite repellent is specified the MDPE outer sheath shall be impregnated with an effective termite repellent. Material Safety Data Sheets (MSDS) quoting the active ingredient, toxicity level and safety information shall be submitted with the tender.

To facilitate over-sheath testing a graphite coating shall be applied to the outside of the outer-sheath. The Tenderer shall give details of the graphite coating being offered.

## 5.1.9 System Earth Fault Duties

The XLPE insulated cables shall be designed to meet the system earth fault duties as follows:

Voltage	ENERGEX	Ergon Energy
11 kV	6kA for 1 sec (light)	13.1kA for 1 sec (heavy)
33 kV	5kA for 3 sec (light)	13.7kA (medium) for 1 sec and 25kA (heavy) for 1 sec

## 5.2 Option to Include Optical Fibres in the Cable Construction

As an optional inclusion in the power cable construction of 33kV cables, the Tenderer is invited to offer the addition of multi-mode and single mode optical fibres to enable distributed temperature sensing (DTS) utilising a York DTS800-MR machine or equivalent. The OF cables shall be placed preferably between available screen wires for mechanical protection. The maximum operating temperature may range from 85°C continuously to 100°C under 2-hour emergency conditions.

The cable shall incorporate 4 optic fibres. The fibres should be laid up together with strengthening member/s and a protective covering in the lay of the copper screen wires.

The inclusion of the optic fibre cable shall not cause any protrusion of the external profile of the completed power cable that would attract damage to the optic fibre during cable installation.

The Tenderer shall provide detail of the means employed to ensure integrity of fibre during cable installation.

Alternative arrangements for incorporating the fibres into the cable may be considered and the Tenderer must provide full details of any alternative offer in the tender submission.

### 5.2.1 Optical Fibre Requirements

The cable will be comprised of 2 multi mode and 2 single mode fibres shall be completely metal free and shall comply with IEC Publication 60793-2 and Austel Technical Standard 008 with the following characteristics.

#### 5.2.1.1 Multi Mode

The multi mode cable will be used for DTS. Alternative characteristics may be considered if the Tenderer can demonstrate better performance for DTS. The Tenderer must provide full details of any alternative offer in the tender submission. The multi-mode fibres shall meet the requirements of ITU-T Recommendation G651 and be characterised as follows:

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



Transmission wavelength	850nm and suitable for 1,300nm
Mode field diameter	$50 \pm 3.0\mu\text{m}$ at a transmission wavelength of 850nm
Bandwidth	>500Mhz at 850nm and >500Mhz at 1,300nm
Numerical Aperture	$0.2 \pm 0.015$
Attenuation	Not greater than 2.4dB/km at an optical wavelength of 850nm and 0.6dB/km at 1,300nm
Core Eccentricity	Less than 6%
Optical cladding diameter	$125\mu\text{m} \pm 2.0\mu\text{m}$
Life span	Greater than 50 years

## 5.2.1.2 Single Mode

The characteristics of each single mode optical fibre in the optical fibre cable will adhere to the ITU-T's recommendation G.652 and as follows:

Transmission wavelength	1,310nm and suitable for 1,550nm
Mode field diameter	$9.2 \pm 0.4\mu\text{m}$ at a transmission wavelength of 1,310nm $10.4 \pm 0.8\mu\text{m}$ at a transmission wavelength of 1,550nm
Attenuation	Not greater than 0.40dB/km at an optical wavelength of 1,310nm and 0.30dB/km at 1,550nm
Total dispersion	Not greater than 6ps/(nm · km) at optical wavelength in the range 1,270nm to 1,360nm for a zero dispersion wavelength of 1,310nm and 20ps/ (nm · km) at 1,550nm
Optical cladding diameter	$125\mu\text{m} \pm 2.0\mu\text{m}$
Life span	Greater than 50 years

## 5.2.2 Fibre Coatings

The secondary coating is required to be a tight UV Acrylate coating and shall be easily removed by mechanical means for jointing purposes. Preference is likely to be given to fibres, which have a primary buffer coating of  $250\mu\text{m} \pm 15\mu\text{m}$  low modulus UV, cured Acrylate material. Thus the Tenderer is encouraged to offer prices for totally UV cured Acrylate coated fibres where possible. The Tenderer may offer more than one primary, buffer coating material. In such cases the Tenderer should provide as much information as possible regarding the physical, mechanical, and transmission performance of such fibres, with particular regard to the relative susceptibility to hydrogen degradation compared with UV Acrylate coated fibre.

## 5.2.3 Identification of Individual Fibres

The colours of individual fibres as well as other cable components shall allow for the unique identification of individual fibres within the cable.

## 5.2.4 Factory Joints

The fibres shall not be jointed within any un-installed cable length without prior approval by the Purchaser. Where such approval is given, there shall be a maximum of one (1) joint allowed in any continuous length. This joint shall have a two way average splice loss of less than 0.2dB at 1,064nm.

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 5.2.5 Point Loss in Uninstalled Cable

### 5.2.5.1 Multi Mode

For the un-installed optical fibre cable there shall be no point loss (of any cause) in any single fibre, whose average two way attenuation exceeds 0.05dB at 850nm and 1,300nm.

### 5.2.5.2 Single Mode

For the un-installed optical fibre cable there shall be no point loss (of any cause) in any single fibre, whose average two way attenuation exceeds 0.05dB at 1,310nm and 1,550nm.

## 5.2.6 Water Immersion

As the cable may be subjected to total water immersion, a clear water blocking compound shall be used around the optical fibre to prevent the ingress of moisture and other impurities to the optical fibres.

The water blocking compound shall:

- not inhibit movement of the fibre within the interstices of the cable;
- be compatible with the other materials used in the cable;
- remain pliable and maintain its water resistance over the operating temperature range and over the service life of the cable;
- be free of air entrapment;
- not cause hydrogen gas generation over the operating temperature range and service life;
- be toxicologically safe.

The cable sheath shall be resilient to ageing and embrittlement from heat.

The entire cable shall consist of electrically insulating material.

The cable will incorporate a strength member of glass reinforced plastic or equivalent.

The optical fibres shall not be constrained firmly against other fibres, strength members, moisture barrier compound or any other cable components. The preferred construction type is "loose tube".

## 5.2.7 Jointing Techniques

The Tenderer shall provide details of the fibre performance to different jointing techniques (including arc fusion and mechanical splicing), preferably in the form of histograms showing minimum obtainable splice losses.

