

33kV, 66kV & 132kV Cable Accessories

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This amendment replaces the following specification:

ETS 0103 – 33kV, 66kV & 132kV transmission cable joints and terminations – Am 1

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1 Documentation Scope

This specification covers the design, engineering, manufacture, testing, supply, and delivery of 33 kV, 66 kV and 132 kV **cable accessories** to be used in Endeavour Energy's underground network.

The **accessories** offered in response to this Specification shall be manufactured and tested to the Standards with the year of publication listed below. **Accessories** manufactured and tested to previous or later versions of the standards shall not be accepted.

Where this Specification conflicts with a standard, this Specification will prevail. However, significant inconsistencies should be referred to **Engineering Delivery Manager** for resolution.

2 References

External Regulations	
Electricity Supply Act 1995 (NSW)	
ENA National Electricity Network Safety Code (Doc 001-2019)	

External Standards		
Standard No.	Year	Title
AS/NZS 1429.1	2006	Electric cables – Polymeric insulated – For working voltages 1.9/3.3 (3.6) kV up to and including 19/33 (36) kV
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 4325.1	1995	Compression and mechanical connectors for power cables with copper or aluminium conductors
AS/NZS 4805.1	2007	Accessories for electric cables – Test requirements Part 1: Power cables with extruded insulation for rated voltages from 1.9/3.3 (3.6) kV up to and including 19/33 (36) kV
AS/NZS EC 60840	2020	Power cables with extruded insulation and their accessories for rated voltages above 30 kV (36 kV) up to 150 kV (170 kV) – Test methods and requirements
AS 2271.301	2022	Dimensional standardization of terminals
EN 50181	2010	Plug-in type bushings above 1kV up to 52kV and from 250A to 2.5kA for equipment other than liquid filled transformers.
IEC 60502.2	2014	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um =1.2 kV) up to 30 kV (Um = 36 kV) – Part 2: Cables for rated voltages from 6 kV (Um = 7.2 kV) up to 30 kV (Um = 36 kV)

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IEC 60811.501	2018	Electric and optical fibre cables – Test methods for non-metallic materials –Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds
IEC 61442	2005	Test methods for accessories for power cables with rated voltages from 6 kV (Um = 7.2 kV) up to 30 kV (Um = 36 kV)
IEC 62271.209	2022	Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV – Fluid filled and extruded insulation cables – Fluid-filled and dry-type cable-terminations
SA TS 90815.1	2020	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions.

Company Policies and Procedures

Company Policy (Network) 9.1.6 – Approved Materials List

Company Policy (Network) 9.2.5 – Network Asset Design

Company Policy (Network) 9.2.10 – Network Asset Ratings

Company Policy (Network) 9.7.1 – Network Asset Construction

Network Management Plan – December 2013 Review

Company Standards

ETS 0111 - 132kV Polymeric Insulated Underground Cables

ETS 0112 - 66kV Polymeric Insulated Underground Cables

ETS 0113 - 33kV Polymeric Insulated Underground Cables

3 Definitions and Abbreviations

Term	Definition
Accessories	Refers to joints, terminations, and ancillary items
Al	Aluminium
Consumable	Any material/component that has shelf life/expiry date.
Cu	Copper
GIS	Gas insulated switchgear
HDPE	High density polyethylene
HV	High voltage
MSDS	Material safety data sheet
NATA	National Association of Testing Authorities
PE	Polyethylene
PVC	Polyvinyl chloride
r.m.s.	Root-mean-square (or effective) voltage or current.
U	The r.m.s. power frequency voltage between phases.
U₀	The rated r.m.s. power frequency voltage between each conductor and screen or sheath for which the accessories are designed.
U_m	The maximum r.m.s. power frequency voltage between any two conductor phases for which the accessories are designed.
UGOH	Underground to overhead connected cable.
UV	Ultra violet
XLPE	Cross linked polyethylene

4 Actions

All 33 kV, 66 kV and 132 kV cable accessories used on the Endeavour Energy transmission cable network shall comply with the requirements of this specification.

All items within the scope of this document shall be approved by the Head of Asset Planning & Performance prior to purchase.

4.1 Details of polymeric insulated transmission cables in Endeavour's network

All new transmission cables installed on Endeavour's network are polymeric insulated with a black HDPE over sheath and copper conductor. The 132 kV, 66 kV and 33 kV cables shall be manufactured and tested in accordance with Endeavour Energy specifications ETS 0111, ETS 0112 and ETS 0113 respectively.

The cables are single core and longitudinally water blocked including the conductor. The cables are installed either direct buried, in PVC ducts/PE pipes or in a combination of these constructions within the franchise

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boundaries of Endeavour Energy. A summary of the technical details of the standard 33 kV, 66 kV and 132 kV cables installed in Endeavour's transmission underground cable network are provided in Table 1.

Table 1: Summary of technical details of 33 kV, 66 kV and 132 kV cables

Item		132 kV cables	66 kV cables	33 kV cables
Rated operating voltages	U_m	145 kV r.m.s. phase to phase	72.5 kV r.m.s. phase to phase	36 kV r.m.s. phase to phase
	U	132 kV r.m.s. phase to phase	66 kV r.m.s. phase to phase	33 kV r.m.s. phase to phase
	U_0	76 kV r.m.s. phase to earth	38 kV r.m.s. phase to earth	19 kV r.m.s. phase to earth
Impulse withstand voltage, 1.2/50 μ s		650 kV	325 kV	200 kV
Maximum fault rating for duration of 1 s (single phase)		31.5kA	31.5kA	31.5kA
Conductor size and configuration of single core cables		Stranded Compacted 300 mm ² 400 mm ² 630 mm ² 800 mm ² Five Sector Milliken 1200 mm ² 1600 mm ² 2000 mm ² 2500 mm ²	Stranded Compacted 630 mm ²	Stranded Compacted 300 mm ² 630 mm ² 800 mm ² Five Sector Milliken 1200 mm ²
Conductor screen		Extruded cross-linked semi-conductive		
Insulation		XLPE		
Nominal insulation thickness		18.0 mm	11.0 mm	8.0 mm
Minimum insulation thickness		17.1 mm (exceeds the requirement of AS/NZS 1429.2)	10.45 mm (exceeds the requirement of AS/NZS 1429.2)	7.6 mm (exceeds the requirement of AS/NZS 1429.1)
Insulation screen		Extruded cross-linked semi-conductive		
Insulation screen stripability		Solidly Bonded		Hand Strippable
Metallic sheath		- Polyethylene/aluminium foil laminate with Cu wire screen - Smooth aluminium sheath		
Outer sheath		Single layer HDPE with conductive graphite coating on outer surface		
Over sheath colour		Black		
Maximum conductor / screen temperature under 1 s fault conditions		250 °C		
Conductor		Copper		
Maximum conductor temperature (cyclic loading - normal conditions)		90 °C		
Maximum conductor temperature (cyclic loading - emergency)		105 °C		
Rated frequency		50 Hz		

4.2 Joints and terminations

4.2.1 General

Cable joint and termination kits shall be suitable to join and terminate cables in Endeavour Energy's 33 kV, 66 kV and 132 kV transmission network, which has an effectively earthed neutral. Each kit shall be supplied with sufficient components to join/terminate all three phases of the circuit.

