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- **132kV Polymeric**
- **Insulated Underground**
- **Cables**

ETS 0111

Amendment No 1 September 2023

Revision History

This specification replaces amendment no 0. All changes are highlighted in this document with grey colouring.

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1. Document Scope

This specification covers the design, engineering, manufacture, testing, supply and delivery of 132kV polymeric insulated underground cables installed as part of Endeavour Energy's electrical network.

2. References

External Regulations

Electricity Supply Act 1995 (NSW)

External Standards

AS/NZS 1125:2001	Conductors in insulated electric cables and flexible cords
AS/NZS 1429.2:2009	Electric cables – Polymeric insulated – For working voltages above 19/33 (36) kV up to and including 87/150 (170) kV
AS/NZS 1574:1996	Copper and copper alloys – Wire for electrical purposes
AS/NZS 1660:1998	Test methods for electric cables, cords and conductors (series)
AS/NZS 2848.1:1998	Aluminium and aluminium alloys – Compositions and designations – Wrought products
AS/NZS 3808:2000	Insulating and sheathing materials for electric cables
AS/NZS 3983:1991	Metal drums for insulated electric cables and bare conductors
AS/NZS ISO 9001:2016	Quality management systems – Requirements
AS/NZS ISO 14001:2016	Environmental management systems – Requirements with guidance for use
IEC 60811-503:2012	Electric and optical fibre cables – Test methods for non-metallic materials – Mechanical tests – Shrinkage test for sheaths
AS 60060.1:2018	High-voltage test techniques General definitions and test requirements
AS/NZS 60060.3:2018	High-voltage test techniques - Definitions and requirements for on-site testing
AS/NZS 60840	Tests on power cables with extruded insulation for rated voltages above 30kV and up to 150kV

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External Standards

IEC 60229:2007	Tests on cable oversheaths, which have a special protective, function and are applied by extrusion
IEC 61443:2008	Guide to the short circuit temperature limits of electric cables with a rated voltage above 30kV

Company Policies and Procedures

9.2.10	Network Asset Rating
MDI 0051	Underground transmission mains design

3. Definitions and Abbreviations

Term	Definition
AS	Australian Standard
HDPE	High density polyethylene
IEC	International Electrotechnical Commission
NATA	National Association of Testing Authorities
NZS	New Zealand Standard
PVC	Poly Vinyl Chloride
XLPE	Cross linked polyethylene

4. Polymeric Insulated Underground Cables

All cables shall be designed, manufactured, and tested in accordance with this specification, and all standards referenced within this specification.

Cables manufactured and tested to previous or later versions of the Standards shall not be accepted without approval from the relevant organisations.

Cables manufactured to other recognised international standards may be accepted, provided the standards are at least equivalent to Australian/IEC standards.

Where the standards and this specification differ, the requirements of this specification shall prevail.

The cables will be installed either direct buried in suitable backfill material, installed in PVC conduits or polyethylene pipes or in a pit and conduit system.

All cables within the scope of this document are to be reviewed and approved by Endeavour Energy prior to being ordered and/or installed in the network.

The cables required are listed in Appendix A.

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4.1 Requirements exceeding the Australian Standards

The following requirements are above those contained in AS/NZS1429.2:2009: -

- Conductor - water-blocked.
- Conductor screen - supersmooth material.
- Insulation - VCV or MDCV extrusion line, super-clean material, dry-cured and dry-cooled, voids and contaminants specified, concentricity $\geq 95\%$, minimum thickness 17.1mm.
- Screen wires – minimum diameter 1.35mm, maximum diameter 2.3mm.
- Oversheath - nominal & minimum thicknesses specified, minimum density 0.955g/cm³.
- Additional sample tests - insulation and oversheath shrinkage, polyam foil examination, adhesion & peel strength.