## 5.2.8 Fibre Integrity and Test Certificates

Integrity of the fibre shall be tested by measuring the total attenuation by using a 850nm and 1,310nm multimode light source at one end of the fibre and an optical level metre at the other end.

Continuity shall be tested at 850nm and 1,310nm by measuring backscattered light using an Optical Time Domain Reflectometer (OTDR), which is adjusted to see the whole length of the fibre. This measurement shall be done from both ends of each fibre.

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



The overall attenuation and the OTDR traces shall be recorded and shall form part of the test certificates.

The optical fibre attenuation and continuity for each fibre of each cable drum length shall be measured and recorded prior to shipment from the manufacturing plant. The test results shall include date of test, drum number, drum-length and names of test personnel.

## 5.2.9 Purchaser Testing

The cables may be subject to tests after delivery at the Purchasers' expense. The Purchaser reserves the right to reject all cables not in conformance with this Specification or the successful Tenderer's guaranteed parameters. All rejected cables shall be replaced by the successful Tenderer at the successful Tenderer's expense.

The Tenderer offering this option shall provide details of the mechanical protection for the OF cable incorporated into the overall cable design and shall complete Attachment 1.3.

## 5.3 Sealing of Cable Ends

### 5.3.1 Water Corrosion

Cables shall be free of water, gas and corrosion at the time of dispatch from the manufacturer's premises.

### 5.3.2 Moisture Ingress

All cable ends shall be sealed to prevent moisture ingress by the application of heat-shrink caps. This shall seal the individual layers of the cable construction from one another to avoid water transfer to the conductor strands in the event of damage to the outer sheaths. Where specified in the Purchase Order, the "A" end of cables shall be fitted with a sealed pulling eye so attached to the sheath and cable cores as to withstand safely the recommended maximum allowable pulling tension during installation.

### 5.3.3 Sealing Methods

The Tenderer shall provide full details with the tender documents concerning the method used for sealing the cable ends.

## 5.4 Cable (Length) Markings

Cable identification markings and meter markings shall be provided on the outer sheath of the cable in accordance with Clauses 2.16 and 2.17 respectively of AS/NZS 1429.1.

For triplex cables each core of the cable shall be identified by numbers 1 ONE, 2 TWO, 3 THREE, printed as numerals and words on the outer surface of the cores in accordance with clause 2.6 of AS/NZS 1429.1, before they are wound in a trefoil formation.

### 5.4.1 Colour

All power cable sheaths shall be indelibly marked in a contrasting colour with sequential metre markings at one metre intervals.

## 5.5 Drum Flange

The markings need not start at zero and the starting and finishing metre markings shall be recorded on the drum flange.



# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 5.6 Identification Printing

To permit identification of cables, the following information shall be printed or embossed on the outer sheath at regular intervals, in accordance with AS/NZS 1429.1:

Manufacturer's name or identifying initials.

Year of manufacture.

Type of cable (including the conductor size and type, rated voltage and insulation type).

Metre markings.

The Purchasers' Brand i.e. either "ENERGEX", or "Ergon Energy"

(Ergon Energy only) The unique cable code number (typically 4 numerals)

## 5.7 Laying

For triplex cables, three individual cores marked 1 ONE, 2 TWO, and 3 THREE shall be laid up in a trefoil formation (triplex) with a right hand direction of lay to form a substantially compact cable assembly.

## 6. Performance and Testing

### 6.1 General

The cables shall be type tested and routine tested in accordance with the requirements of Section 3 of AS/NZS 1429.1 or AS/NZS 60840 as appropriate.

The Purchaser reserves the right to witness any test. The Tenderer shall give reasonable notice of when each and every test is to be carried out.

### 6.2 Water Penetration Tests

Water penetration tests shall be conducted for all water blocked 11kV and 33kV cables in accordance with Appendix C of AS/NZS 1429.1 with the additional requirement to expose 50mm of the conductor at the centre of the cable test piece as shown in Figure C1 of Appendix C of AS/NZS 1429.1.

For all water blocked 33 kV cables having a metallic sheath of laminated aluminium tape an additional water penetration test in accordance with Attachment 7 of this specification shall be conducted as a Type Test where 300 mm of the laminated aluminium sheath of a section of the cable sample that has undergone the bending test shall be exposed to water under pressure to test the integrity of the longitudinal polymer seam in the overlapped aluminium tape forming the metallic water barrier.

### 6.3 Type Testing

Type test certificates that qualify all items offered, in accordance with the Standards as specified in Clause 6.1 above, shall be submitted with the tender in a Qualification Test Report. The Tenderer shall advise the Purchasers' responsible officer of any changes in the composition of the materials and processes used for manufacture of the cables and the Purchasers' responsible officer will decide on the necessity for a new Type Test.

A list of the cable accessories, joints and terminations, that have been satisfactorily tested with each cable offered, giving details of the manufacturer and product identification, shall be provided with the tender.

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 6.4 Routine Tests

A "Certificate of Compliance" shall be supplied with each cable delivery. Routine test certificates shall be held by the Manufacturer and provided to the Purchaser within 24 business hours upon request. In addition the Tenderer is required to submit all Sample and Routine test certificates relating to the cables supplied under the contract, including the Purchasers' Order Numbers and the associated cable drum numbers and lengths recorded on a compact disc on completion of the contract.

The Tenderer may be required to provide a sample and/or a photograph of each core, taken from each manufacturing run. Photographs shall show the condition of LAT.

The following Routine tests shall be carried out, on each completed drum of cable, in addition to those specified in accordance with applicable Standards nominated in Clause 6.1.

- An insulation resistance test between the cable conductor core and the metallic screen. The test shall be carried out at a voltage level of 5kV D.C. and 10kV D.C. for 11kV / 33kV cables respectively. The results shall be recorded after 10 minutes.
- An insulation resistance test between the metallic screen and the graphite coating covering the outer sheath cable. The test will be carried out at a voltage level of 2.5kV DC and the results recorded after 10 minutes.

The results will be recorded and submitted with the results of other "Routine" tests.

## 6.5 Additional Tests

### 6.5.1 Cables with LAT

In accordance with AS/NZS 60840 Clause 12.4.19 regarding examination, adhesion and peel strength.

### 6.5.2 Fibre Routine Test

Each fibre of a manufactured lot shall be tested for integrity and continuity immediately after drawing and cladding.

Integrity of the fibre shall be tested by measuring the total attenuation by using:

- an 850nm and 1,310nm light source at one end of the fibre for multi mode fibres;
- a 1,310nm and 1,550nm light source at one end of the fibre for single mode fibre; and
- an optical level meter at the other end.