The cables currently installed in Endeavour Energy's transmission network have 95% concentricity. The suppliers shall cover the entire range of joints/terminations listed in Appendix A, with the least number of joint/termination kits of each voltage category as far as possible. Preference shall be given to the suppliers who offer the minimum number of joint/termination kits in each designated operating voltage to cover the entire range.

Where joints and terminations contain consumables, these consumables shall be packed separately within the kit and be available for purchase as replacement parts if required.

The supplier shall provide a complete description (including part numbers) and price of all special tools and equipment that are recommended for the proper installation, operation, and maintenance of the accessory.

Range taking shear bolt mechanical or compression type connectors/lugs to suit copper conductors of the range of cable sizes may be used in kits for which each kit is designed and type tested.

Unless stated otherwise, the joint and terminations shall be manufactured and tested complying with the requirements stated in this specification and the following standards, as applicable to each voltage category and type of cable insulation:

- a. 33 kV – AS/NZS 4805.1 (test methods as stated in IEC 61442)
- b. 66 kV and 132 kV – AS/ANZ IEC 60840
- c. 33 kV Plugin terminations - EN 50181
- d. 66 kV and 132 kV Plugin terminations - IEC 62271.209.

All joints and terminations shall be provided with adequate mechanical protection and protection against environmental conditions such as moisture ingress and UV radiation, if exposed to direct sunlight.

Joints and Terminations shall be compatible with the cable sheath types nominated in this specification as well as transitioning to legacy corrugated aluminium sheath cable in Endeavour's network. Sheath to earth bonding connections shall be achieved via suitable mechanical means - hot-plumbed/wiped connections are no longer acceptable.

Joints and terminations shall be offered using the technologies in Table 2:

Table 2: Summary of joint & termination technologies

Voltage	Cold Applied*	Heat Applied	Taped
33 kV	Acceptable	Acceptable	X
66 kV	Acceptable	X	X
132 kV	Acceptable	X	X

**Cold applied joints and terminations with pre-expanded components having a shelf life less than 24 months are not acceptable.*

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Note: outdoor terminations shall be dry type, ie. non-fluid filled or cold pour gel set type. Pre-heated silicone, polyisobutylene, and other hot-pour liquid insulation compound types will not be considered.

All joints shall be offered in both a cross bonded and non-cross bonded form. The joints offered for use in a cross-bonded system shall incorporate a method for sectionalising the copper wire-screen and connecting the wire screen onto 240 mm² stranded circular copper X-90 insulated PVC sheathed bonding cables that are brought out of the joint.

The method used for such connection shall not impair the electrical or mechanical performance of the hermetically sealed joint. Materials required to protect these connections and prevent moisture ingress to the joint shall be included in the joint kit.

The joints shall be encapsulated in a suitable enclosure to provide adequate mechanical protection and protection against environmental conditions. The enclosure of 66kV and 132kV joints shall be filled with a suitable quality insulating compound so that the joint is fully protected from ingress of moisture. The 33kV accessories may use other means to achieve protection against ingress of moisture.

Cables with wire screens have been protected against ingress of moisture by an aluminium foil/polythene laminate sheath. The sheath is separated from the copper wire screen by a water swellable, semi-conductive tape. The design of the joints and terminations shall preserve the purpose of the laminated sheath.

It is preferred to have the same joint proposed for use in a cross bonded system or a non-cross bonded system with minor additional inclusions in the kit to allow both purposes (e.g. a suitable link to connect the screen wires and components to seal the openings provided for bonding leads).

A Bill of Materials (BOM) to complete the joint/termination shall be provided in each kit (separate from the installation instructions). The consumables such as resins, solvents, mastics, lubricants etc. that have an expiry date or shelf life shall be listed separately on the BOM. The expiry date of each consumable item shall be provided on the item packaging.

The identity of each component, or part number referred to in the BOM shall appear on the relevant component(s) or on the individual package of each component. The same identity of the components shall be used in the installation instructions. The minimum allowable settlement time applicable after completion of the joint shall be clearly specified in the installation instruction.

Each joint and termination kit shall be accompanied with a set of installation instructions. The instructions shall be sequential and well detailed with clear dimensions and illustrations. A BOM clearly identifying each component shall be included in the beginning of the installation instruction.

A copy of the installation instruction and BOM shall be included in the offer for each item.

The following information shall also be provided for each product:

- whether the item is a joint or a termination.
- the operating voltage.
- the applicable range of cable sizes (including conductor, insulation, and overall cable diameters).
- the range and tolerance of each critical component.
- the accessory type, that is, Heat applied or cold applied.

Endeavour Energy reserves the right to request the supplier to modify the installation instructions in any or all of the kits. Any such modifications shall be carried out in consultation with the manufacturer. No changes shall be made to any of components or installation instructions in the kit without prior approval from Endeavour Energy.

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It is desirable that the product(s) will withstand contamination by transformer oil. The performance of the product(s) when subjected to contamination of transformer oil shall be provided along with any submission.

4.2.1.1 Technical information to be supplied with offer

A complete description of the items offered which shall include dimensional drawings, jointing instructions and special tooling requirements with reference but not limited to the following items shall be provided:

- proof of field performance of the product offered.
- detailed dimensional drawing of the longitudinal cross-section of each joint/termination type offered.
- the specification for the stress grading material, the method of stress control and the quality control procedure employed in its manufacture.
- copy of the original laboratory type test reports
- installation instruction written in English for each type of accessory offered. The instruction shall be logical, sequential, concise, and include clear illustrations for each step of the installation process.
- an estimate of the time and number of persons that would be required to install each type of accessory offered.
- material safety datasheets for all components of each kit.
- details of shelf life and storage conditions (if any) of all component/materials offered.
- a comprehensive listing of all specialised tooling that is required to complete all offered accessory types.

4.2.1.2 Packaging

Each kit shall be packaged with the detailed installation instruction and correct components required to complete the installation of the joint or termination. Each component in each kit shall be suitably labelled for easy identification. Each kit shall include an itemised check list of components including consumables with reference to the identity and quantities of each component that are required to complete the installation of the joint or termination. A separate list of consumable items in the kit shall also be provided. The lists shall also provide additional information including the name of the manufacturer, the part number, and if applicable the expiry date.

The terminology used for labelling shall be consistent with the identity used in the itemised list and the installation instructions relevant to the item. If there are items that have special storage requirements or expiry dates, such items shall be packed separately to the main kit.

The following information shall clearly be displayed on the box(s) of each kit:

- tender number including the year of award of the contract
- supplier's name and logo
- special care in handling of the box/components of the kit
- manufacturer's name (if different from the supplier)
- manufacturer's part number
- short description of the kit which specifies the purpose of the kit
- date of manufacture
- date of expiry of applicable items with their identity (if the product has a component that has a limited shelf life)
- special storage requirement (if applicable only)
- a short description of the product providing the range taking capability (that is range of conductor cross sections, insulation diameters and cable overall diameters, and the like)

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The packaging shall protect the contents against dust and moisture and shall be robust enough to protect the enclosed components against potential mechanical damages that could occur during delivery and handling.

4.2.1.3 Terminations

Indoor and outdoor type cable terminations are required to terminate all cable sizes listed in **Table 1 - Appendix A**. Dry type plugin terminations are also required for indoor GIS switchgear connections.