4.2 Technical requirements

Table 1 – Summary of technical requirements

Rated voltages	132kV rms phase to phase 76kV rms phase to earth
Rated frequency	50 Hz
Impulse withstand voltage, 1.2/50µs	650kVp
System earthing	Neutral point effectively earthed
Maximum conductor temperature (cyclic loading – normal conditions)	90°C
Maximum conductor temperature (cyclic loading – emergency)	105°C
Maximum fault rating for duration of 1s (per phase)	31.5kA
Maximum conductor temperature under 1s fault conditions	250°C
Conductor	Copper
Conductor size & configuration Single Core Cables	• 300mm² stranded compacted • 400mm² stranded compacted • 630mm² stranded compacted • 800mm² stranded compacted • 1200mm² five-sector Milliken • 1600mm² five-sector Milliken • 2000mm² five-sector Milliken • 2500mm² five-sector Milliken
Conductor screen	Extruded cross-linked semiconductive

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Rated voltages	132kV rms phase to phase 76kV rms phase to earth
Insulation	XLPE
Insulation screen	Extruded cross-linked semiconductive
Metallic sheath	- Smooth aluminium - Polythene-aluminium foil laminate
Oversheath material	HDPE
Oversheath colour	Black

4.2.1 Conductors

The conductors shall be plain circular annealed compacted copper of the type specified in AS/NZS 1125, and with each conductor size configured as described in section 4.2. For cables with cross section areas of 800mm² the conductor shall be arranged in a stranded compacted configuration and for 1200mm² and above shall utilise Milliken construction with five or more equal segments.

Conductors shall be free from particles, which could contaminate the semi-conducting screen, causing high stress points at the surface of the semi-conductive screen.

A suitable non-hydroscopic semi-conductive binder/barrier tape may be included over the conductor at the discretion of the manufacturer.

Conductor shall be water blocked, using materials that will not, over the design life of the cable, adversely affect the performance of cable system (including joints or terminations) and will not impact on the rating of the cable installation. The water blocking system must achieve this without the need for additional preparation of the conductor prior to jointing or terminating. Loose powder shall not be accepted for water blocking of the conductors. The effectiveness of the water blocking shall be tested in accordance with clause 4.2.5. Conductor Screen.

4.2.2 Conductor Screen

The conductor screen shall consist of a continuous extruded layer of supersmooth black, thermo-setting, semi-conductive material compatible with the insulation and readily removable from the conductor. The conductor screen shall be concentric and shall have a smooth circular outer surface that is free from protrusions and irregularities that extend more than 75µm into the insulation.

The conductor screen shall contain no voids, be readily removable from the conductor, be firmly bonded to the inner surface of the insulation and have no tendency to separate from the insulation either during installation or under service conditions. The minimum thickness shall be 0.80mm and shall be measured in accordance with the method specified in AS/NZS 1660.2.1. The maximum DC resistivity shall be 1000Ωm.

4.2.3 Insulation

The insulation shall consist of a homogenous extrusion of super-clean cross-linked polyethylene suitably stabilised.

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The insulation, conductor and insulation screens shall be extruded in one manufacturing process using a single triple extrusion head. Extrusion shall take place using the Vertical Continuous Vulcanisation (VCV) or Mitsubishi-Dainichi Continuous Vulcanisation (MDCV) process. However, the catenary continuous vulcanising (CCV) extrusion process will be considered for cross sections 630 mm² and lower.

Cross-linking will be achieved via a peroxide reagent and will be dry cured and dry cooled. The degree of cross-linking will be adequate for the material to comply with the hot set requirements detailed in AS/NZS 60840 section 10.9.

The insulation of the completed cable and the interfaces with semi-conducting screens shall comply with the following requirements in Table 2 relating to voids and contaminants:

Table 2– Insulation quality

Number of voids	Voids >0.050mm diameter shall be zero
Size of contaminants	≤ 0.050mm
Size of discoloured translucents	≤ 0.250mm
Number of contaminants	≤ 5 per 16cm ³

The thickness of the semi conducting screens shall not be included in the calculations of the thickness of the insulation.

The minimum thickness at any point may vary from the nominal thickness but be no more than 5% less than the nominal value. The nominal thickness shall be 18mm, and the minimum thickness shall be 17.1mm.

Concentricity shall be measured and calculated as per AS1429.2 2.4.4, however 95% concentricity is required as per the following requirement

$$\frac{t_{\max} - t_{\min}}{t_{\max}} \leq 5\%$$

Cables shall be degassed during the manufacturing process to ensure that the cable has the correct dielectric properties and is free of gas produced by the crosslinking process. . The degassing process shall be conducted prior to the radial water blocking layer being applied.