Continuity shall be tested at 850nm and 1,310nm for multi-mode fibres and 1,310nm and 1,550nm for single mode fibres, by measuring backscattered light using an Optical Time Domain Reflectometer (OTDR), which is adjusted to see the whole length of the fibre. This measurement shall be done from both ends of each fibre.

The overall attenuation and the OTDR traces shall be recorded and shall form part of the test certificates.

### 6.5.3 Carbon Black Test

Carbon black content of the outer sheath shall be tested in accordance with ASTM D1603. Test certificates are not required to be despatched with each delivery of cable but shall be made available to the purchaser when requested, within 1 working day.

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 7. Risk Assessment

### 7.1 Legislation

The Tenderer must comply with the requirements of the Queensland Workplace Health and Safety Act 1995, Queensland Electrical Safety Act 2002 and associated regulations, codes of practice and compliance/advisory to Attachment 3.

### 7.2 Documentation

Tendered items shall be subjected to a formal risk assessment. The Plant Code of Practice 2005 requires the Tenderer to perform a risk assessment and provide the resultant documentation to the Purchaser with their tender in accordance with the 'Risk Assessment' schedule (Attachment 3) included with this specification. Where required by some questions, full details to support answers must be furnished.

If the complete risk assessment documentation is not provided with the tender, or does not meet the required standard, the tender may either be rejected, or may have their price loaded with the estimated costs associated with the Purchaser conducting the assessments. Any documented risk assessment that accompanies the tender must meet the requirements of the Risk Management Advisory Standard 2000 as a minimum standard and address the five main steps of the risk management process. It is preferred that the risk assessment methodology uses an energy model to identify hazards.

The risk assessment/s must both state recommended practices and identify hazards to the Purchaser's personnel, public and property associated with the items offered as follows:

- The Installation of the cable.
- Transport, handling and storage of the cable.
- The Operation and Maintenance of the cable during life expectancy.
- Dismantling / disposal of cable at end of life.
- The range of uses for which the cable is intended.
- Effects of environmental conditions on the cable.

### 7.3 Tie Down Restraint

The risk assessment must address and describe the means of tie-down restraint to be employed to secure the drums during transport. Where tie-down chains are passed through drum spindle holes, the edges of the holes are to be protected from damage by the use of removable collars that will leave a smooth cylindrical surface to accommodate the spindle.

### 7.4 Cable Fastening

The risk assessment must address and describe the means of fastening the A and Z ends of the cable to the drum flanges to prevent dislodgement during transportation, unpacking and paying out of cable from the drum.

## 8. Quality Assurance

It is the Purchasers' policy to procure goods, equipment and services from sources that demonstrate the ability to supply quality products.

It is expected that the Tenderer and manufacturer will have a quality system certified to ISO 9001 in operation.

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



Documentary evidence shall be provided concerning the level of Quality System Certification associated with the Tenderer and/or Manufacturer. This documentation shall include the Capability Statement associated with the Quality System Certification.

The Tenderer shall complete Attachment 4 in documenting the above requirements and shall include it with their Tender submission.

The location of manufacture and the Manufacturer as nominated in the tender in respect of any good or component of a good or basic processed material shall not be changed without the submission of relevant additional Quality Assurance documentation and without the prior approval in writing of ENERGEX/Ergon Energy.

## 9. Samples

### 9.1 Production Samples

When requested, production samples of each item offered shall be submitted, at no cost to the Purchaser, to assist in the evaluation of the offer.

### 9.2 Delivery and Purchase

Production samples of the items offered shall be delivered freight free, suitably packaged and labelled including this Contract Number and Contract Item number. Samples must be delivered within two weeks of the date requested to a location nominated at time of request.

## 10. Packaging and Marking

### 10.1 General

#### 10.1.1 Drums

The cable shall be of one length on each drum and may be supplied on either timber drums complying with the requirements of AS/NZS 2857 or steel drums complying with the requirements of AS/NZS 3983. Steel drums are preferred for 33kV cables. Operational difficulties are anticipated with the use of timber drums manufactured in accordance with AS 2857-1996. Hence this specification is based on cables supplied on timber drums manufactured in accordance with the requirements of superseded standard AS 2857-1986.

#### 10.1.2 External Lagging

The cable on the drum shall be protected by suitable external lagging to ensure that it is delivered undamaged, giving due consideration to the methods and distance of transportation and handling. Sheet form wrapping alone is NOT acceptable. Further, additional cushioning material shall be provided between the cable and the external laggings in order to minimize the risk of cable sheath damage during the removal of the latter. The Tenderer shall provide details concerning the method to be used.

#### 10.1.3 Exposure

Drums must be of suitable quality to withstand a minimum of twenty-four (24) months exposure to all types of weather conditions during outside storage.

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 10.2 Drum Sizes and Lengths

### 10.2.1 Quantity

The cables shall be of one length on each drum. The length of cable shall not exceed 105% of the nominal length specified.

### 10.2.2 Drum Sizes

For handling purposes utilising the Purchasers' cable jinkers, the maximum cable drum size and mass, shall be:

#### 10.2.2.1 HV Distribution Cables

Drum dimensions shall not exceed the following:

Parameter	Value
Diameter over lagging	2,400mm
Spindle Hole Diameter for drums of gross mass up to 7 tonnes	110mm
Spindle Hole Diameter for drums of gross mass greater than 7 tonnes	150 mm
Overall Width excluding bolt projections	1,200mm
Gross Mass (cable + drum)	6,000kg

Spindle holes shall be reinforced on each side by means of adequate iron bearing plates bolted to the drum flange

### 10.2.3 Nominal and Minimum Drum Lengths

As these cables will primarily be required for specific projects, cable drum lengths shall be supplied to suit the cable installation layout and pre-determined joint positions for the specific projects, or otherwise supplied in nominal drum lengths as described in the table below.

Cable Item Numbers	Nominal Drum Length	Minimum Drum Length
1-3	370m	350m
4-10	630m	600m

### 10.2.4 Drums with Flange Height over 1,800mm

The spindle holes of drums having a flange height of over 1,800mm shall have a tubular spindle liner between spindle holes with no shoulders in the liner between the outside drum cheeks.

### 10.2.5 Lifting Chains

The spindle liner shall not be damaged by lifting chains passed through the drum spindle liner.