All terminations shall facilitate cable sheath testing without disassembling or disconnecting any component of the termination other than the earth connection of the wire screen of the cable at the termination.

The normal service conditions of the terminations are as follows:

- the ambient air temperature does not exceed 45°C, and its average value measured over a period of 24 hours does not exceed 40°C
- the ambient air temperature is not less than -10°C
- for terminations installed in transformer cubicles, the maximum temperature due to sunlight/other heat sources such as transformers in the cubical does not exceed 80°C
- maximum continuous cable temperature 90°C
- maximum emergency rating of the cable 105°C
- the altitude does not exceed 1000m.

4.2.1.4 Straight through Joints

The joints shall be supplied to join any combination of two cables listed in **Table A.1 - Appendix A**.

All joints shall be straight through joints (cross bonded and non-cross bonded). Stub and/or tee joints are not required.

All joints shall be suitable for being installed in an environment such as waterlogged outdoor cable trenches, partially covered pits or indoor cable basements.

4.3 Technical requirements

Technical requirements for all cable joints and terminations are detailed below.

The joints / terminations shall not reduce the continuous current rating of the cable it is installed on.

Endeavour Energy's typical continuous current ratings for transmission cables are listed in clause 5.5 of MDI 0046.

The installation instructions shall provide details for installing the joint / termination on cables within and without a graphite conductive layer. Details shall be provided specifying the recommended method of removing the graphite coating from the cable sheath as well as the minimum distances.

4.3.1 Internal stress control

The internal stress control shall consist of a prefabricated unit(s) applying active pressure on the cable insulation to provide geometric stress control. The unit shall be pre-moulded and factory tested to IEC 60840. Alternative stress control regime may be proposed for 33 kV joints and terminations.

4.3.2 Compatibility of materials

The materials and installation techniques of the joints and terminations shall be physically, chemically, electrically, and thermally compatible with the relevant cable material including materials used in the industry by other manufacturers. If the materials of the joints and terminations offered are not compatible with any

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other joint materials used in the industry, the supplier shall specifically identify such materials with the offer. Preference shall be given for the offers with unrestricted compatibility.

4.3.3 Termination lugs

The termination lugs to suit the range of conductor size, maximum conductor current and relevant fault current shall be included in the kit. Termination lugs shall be range taking shear bolt type, compression type termination lugs will not be considered.

Cable lugs for 33 kV indoor (except plugin's) and outdoor terminations are not required to be included in the kit.

Top bolts (cylindrical terminals) and suitable straight and right-angle adaptor palm terminal connections shall be offered with all 66 kV and 132 kV outdoor terminations. Top bolts shall be 60mm in diameter and have a current rating commensurate with this diameter in Table 2 Clause 7.3 of AS 62271.301. Adaptor terminal palms shall be tinned copper as per the dimensions / requirements of No.5 Clause 7.3 AS 62271.301 with 4x14 mm diameter holes.

All terminations shall have the facility to carry out periodical 10 kV d.c. for one minute cable sheath testing without disassembling the termination. Therefore, the termination shall be sufficiently insulated from the mounting structures and allow the disconnection of earthing connections. The rated insulation level of all materials used to insulate the metallic sheath from the grounded mounting structures shall withstand minimum of 15 kV d.c. for one minute, to sustain the multiple periodical sheath testing for the life of the cable circuit.

4.3.3.1 Outdoor terminations

Outdoor terminations are required for both UGOH constructions and termination within substations. The outdoor terminations shall be dry type and self-supporting. The terminations used in substations will be on steel support structures and the UGOH terminations will be installed on steel brackets mounted on conductive and insulated poles. The outdoor termination shall consist of a weather-proof housing designed to withstand exposure to full solar UV radiation. The outer surface of the housing shall have high resistance to damage due to flash overs and tracking that could occur due to lightning/switching surges. Light weight polymeric type housings with high level of anti-tracking properties are preferred.

Outdoor terminations shall have suitable insulation coordination with existing insulators and installation in areas with heavy industrial pollution or near coastal areas.

The minimum nominal creepage distance of the outdoor terminations shall be no less than 31 mm/kV.

This value is the ratio of the surface leakage distance measured between phase and earth over the r.m.s. phase to phase value of the system highest voltage for the termination which is based on the recommendation for very heavy pollution levels specified in SA TS 90815.1.

The nominal minimum creepage distances are provided in Table 3:

Table 3: Creepage Distance

Voltage	Minimum Creepage Distance (mm)
33 kV	1116
66 kV	2248
132 kV	4495

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Drawings of typical outdoor UGOH terminations are provided in Clause 4.4.

Dry type plug-in cable terminations shall be compatible with the inside cones of GIS in Endeavour Energy transmission network and are required for entire range of 33kV, 66kV and 132kV cable sizes provided in Table A.2 - Table 1.

Endeavour Energy needs to carry out periodical tests on GIS components that require disconnecting the cables by withdrawing the plugin terminations from the switchgear. Therefore, the supplier/manufacturer shall provide the following information for each type of plug-in terminations offered along with the submission for consideration during the evaluation of the offer:

- guaranteed number of in and out offload operations that can be carried out without impairing the electrical performance.
- recommended maintenance requirements such as replacements of parts (for example contact rings/fingers as applicable), after fault inspections, etc, to maintain the electrical performance.
- details of the suitability / compatibility of the plugin terminations to be installed into other suppliers / manufacturers' insulator bushing.

The 33kV plug-in terminations shall be dry type and shall be suitable for 33kV gas insulated metal enclosed switchgear (GIS). The insulator bushings that house the cable terminations in the 33kV GIS shall comply to interface type 3 specified in EN 50181.

Manufacturers/suppliers may supply 72.5kV rated plug-in terminations that comply to IEC 62271.209 (that is Type A of figure 4 and dimensions as given for rated voltage 72.5 kV to 100 kV in figure 5 of the IEC standard) for 33kV cable sizes in Table 1 - Appendix A only if the terminations suitable for those cable sizes cannot be manufactured to suit interface type 3 specified in EN 50181.

The 66kV and 132kV plug-in terminations shall be dry type and shall be compatible with the cable connection enclosure provided at the switchgear / transformer. The cable connection enclosures are manufactured in complying with IEC 62271.209. The typical arrangement of the cable connection assembly and the assembly dimensions are as described in Type A of Figure 4 and dimensions to suite the appropriate rated voltages given in Figure 5 of IEC 62271.209 respectively.

Offers shall include the plug and the insulator bushing parts of the plugin terminations and shall be quoted separately. All dimensions of the plug part and the insulator bushing part of the plugin terminations shall be fully complied with the relevant dimensions specified in the international standards referred above.

4.3.4 Joint kits

Joints may be range taking with shear bolt mechanical connectors that are suitable to join more than one size of copper conductor. If the other components of the joint (such as pre moulded stress relief cone) permit, the joint kit can cover a range of cable sizes which minimises the total number of joints required in Table A.1 - Appendix A.

4.3.4.1 Metallic screening

All joints shall include full metallic screening for the entire length of the joint. The metallic screen shall solidly connect to the metallic sheath of the cable and must be capable of carrying the designated full fault current of the cable provided in Table 1.

The metallic screen shall be insulated from the external environment and be well protected against possible galvanic corrosion. The insulation of the metallic screen shall be capable of withstanding minimum of 15 kV d.c. applied between the metallic sheath and earth for at least for one minute when the joint is buried. The test reports shall demonstrate compliance to this requirement.