4.2.4 Insulation Screen

The insulation screen will consist of an extruded layer of black thermo-setting semi conductive material applied directly over the insulation, with minimum thickness 0.8mm.

The inner surface of the insulation screen will be smooth and free from protrusions and irregularities that extend more than 125µm into the insulation. The maximum DC resistivity shall be 500Ωm.

The insulation screen shall be solidly bonded to and have no tendency to separate from the insulation either during installation or under service conditions.

The cable core shall be circular in shape, with no flat spots.

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4.2.5 Water Blocking

The longitudinal water blocking systems (including water blocking of the conductor) shall comply with the requirements of AS/NZS 1429.2 section 2.6, with no evidence of water leakage at the cable ends when tested in accordance with AS/NZS 60840 clause 12.4.18 and Annex F.

Tenderers shall submit the SDS information on the water blocking tape as part of the tender submission.

Water-blocking of the conductors shall be achieved by non-biodegradable, water-swelling yarns or tapes applied within the wires of the conductor.

Water-blocking of the screens shall be achieved by non-biodegradable, semi-conductive, water-swelling tape applied under the metallic sheath. The tapes shall be compatible with other cable components and shall be readily removable from the core.

4.2.6 Metallic Sheath

The following types of metallic sheath are approved:

- (a) Smooth longitudinally welded aluminium to AS/NZS1429.2, Clause 2.7.5
- (b) Polythene/aluminium foil laminate to AS/NZS1429.2, Clause 2.7.8

Smooth aluminium sheath shall be aluminium alloy 1050, temper O material complying with AS/NZS 2848.1 and shall have a nominal thickness of at least 0.9mm.

The cross-sectional area of the smooth aluminium sheath shall be accounted for when calculating the short circuit rating.

For longitudinally welded smooth aluminium sheath, documentary evidence shall be provided showing the suitability of the design as a moisture barrier. Tenderers must provide information on the material/alloys used, manufacturing process adopted, tests performed and results of the tests. A sample of welded sheath is also desirable. The manufacturer's process shall include online eddy current NDT monitoring and a routine 200kPa/2 hour pressure drop test shall be carried out.

Where the sheath utilises longitudinally applied metal foil, documentary evidence shall be provided detailing the performance of the cable when subjected to the tests as detailed in Annex G of AS/NZS 60840. In addition, results shall also be provided for those tests carried out under Clause 12 of AS/NZS 60840 - in particular, tests relating to bending, impact, sidewall pressure and corrosion.

A moisture barrier consisting of a polyethylene/aluminium tape laminate shall be provided and shall comply with the requirements of AS/NZS1429.2, Clause 2.7.8. The foil shall be single side polymer coated to enable bonding to the oversheath and shall be longitudinally applied with overlap and sealed. The nominal thickness of the aluminium foil shall be at least 0.15mm, and the moisture barrier shall be applied over the metallic screen wires.

4.2.7 Metallic Screen

The metallic screen shall be of adequate cross-sectional area, calculated to ensure that, under fault conditions, the transient temperature of the screen does not exceed 250°C.

In the case where the metallic screen is necessary to supplement the fault capacity of the metallic sheath, it shall comprise plain annealed copper wires complying with AS/ANZ 1125. All wires shall be the same nominal diameter, minimum diameter shall be 1.35mm and maximum diameter shall be 2.3mm.

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The wires shall be helically applied with a length lay not exceeding 10 times the pitch circle diameter of the screen and shall be applied equally spaced between water-blocked semi-conductive tape(s) and the metallic sheath.

4.2.8 Oversheath

A single layer black HDPE oversheath shall be provided with the following requirements -

- Minimum density: 0.955g/cm³
- Carbon content: 2.5% ± 0.5%

The oversheath shall be close fitting and be readily removable from the cable without damage to the underlying cable component. A graphite coating is to be applied to the outer surface to facilitate HV testing of the oversheath. Details shall be provided specifying the recommended method of removing the graphite from the cable for jointing / installation purposes.

The nominal and minimum thickness of the oversheath shall comply with **Error! Reference source not found.** below.