## 10.3 Drum Marking

Each drum of cable shall be indelibly and legibly marked on both flanges with the appropriate information required by the relevant Australian Standard, AS/NZS 1429.1 including the following information:

- The name or registered trade name or mark of the manufacturer or other

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



distinguishing mark.
<ul style="list-style-type: none"> <li>The rated operating voltage expressed in the form '6.35/11 (12) kV' or '19/33(36) kV'</li> </ul>
<ul style="list-style-type: none"> <li>The number of cores and size of the conductors and the conductor material.</li> </ul>
<ul style="list-style-type: none"> <li>Wording to identify the insulation and sheath.</li> </ul>
<ul style="list-style-type: none"> <li>Year of Manufacture</li> </ul>
<ul style="list-style-type: none"> <li>A manufacturer's drum traceability number.</li> </ul>
<ul style="list-style-type: none"> <li>The gross mass of the drum and cable.</li> </ul>
<ul style="list-style-type: none"> <li>An arrow to indicate the direction for rolling cable onto the drum</li> </ul>
<ul style="list-style-type: none"> <li>Any special handling instructions</li> </ul>
<ul style="list-style-type: none"> <li>The number of the Standard, i.e. AS/NZS 1429.1, with which the cable complies.</li> </ul>
<ul style="list-style-type: none"> <li>The start and finish numbers of the metre marking.</li> </ul>
<ul style="list-style-type: none"> <li>Length of the cable wound onto the drum</li> </ul>
<ul style="list-style-type: none"> <li>The Purchasers' brand i.e. "ENERGEX", or "Ergon Energy"</li> </ul>
<ul style="list-style-type: none"> <li>The Purchasers' Contract Number (to be advised)</li> </ul>
<ul style="list-style-type: none"> <li>Purchase Order Number</li> </ul>
<ul style="list-style-type: none"> <li>The Purchasers' Stock Code Number</li> </ul>
<ul style="list-style-type: none"> <li>(Ergon Energy only) Manufacturer's traceability number – derived from Manufacturer's first letter, hyphen, batch number, hyphen, drum number for this batch.</li> </ul>

## 10.4 Quarantine Requirements

Should the cable be supplied from overseas manufacturers, it is mandatory that all conditions and inspections required by the Australian Quarantine Act are met and that all these costs are included in the tendered price. In particular, timber drums must be fumigated with methyl bromide with a concentration of 48g/m<sup>3</sup> for 24 hours at 21°C. The Tenderer shall ensure that the procedure does not produce any deleterious effects to the cable supplied on the drum.

## 11. Service History

The Tenderer shall, for the items offered, state:

- The period of service achieved by the items offered within Australian conditions (and worldwide);
- Australian (and worldwide) authorities who have a service history of the items offered;
- Contact names and phone numbers of relevant employees of those supply authorities who can verify the service performance claimed.

The Tenderer is also requested to submit proposals for improving the service life of the cables.

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 12. Reliability

### 12.1 Guarantee

The Tenderer is required to guarantee the reliability and the performance for Aluminium conductor cables under the specified system and environmental conditions by specifying the guaranteed performance and service life in the Attachments of Technical Details.

### 12.2 Service Life

The Tenderer is required to provide comment and submit evidence in support of the reliability and performance claimed including detailed information on Failure Mode and Effect Analysis.

## 13. Traceability

Details of the subcomponents of the Cables that are traceable shall be provided by the Tenderer by completion of Attachment 5. The criteria for traceability shall be based on previously identified failure modes which may necessitate the recall of plant from service for rework or replacement should they occur either in the field or are discovered during manufacture or testing at works. The Purchaser will give due recognition to the number of sub-components incorporating traceability when assessing conformance of the Tenderer's Quality Assurance System to the specified requirements.

## 14. Training

Training material in the form of drawings, instructions and/or audio visuals shall be required for the items accepted under this offer. The Tenderer shall provide an optional price for the provision of training to the Purchasers' staff. Brief details of the training offered shall be provided in the tender documents. This material shall include but is not limited to the following topics:

- Handling
- Storage
- Installation, including cable hauling and methods of attachment of hauling rope to cable cores
- Application (particularly in areas of heavy coastal pollution)
- Maintenance
- Environmental performance
- Electrical performance
- Mechanical performance
- Cable rating software
- Disposal

## 15. Environmental Considerations

The Tenderer is required to comment on the environmental soundness of the design and the materials used in the manufacture of the items offered (including additives such as Termite Repellents). In particular, comments should address such issues as recyclability and disposability at the end of service life and also disposal of packaging materials. The Tenderer is required to document Environmental Management particulars in Attachments 3 and 4.

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 16. Information to be Provided

### 16.1 General

The specific technical requirements for the items offered shall be as stated in Attachments 1 and 2 of this specification. The Tenderer shall provide all details requested by Attachments 1 and 2 and shall guarantee such data. A separate Schedule/ Column of a Schedule shall be completed for each item offered.

### 16.2 Drawings

The Tenderer shall provide, with the tender, full scale, dimensioned, cross sectional drawings detailing the construction of the cables in a similar manner to that shown in AS/NZS1429.2. The various components of the cable shall be labelled on the drawing together with the diameter over each layer of the cable construction, and in the case of Triplex cable, shall include the overall diameter of the 3 core envelope.

### 16.3 Risk Assessment

The Tenderer shall complete a risk assessment and respond to the referenced items in Attachment 3 of this specification.

### 16.4 Management Systems

The Tenderer shall complete Attachment 4 including details of Quality, Environmental, and Workplace Health & Safety Management Systems.

### 16.5 Traceable Item Reliability Performance Guarantee

The Tenderer shall complete Attachment 5 including details of performance reliability of traceable items per Section 13.

### 16.6 Technical Documentation Checklist

Attachment 7 details a checklist of supporting technical documentation which is required to be submitted with the tender.



# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 17. Attachment 1 – Technical Details

### 17.1 Technical Details – 11kV CABLE (Separate sheet for each item)

PARTICULARS	UNITS	Triplex 6.35/11 (12) k V
Cable Details – mm <sup>2</sup> , Conductor Type, Cable Type		
Nominal area of core conductors	(mm <sup>2</sup> )	
Number of conductor strands		
Maximum shrink of core insulation (Clause 12.4.13 of CENELEC Document HD 632 S2:2008 Part 1)	(%)	
Cross-sectional area of conductor ± manufacturing tolerances	(mm <sup>2</sup> )	
Water blocking tape material		
Number and thickness of water blocking tape	(x & mm)	
Diameter over conductor ± manufacturing tolerances	(mm)	
Diameter over conductor screen	(mm)	
Number of screen wires per core		
Diameter of screen wires	(mm)	
Minimum radial thickness of semi-conductive insulation screen	(mm)	
Nominal radial thickness of TRXLPE insulation	(mm)	
Minimum radial thickness of TRXLPE insulation	(mm)	
Diameter over insulation +/- manufacturing tolerance	(mm)	
Nylon jacket thickness	(mm)	
Nylon grade		
PVC grade		
Radial thickness of PVC	(mm)	
Over-sheath material and grade (a) Inner layer (b) Outer layer		
Over-sheath thickness – Nominal (a) Inner layer (b) Outer layer	(mm) (mm)	
Over-sheath thickness – Minimum (a) Inner layer (b) Outer layer	(mm) (mm)	
Outer over-sheath colour		
Maximum shrink-back of sheath (Clause 12.4.13 of CENELEC Document HD 632 S2:2008 Part 1)	(%)	
Overall diameter of each cable core	(mm)	
Overall diameter of triplex cable envelope	(mm)	
ID of recommended minimum conduit size	(mm)	
Recommended maximum pulling tension - stocking grip on sheath	(kN)	
Recommended maximum pulling tension - pulling eye on conductors	(kN)	
Recommended minimum bending radius (a) during installation (b) setting	(mm) (mm)	
Maximum side wall bearing pressure	(kN/m)	
Maximum continuous current rating		

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



PARTICULARS	UNITS	Triplex 6.35/11 (12) k V
Cable Details – mm <sup>2</sup> , Conductor Type, Cable Type		
(a) Buried direct	(A)	
(b) In light duty PVC conduits	(A)	
Emergency two hour current rating factor - cable at 50% and 70% load prior to emergency	(A)	
(a) Buried direct	(A)	
(b) In light duty PVC conduits	(A)	
Maximum D.C. resistance of conductor @ 20°C	(Ω/km)	
D.C. resistance of Cu screen wires @ 20°C	(Ω/km)	
Maximum AC resistance of conductor of completed cable at 50Hz and 90°C	(Ω/km)	
Positive and negative sequence impedance at 50Hz of completed cable (resistive and reactive components)		
(a) At 20°C	(Ω/km)	
(b) At max. operating temperature	(Ω/km)	
Zero sequence impedance at 50Hz of completed cable at 20°C (resistive and reactive components)	(Ω/km)	
Voltage drop - 3φ at 90°C	(mV/A/m)	
Three-phase symmetrical fault rating for 1 or 3 seconds	(kA)	
Fault rating of screen for 1 second	(kA)	
Inductance per phase per km at 20°C	(mh/km)	
Capacitance per phase per km at 20°C	(µf/km)	
Power frequency withstand voltage five minutes	(kV RMS)	
Lay of cores stating distance of conductor convolution	(m)	
Insulation megger readings 100m section tested with 5kV megger - Phase/Earth		
(a) Expected value	(GΩ)	
(b) Minimum acceptable value	(GΩ)	
Type test copies attached	(yes/no)	
Type Test Certificate Number		
Length of cable per drum	(m)	
Cable mass	(kg/m)	
Drum mass complete with cable and lagging	(kg)	
Australian Standard drum size	Flange Barrel Width	
Spindle Hole Diameter	(mm)	
Service Life	(years)	
Manufacturer's Name and Address		

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 17.2 Technical Details – 33kV CABLE (Separate sheet for each item)

PARTICULARS	UNITS	Single Core 19/33 (36) kV
Cable Details - mm <sup>2</sup> , Conductor Type, Cable Type		
Number and size of strands in each conductor		
Maximum shrink-back of TRXLPE insulation (Clause 12.4.13 of CENELEC Document HD 632 S2:2008 Part 1)	(%)	
Number and size of strands in the copper wire screen		
Diameter over conductor ± manufacturing tolerances	(mm)	
Diameter over conductor screen	(mm)	
Shape and dimensions of each core		
Extruded semi-conductive conductor screen material		
Average radial thickness of semi-conductive conductor screen	(mm)	
Water blocking tape material		
Number and thickness of water blocking tape	(x & mm)	
Metallic Sheath Material		
Thickness of the metal sheath	(mm)	
Minimum radial thickness of the composite sheath over the screen wires / water blocking barrier	(mm)	
Density of LLDPE in the composite sheath	(g/cm <sup>3</sup> )	
Radial thickness of LLDPE sheath	(mm)	
Temperature at which density was measured	(°C)	
Termite protection layer material		
Nylon jacket thickness	(mm)	
Shore D hardness of MDPE material		
Density of MDPE material	(g.cm3)	
Temperature at which Density is measured	(Deg C)	
Radial thickness of MDPE	(mm)	
Maximum shrink-back of sheath (Clause 12.4.13 of CENELEC Document HD 632 S2:2008 Part 1)	(%)	
Maximum continuous conductor operating temperature	(Deg C)	
Three phase symmetrical fault rating of conductor for one second	(kA)	
D.C. Resistance of conductor at 20°C	(Ω/km)	
D.C. Resistance of copper wire screen at 20°C		
A.C. Resistance of conductor at maximum conductor operating temperature (90°C)	(Ω/km)	
Inductance per conductor (when installed in trefoil and touching)	(mH/km)	
Capacitance of conductor to screen at 20°C	(µF/km)	
Positive sequence impedance per phase in R+jX form at maximum conductor operating temperature	(Ω/km)	
Zero sequence impedance per phase in R+jX form at maximum conductor operating temperature	(Ω/km)	
TRXLPE material designation		
Method of curing insulation		
Minimum thickness of TRXLPE insulation	(mm)	
Diameter over insulation +/- manufacturing tolerance	(mm)	
Lay of cores stating the distance in which one complete convolution of the conductor takes place	(m)	
Insulation megger readings 100m section tested with 10kV megger - Phase/Earth		
(a) Expected value	(GΩ)	
(b) Minimum acceptable value	(GΩ)	
Semi-conductive screen material over the insulation		
Average radial thickness of the semi-conductive insulation screen	(mm)	
(Nominal) Diameter over insulation on each core	(mm)	
Diameter over screen wires on each core	(mm)	
Dielectric loss/φ at 50Hz, 90 °C conductor temperature, direct buried at 33kV	(kW/km)	