4.3.4.2 Core connectors

Each joint kit shall be provided with connectors (links) that can be used to connect any two copper cores of sizes in the designated range of the joint kit. Range taking shear bolt mechanical connectors are preferred, however compression type connectors may also be considered.

The connectors shall be type tested to satisfy the Class A requirements specified in AS/NZS 4325.1.

The connectors shall be centrally blocked preventing any form of liquid migrating through the connector under all conditions of operation. Unless the connectors are machined from a solid bar without through drilling, the connectors shall be type tested to the method described in Appendix B of AS/NZS 4805.1 to prove that they are hydraulically blocked, and the type test certificates shall be provided.

The connectors used within the accessories shall be correctly identified in the assembly instructions, where applicable, with respect of the following:

- size range of the connector.
- assembly technique.
- tooling and necessary setting.
- preparation of contact surfaces.
- type, reference number and any other identification of the connector.

4.3.4.3 Water blocking capability of joints

All cable joints shall be capable of blocking the water transmission through the joint as well as any migration of water from the environment into the joint. Where necessary, mastic tapes or alternative method shall be used to prevent water migration through as well as into the joint/termination.

All joints shall be subjected to heat cycle test under water, as a type test detailed in IEC 60840 Clause 15.4.2 test f.

4.3.4.4 Environmental conditions of installation

All joints shall be suitable for installation in outdoor pits or direct in stable but wet ground. The joint shall be able to be direct buried after being lowered to its final resting position within a reasonable settlement time. Preference will be given to kits that have a minimal settlement time, which shall be clearly stated in the installation instructions.

4.4 Typical construction drawings

The details of the typical construction of 33kV, 66kV and 132kV UGOH terminations in Endeavour Energy's transmission network can be found in the drawings listed in Table 4:

Table 4: Typical construction drawings of UGOH connections

Drawing number	Amendment	Title	Line Construction
398007	B	Overhead transmission 33 kV construction No.50C UG/OH Delta termination	Delta on concrete pole
398032	B	Overhead transmission 33 kV construction No.50VT UG/OH vertical termination	Vertical on timber pole
398022	A	Overhead transmission 66 kV construction No.60S UG/OH Delta termination	Delta on steel pole
397809	A	Overhead transmission 132 kV construction No.80S UG/OH Delta termination	Delta on steel pole
397820	A	Overhead transmission 132 kV construction No.80VT UG/OH Delta termination	Vertical on steel pole

4.5 Testing and supporting evidence

Several categories of accessories included in this specification require a series of tests in accordance with relevant standards specified. Where the accessory offered has been tested to different international/industry standards, the supplier shall detail the differences between the two standards and provide a copy of the relevant standard to which the product has been tested. If any test found to be inferior to the test specified in the relevant Australian standard, the test will be rejected.

All costs associated with type, sample (batch) or routine tests shall be borne by the manufacture/supplier. Endeavour Energy shall not be held responsible for any costs associated with testing and Endeavour Energy will not be paying or reimbursing the manufacturer/supplier for the cost associated with testing or any other costs associated with the submission.

All accessories shall be tested appropriately as specified in this clause, which is prepared in accordance with this standard and AS/NZS 4805.1, IEC 61442, AS/NZS 4325.1 for 33kV accessories, and IEC 60840 for 66kV and 132kV accessories. For the purpose of carrying out the accessory tests as required by this standard, and recording the results, the accessory and the cable used for testing accessories shall be correctly identified and recorded by the testing authority as required by Appendix A of AS/NZS 4085.1 for 33 kV cable accessories, and Clause 7 of IEC 60840 for 66 kV and 132 kV accessories.

The assembly of accessories to be tested shall comply with the manufacturer's relevant installation instruction included in the kit.

All type tests shall be performed according to the test sequence as listed in Table 6 and Table 7 for 33kV cable accessories, and Table 8 for 66 and 132 kV cable accessories. All type tests shall be carried out by a testing authority holding accreditation:

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

Tests from other testing authorities, such as KEMA, may be accepted at the discretion of Endeavour Energy.

All type test reports shall be accompanied by copies of the accreditation certificate(s) issued to the testing laboratory. The accreditation certificate(s) shall be valid for the relevant test(s) and for the duration of the

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test(s). A copy of the original laboratory type test report accompanying the signatures of the testing authorities shall be required. Reports compiled based on the laboratory test reports are not acceptable.

Type tests should be less than five years old. Type tests beyond this limit may be acceptable at the discretion of Endeavour Energy, 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.

Reports/tests written in any language other than English shall not be accepted unless the reports are translated into English by a Certified translator.

4.5.1 Designation of voltages

The values for U_m , U_0 and U corresponding to the given nominal system voltages for testing purposes are given in Table 5:

Table 5: Voltage ratings to be used for testing of accessories

Nominal system voltage (kV)	U_m (kV)	U_0 (kV)	U (kV)
19/33	36	18	33
38/66	72.5	38	66
76/132	145	76	132

4.5.2 Accessory characteristics

For the purpose of carrying out the accessory tests described in this specification and recording the results, the accessory shall be correctly identified with respect to:

- a) cable/s used for testing accessories (as in Clause 6 of IEC 60840).
- b) conductor connections used within the accessories, where applicable, with respect to:
 - assembly technique.
 - tooling, dies and necessary setting.
 - preparation of contact surfaces.
 - type, reference number and any other identification of the connector.
 - details of the type test approval of the connector.
 - name of manufacturer.
 - type, designation and manufacturing date or date code.
 - rated voltage.
 - installation instruction (reference and date), and
 - cable/s used for testing accessories (as in Clause 6 of IEC 60840).

4.5.3 Type tests on accessories

4.5.3.1 General

The tests specified in this clause are intended to demonstrate the satisfactory performance of accessories alone.

33kV, 66kV & 132kV Cable Accessories

The maximum conductor temperature of the cable for normal operation and short circuit operation during tests shall be considered as 90°C and 250°C respectively for polymeric insulated cables.

All 33kV accessories shall be type tested appropriately as specified in Table 6 and Table 7, which are prepared in accordance with this standard, AS/NZS.4805.1, IEC 61442 and AS/NZS 4325.1. The cables used for testing shall comply with AS/NZS 1429.1 or IEC 60502.2 and shall be of the same voltage as the accessories to be tested. The cables shall be correctly identified as in Appendix A of AS/NZS 4805.1.

All 66kV and 132kV accessories shall be type tested appropriately as specified in Table 8. The test procedures in Table 8 shall be performed in accessories for 66kV and 132kV cables where the calculated nominal electrical stresses at the conductor screen not higher than 8.0 kV/mm and at the insulation screen not higher than 4.0 kV/mm. In other cases, the type tests on the cable systems according to Clause 12 of IEC 60840 shall apply.

4.5.3.2 Type tests on 33 kV accessories

a) Type tests on 33 kV terminations

All tests specified for 33 kV terminations within this specification are type tests. The following type tests in Table 6, which is prepared based on the information provided in Table 4 of AS/NZS 4805.1, shall be carried out on polymeric insulated cable terminations. Unless otherwise specified in the test description/criteria column of the table, all tests shall be carried out at ambient temperature. All tests shall be carried out to the relevant method described in IEC 61442.