Table 3 – Oversheath Thickness

Conductor size [mm ²]	Nominal thickness [mm]	Minimum thickness [mm]
300	3.6	3.0
400	3.6	3.0
630	3.7	3.0
800	3.7	3.0
1200	4.0	3.3
1600	4.2	3.5
2000	4.4	3.6
2500	4.5	3.6

4.2.9 Cable Identification

The oversheath shall be embossed at 1 metre intervals on diametrically opposite sides with the following information to describe the cable type -

- Supplier name
- Voltage 132,000 VOLT ELECTRIC CABLE
- Conductor size 300mm² to 2500mm²
- No. of cores 1C Cu
- Insulation XLPE
- Metallic sheath SAS (smooth aluminium)
APL (aluminium poly laminate)
- Fault rating XX kA per 1 second (*As per the manufacturers specification*)
- Contract number "09/XYZ"

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- Year of manufacture "20xx"

Example:

Supplier 132,000 VOLT ELECTRIC CABLE 1200mm² 1C Cu XLPE SAS xxkA/1S
09/XYZ 20XX

The letters and figures used shall be in accordance with clause 2.14 of AS/NZS 1429.2

4.2.10 Cable metre marking

The external surface of the cable shall be indelibly marked in a contrasting colour, at 1 metre intervals, with the length in metres from the inner end. The marking shall otherwise be in accordance with Clause 2.15 of AS/NZS 1429.2.

4.3 Sealing of Cable Ends

All cables shall be earthed and discharged of any remaining test voltages / charge that may existing from routine, sample, or type tests. Prior to sealing, a secure short-circuiting bond shall be applied between the central conductor core and the aluminium sheath/copper wire screen, and then sealed under the cap.

The trailing (inner) end of the cable shall be hermetically sealed by means of a tri-seal heat shrink cap so designed as to give maximum security against water ingress. The minimum overlap required between the oversheath of the cable and the cap shall be 75mm. A combination of shrinkable tubing and caps as shown in the figure below must be used as a minimum requirement.

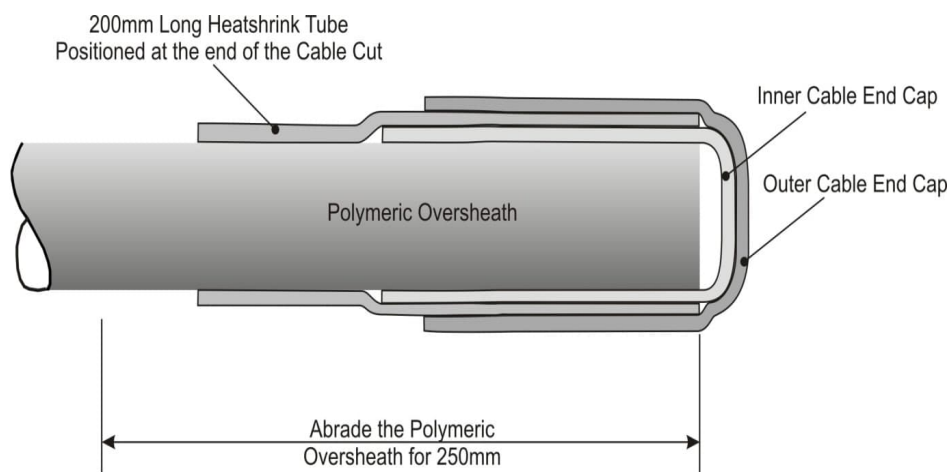


Figure 1 – Sealing of Cable Ends for HDPE Sheath Cables

4.4 Pulling Eyes

The outer (pulling) end shall be fitted with a suitable waterproof pulling eye in the form of a compressed or multi-crimped sleeve over the sheath to provide protection to the cable end. Such compression or crimping shall be such as to transfer the pulling force to the conductors and shall be tested to show the ultimate breaking load is compatible with the maximum permissible pulling tension.

The safe working load of the pulling eye shall exceed the maximum pulling tension of the cable for which it is intended by a minimum safety factor of two, up to a limit of 80kN.

Table 4– Safe working load of pulling eyes

Cable Cross Section Area (mm ²)	Safe working load (kN)
300	42
400	56
630	80
800	80
1200	80
1600	80
2000	80
2500	80

The maximum safe working load for each pulling eye offered shall be specified. Supporting documentation and the test method used to arrive at the safe working load shall be provided. The safety factor shall also be specified. Pulling eyes will be subjected to water in the cable installation environment. The pulling eye will also remain on the end of the cable whilst stored on a cable drum.