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



PARTICULARS	UNITS	Single Core 19/33 (36) kV
Cable Details - mm <sup>2</sup> , Conductor Type, Cable Type		
Insulation impulse level	(kVp)	
D.C. Resistance of collective copper screen wires	(Ω/km)	
Minimum radial thickness of LLDPE/MDPE over-sheath	(mm)	
Fault rating of screen for three seconds	(kA)	
Power Frequency withstand voltage five minutes	(kVrms)	
Overall diameter of cable (single core)	(mm)	
Overall diameter of 3 single core cables in trefoil formation	(mm)	
Minimum bending radius (a) pulling	(mm)	
(b) setting	(mm)	
Maximum pulling tension - Stocking grip on sheaths (straight pulls)	(kN)	
Maximum pulling tension - Stocking grip on sheaths (pulling around bends with minimum recommended bending radius)	(kN)	
Maximum side wall bearing pressure	(kN/m)	
Mass of cable	(tonnes/km)	
Cable drum size	(F x B x W)	
Cable route length per drum	(m)	
Spindle hole diameter	(mm)	
Gross mass of cable and drum	(kg)	
Service life	(years)	
Manufacturer's Name and Address		

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 17.3 Technical Details – FIBRE OPTIC CABLE

PARTICULARS	UNITS	FIBRE OPTIC CABLE
Cable Details		
<b>Multi Mode:</b>		
Mode field diameter at 850nm	( $\mu\text{m}$ )	
Tolerance	(%)	
Attenuation (at zero fibre tension) @ 850nm	(dB/km)	
@ 1,300nm	(dB/km)	
Maximum permissible fibre strain	(% strain)	
Fibre Proof test strain	(% strain)	
Attenuation (at Maximum permissible fibre strain) @ 850nm	(dB/km)	
@ 1,300nm	(dB/km)	
Optical cladding diameter and Tolerance	( $\mu\text{m}$ ) (%)	
Dispersion @ 1,270 to 1,340nm	(ps/km.nm)	
@ 1,550nm	(ps/km.nm)	
Maximum continuous operating temperature	( $^{\circ}\text{C}$ )	
Minimum bending radius for coated optical fibre (a) Under no tension	(mm)	
(b) Under maximum tension	(mm)	
<b>Single Mode:</b>		
Mode field diameter at 1,310nm and Tolerance	(mm) (%)	
Attenuation (at zero fibre tension) @ 1,310nm	(dB/km)	
@ 1,550nm	(dB/km)	
Maximum permissible fibre strain	(% strain)	
Fibre Proof test strain	(% strain)	
Attenuation (at Maximum permissible fibre strain) @ 1,310nm	(dB/km)	
@ 1,550nm	(dB/km)	
Optical cladding diameter and Tolerance	( $\mu\text{m}$ ) (%)	
Dispersion 1,270 to 1,340nm	(ps/km.nm)	
1,550nm	(ps/km.nm)	
Maximum continuous operating temperature		
Minimum bending radius for coated optical fibre (a) Under no tension	(mm)	
(b) Under maximum tension	(mm)	
Maximum protrusion of outer sheath due to optic fibre cable	(mm)	
Service life	(years)	
Manufacturer's Name and Address		

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 18. Attachment 2

### 18.1 Underground Cable Current Rating

INSTALLATION CONDITIONS		
Ground Thermal Resistivity	1.2°C.m/W	
Bedding and Backfill for 11kV Cables	1.2°C.m/W	
Bedding and Backfill (flowable fill) for 33kV Cables	0.9°C.m/W	
Soil Temperature	28°C	Summer
	18°C	Winter
Air Temperature	40°C	Summer
	25°C	Winter
Burial Depth	750mm	11kV
	900mm	33kV
	1200mm	
<p>Single phase cables up to 33kV are laid in trefoil and are either single-point bonded (and cross-bonded), or, solid bonded.</p> <p>11kV Triplex cables are solid bonded.</p> <p>For double circuit construction at 11kV, calculate current ratings based on 300mm spacing between circuit centres.</p> <p>For double circuit construction at 33kV, calculate current ratings based on 600mm spacing between circuit centres for single point and solid bonded screens/sheaths.</p>		

#### Note:

*Tenderers are required to nominate the designed maximum Continuous current rating of each cable type. The continuous current ratings shall be determined by the methods and formulae given in Publication 287 of the International Electrotechnical Commission (IEC). Tenderers are also required to nominate the Cyclic and Emergency ratings of the cables.*

*The “Cyclic rating” is defined as the maximum permissible peak daily load current, for the given daily load cycle, that the cable may conduct without the conductor temperature exceeding 90oC for XLPE insulated cables;*

*The “Emergency rating” is defined as the maximum current carrying capacity of the cable for a period of 2 hours immediately following having been loaded for 50% of the nominated maximum continuous load.*

*The cyclic current and emergency ratings shall be calculated by the method recommended in CIGRE Current Ratings of Cables for Cyclic and Emergency Loads (Part 1), - (Study Committee No. 2, Electra No. 24, October 1972).*

*Cable current ratings for cables in conduit shall be determined for cables in light duty PVC conduits to AS/NZS 2053.2:2001 as follows:*

- *11kV Triplex cables installed in both 125 and 150mm;*
- *33kV Single Core cables installed in both 100 and 125mm.*

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 18.2 Underground Cable Current Rating (Continued)

The daily load cycle is given in the following table.

Time	Load (p.u.)
00:00	0.70
00:30	0.61
01:00	0.61
01:30	0.61
02:00	0.61
02:30	0.61
03:00	0.61
03:30	0.62
04:00	0.62
04:30	0.63
05:00	0.65
05:30	0.70
06:00	0.74
06:30	0.82
07:00	0.88
07:30	0.96
08:00	1.00
08:30	1.00
09:00	1.00
09:30	1.00
10:00	1.00
10:30	1.00
11:00	1.00
11:30	1.00

Time	Load (p.u.)
12:00	1.00
12:30	1.00
13:00	1.00
13:30	1.00
14:00	1.00
14:30	1.00
15:00	1.00
15:30	0.98
16:00	0.94
16:30	0.90
17:00	0.88
17:30	0.88
18:00	0.88
18:30	0.88
19:00	0.86
19:30	0.86
20:00	0.84
20:30	0.82
21:00	0.80
21:30	0.78
22:00	0.76
22:30	0.74
23:00	0.73
23:30	0.72

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 18.3 Underground Cable Current Rating (Continued)

<b>CABLE DESCRIPTION:</b>	<b>Season</b>	<b>SINGLE CIRCUIT DIRECT BURIED</b>			<b>SINGLE CIRCUIT BURIED in CONDUIT</b>		
		Maximum Continuous Current Rating (amps)	Emergency Current Rating (amps)	Cyclic Current Rating (amps)	Maximum Continuous Current Rating (amps)	Emergency Current Rating (amps)	Cyclic Current Rating (amps)
	Summer						
	Winter						
	<b>Season</b>	<b>DOUBLE CIRCUIT DIRECT BURIED @ 300 and 600mm Spacing for 11 and 33kV respectively.</b>			<b>DOUBLE CIRCUIT BURIED in CONDUIT @ 300 and 600mm Spacing for 11 and 33kV respectively.</b>		
		Maximum Continuous Current Rating (amps)	Emergency Current Rating (amps)	Cyclic Current Rating (amps)	Maximum Continuous Current Rating (amps)	Emergency Current Rating (amps)	Cyclic Current Rating (amps)
	Summer						
	Winter						

Ratings required for:

- 11kV Triplex cables installed in both 125 and 150mm (light duty);
- 33kV Single Core cables installed in both 100 and 125mm (light duty).



# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 19. Attachment 3

### 19.1 Risk Assessment

Ref.	Particulars	Response
1.	<p>Does the Equipment offered comply with the Queensland Workplace Health and Safety Plant Code of Practice 2005?  <a href="http://www.dir.qld.gov.au/workplace/law/codes/plant/">(http://www.dir.qld.gov.au/workplace/law/codes/plant/)</a>                      If so, have the following obligations been fulfilled for Manufacturers and/or Tenderers of Plant to ensure (according to the definitions under the Workplace Health and Safety Act 1995 s. 32B):                      that the Equipment offered has been examined and tested to ensure it is safe and without risk to health when used properly?                      the Equipment offered is accompanied by information about the way the equipment must be used to ensure health and safety?                      In particular, information relating to the following points?  <a href="http://www.deir.qld.gov.au/workplace/resources/pdfs/plant_code.pdf">                     (http://www.deir.qld.gov.au/workplace/resources/pdfs/plant_code.pdf                     </a> section 3.6)                      If so, please provide provision of appropriate information?</p>	
2.	<p>Does the Equipment offered comply with the Queensland Electrical Safety Act 2002?  <a href="http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/E/ElectricalSA02.pdf">                     (http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/E/ElectricalSA02.pdf                     )</a></p>	
3.	<p>Has a Risk Assessment been performed on the Equipment offered, which meets the requirements of the Workplace Health and Safety Act Risk Management Advisory Standard 2000?  <a href="http://www.dir.qld.gov.au/workplace/law/codes/riskman/">                     (http://www.dir.qld.gov.au/workplace/law/codes/riskman/)                     </a>                      If so, please include a copy of the risk assessment with the tender.</p>	
4.	<p>Do any of the items offered involve assembly of components from a variety of sources?                      If so, are the components compatible to ensure the item is safe and without risk to health and safety when used properly?</p>	
5.	<p>Has the Equipment been examined and tested to ensure it is safe when used properly?                      In particular, have all Test Certificates specified in this Technical Specification been supplied?                      Is information available for safe operation and maintenance of the Equipment?</p>	
6.	<p>Comment on the environmental soundness of the design and the materials used in the manufacture of the items offered (including additives such as Termite Repellents). In particular, comments should address such issues as recyclability and disposability at the end of service life and also disposal of packaging materials.</p>	

<b>NAME OF TENDERER</b>	
<b>SIGNATURE (FOR AND ON BEHALF OF TENDERER)</b>	
<b>DATE</b>	

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 20. Attachment 4

### 20.1 Management Systems Information Schedule

#### 1) Tenderer Details

Tenderer:-	Representative's Name:-
Address:-	Telephone:- Facsimile:- Mobile / Other:-
Product / Service:-	ABN:-

#### 2) Quality Assurance

Do you have a fully implemented Quality Management System in place which has been certified by an external certification body? (3 <sup>rd</sup> Party Industry Specific Certification)	YES / NO
If YES, advise name of certification body and Certificate number. Attach copy of the certificate and Standard number.	Certified by: Certificate Number:
Copy of Certificate and Schedule(s) attached?	YES / NO
Do you hold a current ENERGEX / Ergon Energy, or other Electricity Authority and/or the Queensland Government Contractor Rating? (2 <sup>nd</sup> Party)	YES / NO
If YES, advise Electricity Authority, Certificate Number and rating.	Elec. Authority: Number: Rating:

If you answered “**YES**” to having 3<sup>rd</sup> Party Industry Specific Quality Certification and

- this is **not** “by association” with another entity please complete **Parts 5 and 6**.
- this **is** “by association” with another entity please complete **Part 3**.

If you answered “**NO**” to having 3<sup>rd</sup> Party Industry Specific Quality Accreditation, please complete **Part 4**.

#### 3) Quality Assurance Certification by Association

If you have answered “**YES**” to having Quality Assurance Certification, and have used another entity in providing this answer please provide details of this entity below.

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



<b>Registered Company Name:</b>	
<b>Address:</b>	
<b>ABN:</b>	

Please complete **Parts 5 and 6**.

## 4) Internal Quality System Questions

Have you developed and implemented your own internal non-certified Quality Management System?	YES/NO
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If you answered “**NO**” to the above question please complete **Part 5**.

If you answered “**YES**” to the above question please complete the remaining questions in **Part 4**.

Do you have a Quality Manual?	YES/NO						
Do you have procedures in place to ensure Quality of product and / or service?	YES/NO						
Do you have a sample Quality Inspection and Test Plan or similar that you could provide on request?	YES/NO						
Do you have an Internal Audit System?	YES/NO						
Do you produce Internal Audit Reports that have suitable corrective action mechanisms?	YES/NO						
Do you require your Tenderers / contractors to have a documented Quality Management System in place?	YES/NO						
How do you evaluate your Tenderer’s / contractor’s quality performance?	<table border="0"> <tr> <td>Audit</td> <td>Yes/No</td> </tr> <tr> <td>Inspections</td> <td>Yes/No</td> </tr> <tr> <td>Performance History</td> <td>Yes/No</td> </tr> </table>	Audit	Yes/No	Inspections	Yes/No	Performance History	Yes/No
Audit	Yes/No						
Inspections	Yes/No						
Performance History	Yes/No						
If requested, would your company be able to provide a copy of its Internal Quality Management System to the Purchaser?	YES/NO						

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 5) Environmental

Do you have a fully implemented Environmental Management System in place which has been certified by an external certification body? If YES attach a copy of the certificate.	YES/NO
--	--------

If YES go to **Part 6**.