Table 6: The sequence and requirements for type tests on terminations for 33kV polymeric insulated cables

Test reference	Test name	Test description/criteria
AS/NZS 4805.1 Table 4 Test 1	Voltage withstand	Shall withstand $4.5U_0$ a.c. for 5 min. or $4U_0$ d.c. for 15 min. The test arrangement and sequence shall be as given in sequence 1.1, 1.2 and 1.3 of Figure 1 of AS/NZS4805.1.
	Voltage withstand wet	This test is for outdoor terminations only. Shall withstand $4.5U_0$ a.c. for 1 min. The test arrangement and sequence shall be as given in sequence 1.1 of Figure 1 of AS/NZS4805.1.
AS/NZS 4805.1 Table 4 Test 2	Partial discharge	This test is not required for terminations installed on cables having unscreened insulation. 10pC maximum at $1.73U_0$. The test arrangement and sequence shall be as given in sequence 1.1 of Figure 1 of AS/NZS4805.1.
AS/NZS 4805.1 Table 4 Test 3	Impulse test at maximum cable conductor temperature in normal operation +5K to +10K	Shall withstand 10 impulses of each polarity. The peak voltage of impulses shall be 170 kV and 200 kV for indoor and outdoor terminations respectively. The test arrangement and sequence shall be as given in sequence 1.1 of Figure 1 of AS/NZS4805.1.

Test reference	Test name	Test description/criteria
AS/NZS 4805.1 Table 4 Test 4	Heating cycles in air.	Shall withstand when subjected to 60 heating cycles at $2.5U_0$. The heating cycle in air shall be of at least eight-hour duration with at least two hours at a steady state temperature of maximum cable conductor temperature in normal operation +5K to +10K followed by at least 3 hour of natural cooling to within 10 K of ambient temperature (refer to Clause 9 of IEC 61442). The test arrangement and sequence shall be as given in sequence 1.1 of Figure 1 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 4 Test 5	Partial discharge at maximum cable conductor temperature in normal operation +5K to +10K and at ambient temperature.	This test is not required for terminations installed on cables having unscreened insulation. 10pC maximum at $1.73U_0$. Partial discharge at elevated temperature is measured at the end of the heating period. The test arrangement and sequence shall be as given in sequence 1.1 of Figure 1 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 4 Test 6	Thermal short circuit (screen)	Two short circuits at least at 31.5 kA for 1 sec. Thermal short circuit may be combined with dynamic short circuit. No visible deterioration. The test arrangement and sequence shall be as given in sequence 1.2 and 1.3 of Figure 1 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 4 Test 7	Thermal short circuit (conductor)	Two (2) short circuits to raise the conductor to maximum permissible short circuit temperature of the conductor. Thermal short circuit may be combined with dynamic short circuit. No visible deterioration. The test arrangement and sequence shall be as given in sequence 1.2 and 1.3 of Figure 1 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 4 Test 8	Dynamic short circuit	This test is a three phase test and only required for single core cable terminations design for initial peak currents larger than 80 kA and for three core cable terminations designed for initial peak currents of larger than 63 kA. One short circuit at short circuit current (initial peak value) in the conductor. The value shall be declared by the manufacturer. No visible deterioration. The test arrangement and sequence shall be as given in sequence 1.3 of Figure 1 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 4 Test 9	Impulse	Shall withstand 10 impulses of each polarity. The peak voltage of impulses shall be 170 kV and 200 kV for indoor and outdoor terminations respectively. The test arrangement and sequence shall be as given in sequence 1.1, 1.2 and 1.3 of Figure 1 of AS/NZS 4805.1.

Test reference	Test name	Test description/criteria
AS/NZS 4805.1 Table 4 Test 10	AC voltage withstand	Shall withstand $2.5U_0$ a.c. for 15 min. The test arrangement and sequence shall be as given in sequence 1.1,1.2 and 1.3 of Figure 1 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 4 Test 11	Humidity	This test is for indoor terminations only. Shall be subjected to $1.25U_0$ a.c. for 300 hours minimum. The test arrangement and sequence shall be as given in sequence 1.4 of Figure 1 of AS/NZS 4805.1. No breakdown or flashover. No more than three trip events. No substantial damage as per the details of assessment provided in Table 13 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 4 Test 12	Salt fog	This test is for outdoor terminations only. Shall be subjected to $1.25U_0$ a.c. for 1000 hours minimum. The test arrangement and sequence shall be as given in sequence 1.5 of Figure 1 of AS/NZS 4805.1. No breakdown or flashover. No more than three trip events. No substantial damage as per the details of assessment provided in Table 13 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 4 Test 13	Examination	Accessory is examined for signs of: cracking in the filling media and/or tape or tube component; and/or a moisture path across a primary seal; and/or corrosion and/or tracking and/or erosion which could, in time, lead to failure of the accessory; and/or leakage of any insulating material. The test arrangement and sequence shall be as given in sequence 1.1,1.2, 1.3, 1.4 and 1.5 of Figure 1 of AS/NZS 4805.1.

b) Type tests on 33kV joints

The following type tests in Table 7, which is prepared based on the information provided in Table 5 of AS/NZS 4805.1, shall be carried out on polymeric insulated straight joints. Unless otherwise specified in the Test description/ criteria column of the table, all tests shall be carried out at ambient temperature. All tests shall be carried out to the relevant method described in IEC 61442.

Table 7: The sequence and requirements for type tests on joints for 33kV polymeric insulated cables

Test reference	Test name	Test description/criteria
AS/NZS 4805.1 Table 5 Test 1	Voltage withstand	Shall withstand 4.5U ₀ a.c. for 5 min. or 4U ₀ d.c. for 15 min. The test arrangement and sequence shall be as given in sequence 2.1, 2.2 and 2.3 of Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 5 Test 2	Partial discharge	This test is not required for joints installed on cables having unscreened insulation. 10pC maximum at 1.73U ₀ . The test arrangement and sequence shall be as given in sequence 2.1 of Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 5 Test 3	Impulse test at maximum cable conductor temperature in normal operation +5 K to +10 K	Shall withstand 10 impulses of each polarity. The peak voltage of impulses shall be 200 kV. The test arrangement and sequence shall be as given in sequence 2.1 of Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 5 Test 4	Heating cycles in air.	Shall withstand when subjected to 30 heating cycles at 2.5U ₀ . The heating cycle in air shall be of at least eight-hour duration with at least two hours at a steady state temperature of maximum cable conductor temperature in normal operation +5 K to +10 K followed by at least 3 hours of natural cooling to within 10 K of ambient temperature (refer to Clause 9 of IEC 61442). The test arrangement and sequence shall be as given in sequence 2.1 of Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 5 Test 5	Heating cycles under water	Shall withstand when subjected to 30 heating cycles at 2.5U ₀ . The heating cycle under 1.0m of water shall be of at least eight hours duration with at least two hours at a steady state temperature of maximum cable conductor temperature in normal operation +5 K to +10 K followed by at least 3 hours of natural cooling to within 10 K of ambient temperature (refer to Clause 9 of IEC 61442). The test arrangement and sequence shall be as given in sequence 2.1 of Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 5 Test 6	Partial discharge at maximum cable conductor temperature in normal operation +5 K to +10 K and at ambient	This test is not required for joints installed on cables having unscreened insulation. 10pC maximum at 1.73U ₀ . Partial discharge at elevated temperature is measured at the end of the heating period. The test arrangement and sequence shall be as given in sequence 2.1 of Figure 2 of AS/NZS 4805.1.