The pulling eye shall prevent water ingress to a head pressure of three metres. Documentation shall be provided with the offer to demonstrate the pulling eyes' ability to prevent moisture ingress to a head pressure of three metres. The moisture proofing mechanism need not be an integral part of the pulling eye.

The pulling eye shall include a method of attachment to winching equipment in the form of an eye. The internal diameter of the eye shall be designed to permit the attachment of swivels or shackles of an equivalent safe working load.

4.4.1 Pulling Eye Dimensions

The design of the pulling eye shall not limit the size of the conduit or conduit bend the relevant cable may be installed in. Endeavour Energy conduit sizes are specified in underground transmission mains design standard MDI0051.

The bending radius of the cable shall not be affected by the installation of the pulling eye.

A design drawing of the pulling eye shall be provided, this shall include the pulling eye diameter

4.5 Testing Requirements

The supplier shall provide the nominated place of manufacturing and specific extrusion line(s) with the offer. The items shall be sourced from only this place for the term of the contract. The supplier will be required to formally request should it wish to change the manufacturing source of the supplied items. Quality assurance and product certification requirements and associated documents shall be presented for approval before any alternate sourced product can be supplied.

Type, sample and routine tests shall be carried out on all cables in accordance with this clause, which is based on the requirements of AS/NZS 1429.2.

Each type test may cover a range of cables within the submission as specified in section 13.1 of AS/NZS 60840 (2006) - Range of Type Approval, and 3.3 of AS/NZS 1429.2 (2009) - Re-Qualification Tests, provided that -

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- (a) the voltage group is not higher than that of the tested cable(s), and;
- (b) the conductor cross-section is not larger than that of the tested cable(s), and;
- (c) the cable has a similar construction to that of the tested cable(s), and;
- (d) the calculated nominal electrical stress at the conductor screen does not exceed the electrical stress at the conductor screen of the tested cable(s) by more than 10%, and;
- (e) the calculated nominal electrical stress at the insulations screen does not exceed the electrical stress at the insulation screen of the tested cable(s).

A table indicating which type test is associated with each cable shall be submitted as part of the tender.

All type tests (including a set of sample and routine tests) shall be carried out by a testing authority/laboratory holding accreditation:

- by NATA Australia; or,
- by an accreditation authority recognised by NATA Australia.

Tests from other testing authorities, such as KEMA, may also be accepted at the discretion of the Manager, Mains Assets.

All type test reports shall be accompanied by copies of the accreditation certificates issued to the testing laboratory. The accreditation certificates shall be valid for the relevant tests and for the duration of the tests.

Type tests shall be less than five years old. Type tests beyond this limit may be accepted if sufficient information can be provided to show that the manufacturing process, raw materials, design and quality control processes have not significantly changed since the original test date.

Type tests shall be repeated should the supplier propose any of the following changes:

- Changes to the processes of manufacturing.
- Change to design of the cable.
- Change in the materials used.
- Change in the manufacturing technology.
- Change in source of the raw material.

All sample and routine tests may be conducted at the manufacturing facility's test laboratory on the condition that sufficient evidence is provided to demonstrate the testing facility's capability to perform the specified tests.

As a minimum, the following information shall be provided:

- qualifications/experience of the testing staff;
- test procedures for all sample/routine tests;
- testing facility quality control procedures; and,
- test instrument calibration certificates/procedures.

All documentation submitted (including reports, tests, testing procedures/policies, calibration certificates and the like) written in any language other than English shall not be accepted unless the reports are translated into English by a **Certified** translator.

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4.5.1 Type Tests

Electrical type tests

Test reference	Test name	Test description/criteria
AS 60840 12.3.3*	Bending test (followed by partial discharge test)	The bending cycle shall be carried out three (3) times in total
AS 60840 12.3.4*	Partial discharge test	5pC at 114kV
AS 60840 12.3.5*	Tan δ measurement (measured at 95 to 100°C)	XLPE (no additives) - 10×10^{-4} at 95-100°C
AS 60840 12.3.6*	Heating cycle test	20 cycles of eight (8) hours each, with at least two (2) hours at 95-100°C followed by at least 16 hours of natural cooling
AS 60840 12.3.7*	Lightning impulse test (cable at 95-100°C)	10 positive and 10 negative impulses at 650kV _{peak}
	Power frequency test	No breakdown of cable with 190kV applied for 15 minutes
AS 60840 12.3.4*	Partial discharge test	5pC at 114kV
AS 60840 12.3.8*	Examination of cable	No signs of deterioration (for example, electrical degradation, leakage, corrosion or harmful shrinkage)
AS 60840 12.3.9	Conductor screen resistivity	Max 1000 Ω m measured at 90 $\pm$ 2°C (before and after ageing)
	Insulation screen resistivity	Max 500 Ω m measured at 90 $\pm$ 2°C (before and after ageing)