Do you have an Environmental Management Policy that is available to the Purchaser within 7 days of request?	YES/NO
Do you have a formal Environmental Management Plan that is available to the Purchaser within 7 days of request that outlines how you will address environmental risks relevant to your activities and conditions?	YES/NO
Are the requirements of your Environmental Management Plan incorporated into your Work Procedures?	YES/NO
Do you have a fully implemented Environmental Management System in place in accordance with ISO14001 which has been certified by an external certification body?	YES / NO
If YES, advise name of certification body and Certificate number. Attach copy of the certificate and Standard number.	Certified by: Certificate Number:
Copy of Certificate and Schedule(s) attached	YES / NO

## 6) Workplace Health and Safety

Do you have a formal Workplace Health and Safety Management Plan that is available to the Purchaser within 7 days of request that outlines how you will address safety risks relevant to your activities and conditions?	YES/NO
Are the requirements of your Workplace Health and Safety Management Plan incorporated into your Work Procedures?	YES/NO
Do you have a Workplace Health and Safety Policy that is available to the Purchaser within 7 days of request?	YES/NO

<b>NAME OF TENDERER</b>	
<b>SIGNATURE</b> (FOR AND ON BEHALF OF TENDERER)	
<b>DATE</b>	

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 21. Attachment 5

### 21.1 Traceable Items Reliability Performance Guarantee

The following information shall be supplied by the Tenderer whose attention is drawn to the relevant Clauses of the Specification. The list below is provided as a guide and is not considered exhaustive. As such, Tenderers should add whatever additional components are traceable.

Traceability			
1.	Sub-components incorporating traceability – for all Tendered main, optional and alternative items - please list:	Traceable Yes / No (Circle)	(Component Manufacturer and Other Comments)
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	
		Yes / No	

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV



## 22. Attachment 6

### 22.1 Technical Documentation Checklist

The following information shall be supplied by the Tenderer whose attention is drawn to the relevant Clauses of the Specification.

Tenderer to answer each question “Yes” or “No”

Clause No.	PARTICULARS	Response
	Have full and comprehensive details been submitted <b>WITH</b> the tender documents associated with each of the following?	
1.3	Recommended “performance based” cable design	Yes/No
	A list of all departures of the tender from this specification and from Australian Standards	Yes/No
5.1.1	Statement regarding concentricity control.	Yes/No
5.1.5	TRXLPE Type, Source, and Test Information	Yes/No
5.1.9	Material Safety Data Sheets for Termite Repellent	Yes/No
	Full details of nylon jacket (if applicable)	Yes/No
5.2	Option of Optical Fibre Cables – Details of Mechanical Protection Design	Yes/No
5.3.3	Sealing of cable ends	Yes/No
6.2	Water Penetration Tests	Yes/No
6.3	Type Test Reports for all items offered	Yes/No
6.3	Detailed list of cable accessories tested with each cable offered	Yes/No
7	Risk Assessment	Yes/No
8	Documented evidence of the Quality systems of <b>both</b> the <b>Tenderer</b> and the <b>Manufacturer</b> (including <b>Capability Statement</b> ), and also the Tenderer / Manufacturer’s programme to update the QA system to ISO 9001:2000	Yes/No
9	Samples	Yes/No
11	Service History	Yes/No
12	Reliability	Yes/No
13	Traceability	Yes/No
14	Training	Yes/No
15	Environmental Considerations	Yes/No
16	Information to be provided inc Full Scale Drawings	Yes/No

## 23. Attachment 7

### 23.1 Additional Water Penetration Test

#### 23.2 1. Scope

This attachment sets out the method of test for determining the effectiveness of the laminated aluminium sheath to withstand radial water penetration into the core material beneath the metallic sheath.

#### 23.3 2. Principle

An exposed portion of the laminated metallic sheath of a prepared cable sample is immersed in water. After a specified period under cyclic thermal conditions, the sample is checked for water penetration and observations reported.

#### 23.4 3. Preparation of Sample

The sample (see Figure 23-1) shall be prepared as follows:

(a) A length of cable shall be cut from the 6m length of completed cable that has been subjected to the bending test and prepared for the Water Penetration Test as described in Appendix C of AS/NZS 1429.1, and placed horizontally.

(b) A ring of 300mm minimum width of the composite LLDPE/MDPE over-sheath shall be removed from the centre of the length using just a sufficient amount of heat to aid in the ring cutting and splitting of the covering (180° from the seam location) and its removal by peeling it away from the metallic sheath in the direction of the overlap so as not to disturb the seal of the seam to be tested.

The interfaces between the over-sheath and the metallic sheath at the extremities of the sample of exposed metallic sheath shall be sealed with a suitable material.

#### 23.5 4. Apparatus

A suitable device shall be arranged (see figure 7-1) to allow a tube to be placed vertically over the exposed ring and sealed to the surface of the over-sheath. The seal where the cable exits the apparatus shall not exert mechanical stress on the cable.

#### 23.6 5. Procedure

The procedure shall be as follows:

(a) The tube is filled within 5 minutes with water to which a suitable visually detectable dye has been added. The water shall be at an ambient temperature of (20 +/- 10)°C so that the height of the water in the tube is 5000mm above the cable centre (see Figure 7-1). The sample shall be allowed to stand for 24 hours.

# Technical Specification for Aluminium Conductor Underground Power Cables for Nominal System Voltages of 11 and 33 kV

(b) The sample shall then be subjected to 10 heating cycles by passing current through the conductor, until the conductor reaches a steady temperature 50°C to 100°C above the maximum conductor temperature in normal operation, which shall not reach 1000°C.

(c) The heating cycle shall be of 8 hours duration. The conductor temperature shall be maintained within the stated temperature limits for at least 2 hours of each heating period. This shall be followed by at least 3 hours of natural cooling in air to a conductor temperature less than 450°C.

Note: The temperature may be measured directly on the conductor of a dummy cable of the same size and type connected in series with the cable to be tested

(d) The water head shall be maintained at 5000mm.

(e) At the completion of the 10 heating and cooling cycles the cable shall be removed from the apparatus. The ringed section of the metallic sheath shall be cut longitudinally in two places 180° apart and at 90° from the overlapped seam area to enable two half shells of the metallic sheath to be removed and the core material to be examined for signs of water penetration as evidenced by the presence of any dyed water.

## 23.7 6. Report

Observations made during Steps (b), (c) and (e) of Paragraph 5 shall be recorded and reported.

Figure 23-1 EQUIPMENT FOR WATER PENETRATION TEST