Test reference	Test name	Test description/criteria
AS/NZS 4805.1 Table 5 Test 7	Thermal short circuit (screen)	Two short circuits at least at 31.5 kA for 1 sec. Thermal short circuit may be combined with dynamic short circuit. No visible deterioration. The test arrangement and sequence shall be as given in sequence 2.2 and 2.3 of Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 5 Test 8	Thermal short circuit (conductor)	Two short circuits to raise the conductor to maximum permissible short circuit temperature of the conductor. Thermal short circuit may be combined with dynamic short circuit. No visible deterioration. The test arrangement and sequence shall be as given in sequence 2.2 and 2.3 of Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 5 Test 9	Dynamic short circuit	One short circuit at short circuit current (initial peak value) in the conductor. The value shall be declared by the manufacturer. No visible deterioration. The test arrangement and sequence shall be as given in sequence 2.3 of Figure 2 of AS/NZS 4805.1. Note: This test is a three-phase test and only required for single core cable joints design for initial peak currents larger than 80kA and for three core cable terminations designed for initial peak currents of larger than 63kA. The peak short circuit current of the cable where the joints are installed does not exceed these limits, the test is not required.
AS/NZS 4805.1 Table 5 Test 10	Impulse	Shall withstand 10 impulses of each polarity. The peak voltage of impulses shall be 200 kV. The test arrangement and sequence shall be as given in sequence 2.1, 2.2 and 2.3 of Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 5 Test 11	AC Voltage withstand	Shall withstand 2.5U ₀ a.c. for 15 min. The test arrangement and sequence shall be as given in sequence 2.1, 2.2 and 2.3 of Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 5 Test 12	Examination	Accessory is examined for signs of: cracking in the filling media and/or tape or tube component; and/or a moisture path across a primary seal; and/or corrosion and/or tracking and/or erosion which could, in time, lead to failure of the accessory; and/or leakage of any insulating material. The test arrangement and sequence shall be as given in sequence 2.1, 2.2, and 2.3 of Figure 2 of AS/NZS 4805.1.

4.5.3.3 Type tests on accessories for 66kV and 132kV cables

The following type tests in **Table 8**, are prepared based on the information provided in Table C.1 of IEC 60840, shall be carried out on polymeric insulated cable joints and terminations.

Unless otherwise specified in the test description/criteria column of the table, all tests shall be carried out at ambient temperature. All tests shall be carried out to the relevant method described in Clause 12 of IEC 60840.

The minimum length of free cable between accessories shall be five metres.

One sample of each accessory type shall be tested.

The accessories shall be assembled on the cable in the manner specified by the manufacturer's instructions, with the grade and quantity of materials supplied, including lubricants, if any.

The external surface of accessories shall be dry and clean, but neither the cables nor the accessories shall be subjected to any form of conditioning not specified in the manufacturer's instructions which might modify the electrical, thermal, or mechanical performance.

During tests a) to e) of **Table 8** it is necessary to test joints with their outer protection fitted. If it can be shown that the outer protection does not influence the performance of the joint insulation, for example there are no thermo-mechanical or compatibility effects, the protection need not be fitted.

Prior to the electrical type tests of the accessories, the insulation thickness of the cable used shall be measured and the test voltage values adjusted, if necessary, as stated below which is prepared as in Clause 12.4.1 of IEC 60840.

The insulation thickness of the cable shall be measured by the method specified in 8.1 of **IEC 60811.501** on a representative piece of the length to be used for the tests, to check that the average thickness is not excessive compared with the nominal value.

If the average thickness of the insulation does not exceed the nominal value by more than 5%, the test voltages shall be the values specified in **Table 5** for the rated voltage of the cable.

If the average thickness of the insulation exceeds the nominal value by more than 5 % but not more than 15%, the test voltage shall be adjusted to give an electrical stress at the conductor screen equal to that applying when the average thickness of the insulation is equal to the nominal value and the test voltages are the normal values specified for the rated voltage of the cable.

The cable length used for the electrical type tests shall not have an average insulation thickness exceeding the nominal value by more than 15%.

Table 8: The sequence and requirements for type tests on 66 kV and 132 kV accessories

Test reference	Test name	Test description/criteria
IEC 60840 Clause 15.4.2 test a)	Partial discharge	This test shall be performed in accordance with Clause 12.4.4 of IEC 60840 using the test methods given in IEC 60885-3. The test voltage shall be raised gradually to $1.75U_0$ for 10 sec. and then slowly reduced to $1.5U_0$ (refer to Table 11, Column 5). The assembly shall be heated by conductor current only, until the cable reaches the required temperature. There shall be no detectable discharge exceeding the declared sensitivity from the test object at $1.5U_0$.

Test reference	Test name	Test description/criteria
IEC 60840 Clause 15.4.2 test b)	Heating cycle voltage test	This test shall be performed in accordance with Clause 12.4.6 of IEC 60840. The cable shall have a U-bend with a diameter as specified in Clause 12.4.3 of IEC 60840. The assembly shall be heated by conductor current only, until the conductor reaches a steady temperature 5K to 10K above the maximum conductor temperature in normal operation. The cycle of heating and cooling shall be carried out 20 times. During whole of the test period a voltage of $2U_0$ (refer to Table 11, Column 6) shall be applied to the assembly and interruption is not allowed until 20 heat cycles under the voltage is completed. No break down shall occur.
IEC 60840 Clause 15.4.2 test c)	Partial discharge at: • ambient temperature; and, • maximum cable conductor temperature in normal operation plus 5 K to 10 K.	This test shall be performed in accordance with Clause 12.4.4 of IEC 60840. The test shall be carried out after the final cycle of Test b) or alternatively after the lightning impulse voltage test in Test d). The conductor temperature shall be maintained within the stated temperature limits for at least two (2) hours prior to commencing the test. The test voltage shall be raised gradually to $1.75U_0$ for 10 sec. and then slowly reduced to $1.5U_0$. (refer to Table 11, Column 5). The assembly shall be heated by conductor current only, until the cable reaches the required temperature. There shall be no detectable discharge exceeding the declared sensitivity from the test object at $1.5U_0$
IEC 60840 Clause 15.4.2 test d)	Lightning impulse voltage test followed by a power frequency voltage test	The assembly shall be heated by conductor current only, until the conductor reaches a steady temperature 5K to 10K above the maximum conductor temperature in normal operation. The conductor temperature shall be maintained within the above stated temperature limits for at least two hours. The lightning impulse voltage shall be applied according to the procedure given in IEC 60230. The assembly shall withstand 10 impulses of each polarity of the appropriate voltage given in Table 11, Column 7, without failure.