Tests identified by an asterisk shall be completed in the order shown in accordance with the requirements of AS/NZS 60840.

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Non-electrical type tests

Test reference	Test name		Test description/criteria
AS 60840 10.4	Conductor examination		As per declared construction
AS 60840 10.6.2	Minimum insulation thickness		17.1mm
	Insulation concentricity		$\frac{t_{\max} - t_{\min}}{t_{\max}} \leq 5\%$
AS 60840 10.6.3	Oversheath thickness		Refer to Table 3
AS 60840 12.4.2	XLPE Insulation	Tensile strength (before ageing)	≥12.5MPa
		Tensile strength (after ageing)	±25% after 168 hours at 135±3°C
		Elongation at break (before ageing)	≥200%
		Elongation at break (after ageing)	±25% after 168 hours at 135±3°C
AS 60840 12.4.3	HDPE Oversheath	Tensile strength (before ageing)	≥12.5MPa
		Elongation at break (before ageing)	≥300%
		Elongation at break (after ageing)	≥300% after 240 hours at 110±2°C
AS 60840 12.4.4	Completed cable ageing test	XLPE tensile strength	±25% after 168 hours at 100±2°C
		XLPE elongation at break	±25% after 168 hours at 100±2°C
		HDPE elongation at break	≥300% after 168 hours at 100±2°C
AS 60840 12.4.6	Oversheath pressure test on HDPE Sheath		The median of the indentation values of the three samples shall not be >50% of the mean thickness of the samples
AS 60840 12.4.10	XLPE hot set test	Elongation under load	≤175% after 200±3°C for 15 minutes with 200kPa load
		Permanent elongation	≤15% after 200±3°C for 15 minutes with the load removed and sample cooled

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Test reference	Test name	Test description/criteria
AS 60840 12.4.12	HDPE carbon black content	2.5±0.5%
AS 60840 12.4.13	XLPE shrinkage test	4% after six (6) hours at 130±3°C
AS 60840 12.4.14	HDPE shrinkage test	<3% after five (5) cycles for 5 hours at 80±2°C
AS 60840 12.4.18	Water penetration test (conductor and under sheath)	No water shall emerge from the ends of the cable
AS 60840 12.4.19	Polylam foil	Examination
		Adhesion
		Peel strength
		Cable dissected, no signs of cracking, separation or damage shall be found
		At least five (5) samples shall be submitted with a minimum adhesion 0.5N/mm
		Minimum value of peel strength to be ≥0.5N/mm

4.5.2 Sample tests

The following sample tests shall be performed for the first drum of each item supplied and every tenth drum of that item thereafter.

Sample test reports shall be submitted with each cable delivery.

Test reference	Test name	Test description/criteria
AS 60840 10.4	Conductor examination	As per declared construction
AS 60840 10.5	Resistance of conductor	Max DC resistance at 20°C – 300mm ² : 0.0601 Ω/km 400mm ² : 0.0470 Ω/km 630mm ² : 0.0283 Ω/km 800mm ² : 0.0221 Ω/km 1200mm ² : 0.0151 Ω/km 1600mm ² : 0.0113 Ω/km 2000mm ² : 0.0090 Ω/km 2500mm ² : 0.0072 Ω/km
AS 60840 10.5	Resistance of metallic wire screen	The DC resistance of the wire screen (at 20°C) shall not exceed the value specified in the Cable Technical Schedule form.
AS 60840 10.6	Insulation thickness	≥17.1mm