Test reference	Test name	Test description/criteria
IEC 60840 Clause 15.4.2 test e)	Partial discharge test, if not carried out in Test c) above, at: • maximum cable conductor temperature in normal operation plus 5 K to 10 K; and, • ambient temperature.	This test shall be performed in accordance with Clause 12.4.4 of IEC 60840. The test shall be carried out after the final cycle of Test b) or alternatively after the lightning impulse voltage test in Test d). The conductor temperature shall be maintained within the stated temperature limits for at least two (2) hours prior to commencing the test. The test voltage shall be raised gradually to $1.75U_0$ for 10 sec. and then slowly reduced to $1.5U_0$. (refer to Table 11, Column 5.) The assembly shall be heated by conductor current only, until the cable reaches the required temperature. There shall be no detectable discharge exceeding the declared sensitivity from the test object at $1.5U_0$.
IEC 60840 Clause 15.4.2 test f) (for outer protection of joints only)	Water immersion and heat cycling	The test shall be carried out as detailed in G.3 of Annexure G of IEC 60840. The test assembly shall be immersed in water to a depth of not less than 1 m at the highest point of the outer protection. A total of 20 heating/cooling cycles shall be applied by raising the water temperature to within 15K to 20K below the maximum temperature of the cable conductor in normal operation. In each cycle the water shall be raised to the specified temperature, maintained at that level for at least 5 hours and then be permitted to cool to within 10K above ambient temperature. The minimum duration of each cycle of heating and cooling shall be 12 hours and the duration for raising the water temperature to the specified temperature shall be as much as possible the same as the duration for cooling the water to within 30 °C or 10K above ambient temperature, whichever is the higher. On completion of the heat cycles and the test assembly still immersed, the voltage tests below shall be carried out as stated in G.4.2 or G.4.3 as applicable to the accessory.

Test reference	Test name	Test description/criteria
	* Voltage tests	For assemblies embodying accessories without sheath sectionalising insulation: • A test voltage of 25 kV d.c. shall be applied for one min between the metallic sheath of the power cable and the earthed exterior of the joint outer protection. For Assemblies embodying sheath sectionalising insulation: • a test voltage of 25 kV d.c. shall be applied for 1 min between the metallic sheath of the power cable, at either end of the accessory, and also between the metallic sheath and the earthed exterior of the joint outer protection • an impulse voltage test: to test each part to earth, a test voltage in accordance with Table 12 shall be applied between the metallic sheath and the exterior of the assembly whilst immersed. To test between metallic sheaths, the assembly shall be removed from the water before the impulse test. The impulse testing procedure shall be performed in accordance with IEC 60230, the joint being at ambient temperature. No breakdown shall occur during any of the above voltage tests.
	Examination of the joint assembly	On completion of the voltage tests described above, the test assembly shall be examined. Joint outer protection boxes filled with removable compounds shall be regarded as satisfactory if there is no visible evidence of either internal voids or internal displacement of compound by water ingress, or of compound loss by way of the various seals or box walls. For joint outer protections employing alternative designs and materials, there shall be no evidence of water ingress or internal corrosion.
IEC 60840 Clause 15.4.2 test g)	Examination of the tested accessory	If possible, the whole accessory shall be examined after undergoing tests a) to f) by dismantling the accessory, using normal or corrected vision without magnification. The observations shall reveal no signs of deterioration for example electrical degradation, leakage, corrosion or harmful shrinkage) which could affect the system in service operation. The examination shall be carried out as stated in Clause 12.4.8 of IEC 60840.

4.5.4 Routine tests on the main insulation of fabricated accessories

The main insulation of each fabricated accessory shall undergo partial discharge test and routine voltage test as given in **Table 9** (prepared based on Clause 9.2 and Clause 9.3 of IEC 60840) according to either 1), 2) or 3) below:

- 1) on accessories installed on the cable
- 2) by using a host accessory into which a component of an accessory is substituted for test, or
- 3) by using a simulated accessory rig in which the electrical stress environment of a main insulation component is reproduced.

NOTE: The main insulation of prefabricated accessories consists of the components that come in direct contact with the cable insulation and are necessary to control electrical stress distribution in the accessory. Examples are pre moulded or precast elastomer or filled epoxy resin insulating components that may be used singly or jointly to provide the necessary insulation or screening of accessories.

Table 9: Routine test on the main insulation of fabricated accessories

Test reference	Test name	Test description/criteria
IEC 60840 Clause 9.2	Partial discharge test	The partial discharge test shall be carried out in accordance with IEC 60885-3 for accessory installed on cables, the sensitivity shall be 5pC or better. The test voltage shall be raised gradually to and held at $1.75 U_0$ for 10 s and then slowly reduced to $1.5 U_0$ (see Table 11 , column 5). There shall be no detectable discharge exceeding the declared sensitivity from the test object at $1.5 U_0$.
IEC 60840 Clause 9.3	Voltage test	The voltage test shall be made at ambient temperature using an alternating test voltage at power frequency. The test voltage shall be raised gradually to $2.5 U_0$ (see Table 11 , column 4) and then be held for 30 min between the conductor and metal screen/sheath. No breakdown of the insulation shall occur.

4.5.5 Sample tests on 66kV and 132kV cable accessories

For accessories where the main insulation cannot be routine tested, the supplier / manufacturer shall provide details of a proposed Sample Testing program (acceptable to Endeavour Energy) that illustrates compliance with the intent of clause 11.2 of IEC 60840.

If the sample fails either of the two tests specified in Clause 4.5.5.2, two further samples of the same accessory type shall be taken from the batch and subjected to the same tests. If both additional samples pass the tests, the other accessories of the same type from the batch shall be regarded as having complied with the requirements of this standard.

If either fails, this type of accessory of the contract shall be regarded as having failed to comply.

4.5.5.1 Sample test on components

As components differ from one supplier to another, it is not possible to define common sample tests on components in this specification. Therefore, the characteristics of each component shall be verified in accordance with the specifications of the accessories manufacturer, either through test reports from the supplier of a given component or through internal tests.

The manufacturer of a given accessory shall provide a list of the tests to be performed on each component, indicating the frequency of each test.

The components shall be inspected against their drawings. There shall be no deviation outside the declared tolerances.

4.5.5.2 Sample test on complete accessories

The following electrical tests shall be carried out by the manufacturer on a fully assembled accessory where the main insulation cannot be routine tested.

The main insulation of each prefabricated accessory shall undergo partial discharge and voltage test as stated in [Table 10](#) below which is prepared based on Clause 9.2 and Clause 9.3 in IEC 60840 respectively.

Table 10: Sample tests on complete accessory

Test reference	Test name	Test description/criteria
IEC 60840 Clause 11.2 test a)	Partial discharge test	The partial discharge test shall be carried out in accordance with IEC 60885-3 for accessory installed on cables, the sensitivity shall be 5pC or better. The test voltage shall be raised gradually to and held at $1.75 U_0$ for 10 s and then slowly reduced to $1.5 U_0$ (see Table 11, column 5). There shall be no detectable discharge exceeding the declared sensitivity from the test object at $1.5 U_0$.
IEC 60840 Clause 11.2 test b)	Voltage test	The voltage test shall be made at ambient temperature using an alternating test voltage at power frequency. The test voltage shall be raised gradually to $2.5 U_0$ (see Table 11, column 4) and then be held for 30 mins between the conductor and metal screen/sheath. No breakdown of the insulation shall occur.