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Test reference	Test name	Test description/criteria
	Oversheath thickness	Refer to Table 3
AS 60840 10.9	XLPE hot set test	The sample shall be subjected to $200\pm 3^{\circ}\text{C}$ for 15 minutes with a load of 200kPa Max elongation under load shall be $\leq 175\%$ Max permanent elongation (after cooling) shall be $\leq 15\%$
AS 60840 12.4.13 (Additional test)	XLPE shrinkage test	4% after six (6) hours at $130\pm 3^{\circ}\text{C}$
AS 60840 12.4.14 (Additional test)	HDPE shrinkage test	$< 3\%$ after five (5) cycles for 5 hours at $80\pm 2^{\circ}\text{C}$
AS 60840 10.10	Capacitance	The capacitance between the conductor and the metallic screen/sheath shall be measured. It shall not exceed the declared nominal value by more than 8%.
AS 60840 12.4.18	Water penetration test (conductor and under sheath)	No water shall emerge from either end of the cable during the test procedure.
AS 60840 12.14.19	Examination	Cable dissected, no signs of cracking, separation or damage should be found
	Adhesion	At least five (5) samples shall be submitted with a minimum adhesion 0.5N/mm
	Peel strength	Minimum value of peel strength to be $\geq 0.5\text{N/mm}$
AS 1429.2 Table 3.1 1(a)	Thickness of extruded conductor screen	The thickness of the conductor screen shall not be less than 0.8mm.
AS 1429.2 Table 3.1 1(b)	Irregularities in conductor screen/ insulation interface	Any projections/irregularities in to the insulation shall be no more than the lower of the following two (2) values: - 0.075mm. - The value guaranteed by the manufacturer in the technical specification.

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Test reference	Test name	Test description/criteria
AS 1429.2 Table 3.1 2	Insulation purity	All values shall be the lower of the following two options. Those specified below or the value guaranteed by the manufacturer in the technical specification: - Voids > 0.05 mm shall be zero. - Size of contaminants shall be $\leq 0.05\text{mm}$. - Size of discoloured contaminants shall be $\leq 0.250\text{mm}$. - Number of contaminants shall be ≤ 5 in each 16 cm^3
AS 1429.2 Table 3.1 3(a)	Thickness of extruded insulation screen	The thickness of the insulation screen shall not be less than 0.8mm
AS 1429.2 Table 3.1 3(b)	Irregularities in insulation screen/ insulation interface	Any projections/ irregularities into the insulation shall be no more than the lower of the following two values: - 0.125mm. - The value guaranteed by the manufacturer in the technical specification.
AS 1429.2 Table 3.1 4	Diameter of metallic wire screen	Wires shall not vary from the nominal diameter by more than 5%.

4.5.3 Routine tests

The following routine tests shall be performed on each length of cable supplied.

Routine test reports shall be submitted with each cable delivery.

Test reference	Test name	Test description/criteria
AS 60840 9.2	Partial discharge test	10pC at 114kV
AS 60840 9.3	High voltage test	No breakdown shall occur during the 30-minute period whilst the cable is at 190kV
AS 60840 9.4	DC voltage test	IEC 60229 3.1 - DC voltage test at 25kV. No breakdown of the oversheath shall occur

5. Cable Drums

5.1 General Requirements

The cable shall be supplied on steel cable drums that have a spindle hole diameter of 130mm and shall be suitable for cable pulling while being supported on the drum rims.

The drums shall be suitable for repeated handling and prolonged storage and shall be completely battened.

To protect the cable from damage, at least two layers of hessian tape or other suitable material shall be applied to the barrel of the drum prior to the cable being wound onto the drum.

The cable ends shall be suitably protected to avoid damage during transport and storage, and both ends of all drum lengths shall be accessible for testing purposes and shall not pass through the drum cheeks.

Cable drums shall be lifted/craned at delivery locations using spreader bars and/or long chains to prevent crushing and damage to cable drums during the unloading process.

5.2 Drum Lengths

Maximum drum lengths shall be at least 800m for all cables.

5.3 Markings

Each drum shall be labelled (clearly and legibly) with the following information:

- Supplier name
- Utility name
- Contract number
- Purchase order number
- Cable type
- Length of cable
- Mass of the drum with and without cable, ie gross & net mass.
- Stores reference number (if provided)
- Project reference name (if provided)
- Delivery location

All drums will likely be stored outside, so drum markings shall be suitable for prolonged sun/weather exposure.

5.3.1 Protective external lagging

Wooden battens or approved equivalent shall be used. Corflute is not acceptable. Drum battens shall be sufficiently robust and arranged to protect the cable from damage during transport, in particular, damage by fork-lift trucks.

6. Safety Data Sheet (SDS)

A Safety Data Sheet (SDS) for each material used in the manufacturing of the cable shall be provided with the offer.

7. Cable Sample

Suppliers must submit sample/s for inspection when requested, at no cost to the purchaser. A 0.3 metre sample of each cable type being offered will suffice.

8. Environmental Considerations

Suppliers are required to demonstrate if each component of the product can be recycled and/or disposed of at the end of products life (e.g. recycling of aluminium conductor). Any materials that cannot be recycled shall be listed and recommended disposal / handling processes provided.

9. Service History

Suppliers shall state:

- The period of service of the items being offered within the Australian environmental conditions.
- Australian Customers/Electricity Supply Authorities who have a service history of the items being offered.
- Contact names and telephone numbers of relevant employees of those customers/electricity supply authorities who can verify the service performance claimed.

10. Quality Assurance

The supplier and/or manufacturer shall provide with the offer, a certificate of Quality Management System in accordance with AS/NZS ISO 9001 or similar and/or an Environmental Management System in accordance with AS/NZS ISO 14001 or similar.

11. Authorities & Responsibilities

Chief Safety Asset & Operating Officer has the authority and responsibility for:

- Approving technical specifications including any variations.
- Making all decisions concerning compliance in respect to this document.
- Approving nominations of Endeavour Energy representatives.
- Delegating any of these authorities and responsibilities to the Head of Asset Planning & Performance.

Head of Asset Planning & Performance has the authority and responsibility for:

- Approving this instruction for minor changes and making recommendations to the Chief Safety Asset & Operating Officer for major changes in respect to this document.
- Making recommendations concerning compliance in respect to this document.
- Making nominations of Endeavour Energy representatives.

Engineering Delivery Manager has the authority and responsibility for:

- Keeping the contents of this document up to date.
- Reviewing all test reports submitted and making recommendations to the Head of Asset Planning & Performance.

Manager Supply Chain is responsible for checking that all cables purchased by Endeavour Energy comply with the requirements of this document.

Customer Network Solutions Branch is responsible for checking that all conductors installed by Level 1 Accredited Service Providers comply with the requirements of this document.

12. Appendix A

12.1 132kV Polymeric Insulated Underground Cables

Item no.	Cable Description
1	132kV 1 Core 300 mm ² Stranded Cu. XLPE smooth aluminium sheath HDPE
2	132kV 1 Core 300 mm ² Stranded Cu. XLPE CWS polylam sheath HDPE
3	132kV 1 Core 400 mm ² Stranded Cu. XLPE smooth aluminium sheath HDPE
4	132kV 1 Core 400 mm ² Stranded Cu. XLPE CWS polylam sheath HDPE
5	132kV 1 Core 630 mm ² Stranded Cu. XLPE smooth aluminium sheath HDPE
6	132kV 1 Core 630 mm ² Stranded Cu. XLPE CWS polylam sheath HDPE
7	132kV 1 Core 800 mm ² Stranded Cu. XLPE smooth aluminium sheath HDPE
8	132kV 1 Core 800 mm ² Stranded Cu. XLPE CWS polylam sheath HDPE
9	132kV 1 Core 1200 mm ² Stranded Cu. XLPE smooth aluminium sheath HDPE
10	132kV 1 Core 1200 mm ² Stranded Cu. XLPE CWS polylam sheath HDPE
11	132kV 1 Core 1600 mm ² Stranded Cu. XLPE smooth aluminium sheath HDPE
12	132kV 1 Core 1600 mm ² Stranded Cu. XLPE CWS polylam sheath HDPE
13	132kV 1 Core 2000 mm ² Stranded Cu. XLPE smooth aluminium sheath HDPE
14	132kV 1 Core 2000 mm ² Stranded Cu. XLPE CWS polylam sheath HDPE
15	132kV 1 Core 2500 mm ² Stranded Cu. XLPE smooth aluminium sheath HDPE
16	132kV 1 Core 2500 mm ² Stranded Cu. XLPE CWS polylam sheath HDPE

Produced by the Asset Planning and Performance Branch

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