Table 11: Test voltages

1	2	3	4	5	6	7
Rated voltage	Highest voltage for equipment	Value of U_0 For determination of test voltages	Voltage test of Cl. 5.4.3 Cl. 5.4.4.2	Partial discharge test of Cl. 5.4.3 Cl. 5.4.4.2	Heating cycle voltage test of Cl. 5.4.3	Lightning impulse voltage of Cl. 5.4.3
U	U_m	U_0	$2.5 U_0$	$1.5U_0$	$2U_0$	kV
kV	kV	kV	kV	kV	kV	
66	72.5	36	90	54	72	325
132	145	76	190	114	152	650

Table 12: Impulse voltage test for outer protection of joints

Rated lightning impulse voltage for main insulation ^a kV	Impulse level			
	Between parts		Each part to earth	
	Bonding leads ≤ 3 m kV	Bonding leads >3 m and ≤ 10 m ^b kV	Bonding leads ≤ 3 m kV	Bonding leads >3 m and ≤ 10 m ^b kV
325	60	60	30	30
650	60	75	30	37.5

^a See Table 11, Column 7.

^b If sheath voltage limiters are placed adjacent to the joint, the voltages for bonding leads ≤ 3 m are used.

4.5.6 Type tests on connectors/links and lugs for all cable accessories

The connectors/links and lugs shall be type tested to satisfy the Class A requirements specified in AS/NZS 4325.1. The following type tests in Table 13, which is prepared based on the information provided in AS/NZS 4325.1, shall be carried out on connectors/links and lugs.

All tests shall be carried out to the relevant method described in AS/NZS 4325.1.

Table 13: Type tests on connectors/links and lugs

Test reference	Test name	Test description/criteria
AS/NZS 4325.1 Clause 6	Electrical tests	Each parameter shall have maximum values given in Table 2 of AS/NZS 4325.1 pertaining to mechanical connectors.
AS/NZS 4325.1 Clause 7	Mechanical tests	No slip shall occur during the one-minute tensile test under the given condition and the force applied as in Table 3 of AS/NZS 4325.1.

4.6 Range of approval

4.6.1 33 kV accessories

4.6.1.1 Range of approval for accessories for cables with polymeric insulation

The following conditions which have been prepared in accordance with the requirement specified in Clause 3 of AS/NZS 4805.1 shall apply:

- Approval of a range of conductor cross sectional areas from 95 mm² to 300 mm² of one type of accessory shall be obtained by successfully completing the full range of type tests specified in this standard, by installing the accessory deemed to test on a cable having nominal conductor cross section area 120 mm², 150 mm² or 185 mm².

Extension of approval to a range wider than that given above shall be achieved by carrying out the additional tests listed in Table 14, which is prepared based on Table 10 in AS/NZS 4085.1, on the smallest and /or largest conductor cross-sectional area of the required range.

- The additional tests as specified in Table 15, which is prepared based on Table 11 of AS/NZS 4805.1, shall be carried out to achieve extension of approval of the accessory for different types of cable insulation screen or different cable conductor shapes from the construction of the cable that used in testing of the accessory.
- Approval of an accessory tested for a specified U_0 shall extend to operation of the joint or the termination at a lower U_0 .
- The dimensions of separators nominated for testing of the terminations qualify the minimum clearance for application of the termination within the terminal box or adjacent to earthed surfaces and structures (including components of switchgear or transformers).

4.6.1.2 Range extension

Extension of approval wider than the range that given in Item (a) of Clause 4.6.1.1 shall be achieved by carrying out the additional tests in the sequence, as indicated in Table 14 which is prepared based on Table 10 in AS/NZS 4085.1, on the smallest and/or largest conductor cross-sectional area of the required range.

Table 14: Additional tests for smallest and largest conductor cross-sectional areas

Test reference	Test name	Test description/criteria
AS/NZS 4805.1 Table 10 Test 1	Voltage withstand	Shall withstand $4.5U_0$ a.c. for 5 min. or $4U_0$ d.c. for 15 min. The test arrangement shall be: for terminations – as set out in sequence 1.1 and testing half the number of samples given in Figure 1 of AS/NZS4805.1 for joints – as set out in sequence 2.1 and testing half the number of samples given in Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 10 Test 2	Partial discharge	This test is not required for joints installed on cables having unscreened insulation. $10pC$ maximum at $1.73U_0$. The test arrangement shall be: for terminations – as set out in sequence 1.1 and testing half the number of samples given in Figure 1 of AS/NZS4805.1. for joints – as set out in sequence 2.1 and testing half the number of samples given in Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 10 Test 3	Impulse test at maximum cable conductor temperature in normal operation +5 K to +10 K	Shall withstand 10 impulses of each polarity. The peak voltage of impulses shall be 200 kV. The test arrangement shall be: for terminations – as set out in sequence 1.1 and testing half the number of samples given in Figure 1 of AS/NZS4805.1. for joints – as set out in sequence 2.1 and testing half the number of samples given in Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 10 Test 4	Examination	Accessory is examined for signs of: cracking in the filling media and/or tape or tube component; and/or a moisture path across a primary seal; and/or corrosion and/or tracking and/or erosion which could, in time, lead to failure of the accessory; and/or leakage of any insulating material. The test arrangement shall be: for terminations – as set out in sequence 1.1 and testing half the number of samples given in Figure 1 of AS/NZS4805.1 for joints – as set out in sequence 2.1 and testing half the number of samples given in Figure 2 of AS/NZS 4805.1.

4.6.1.3 Different insulation screen type extension

In order to achieve extension of approval for a cable having a type of screen different to that of the cable used in the tests, additional tests shall be performed using cable having the same construction of the conductor/screen. Table 15 is prepared based on Table 11 of AS/NZS 4805.1.

Unless otherwise specified in the test description/criteria column of the table, all tests shall be carried out at ambient temperature. All tests shall be carried out to the relevant method described in IEC 61442.

Table 15: Additional tests for different types of cable insulation screen and approval from round to shaped conductors

Test reference	Test name	Test description/criteria
AS/NZS 4805.1 Table 11 Test 1	Voltage withstand	Shall withstand $4.5U_0$ a.c. for 5 min. or $4U_0$ d.c. for 15 min. The test arrangement shall be: for terminations – as set out in sequence 1.1 and testing half the number of samples given in Figure 1 of AS/NZS4805.1 for joints – as set out in sequence 2.1 and testing half the number of samples given in Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 11 Test 2	Partial discharge	This test is not required for joints installed on cables having unscreened insulation. $10pC$ maximum at $1.73U_0$. The test arrangement shall be: for terminations – as set out in sequence 1.1 and testing half the number of samples given in Figure 1 of AS/NZS4805.1 for joints – as set out in sequence 2.1 and testing half the number of samples given in Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 11 Test 3	Heating cycle in air	Shall withstand when subjected to sixty heating cycles at $2.5U_0$. The heating cycle in air shall be of at least eight hours duration with at least two hours at a steady state temperature of maximum cable conductor temperature in normal operation $+5 K$ to $+10K$ followed by at least 3 hours of natural cooling to within $10 K$ of ambient temperature (refer to Clause 9 of IEC 61442). The test arrangement shall be: for terminations – as set out in sequence 1.1 and testing half the number of samples given in Figure 1 of AS/NZS4805.1: 2007; and, for joints – as set out in sequence 2.1 and testing half the number of samples given in Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 11 Test 4	Partial discharge	This test is not required for joints installed on cables having unscreened insulation. $10pC$ maximum at $1.73U_0$. The test arrangement shall be: for terminations – as set out in sequence 1.1 and testing half the number of samples given in Figure 1 of AS/NZS4805.1 for joints – as set out in sequence 2.1 and testing half the number of samples given in Figure 2 of AS/NZS 4805.1.

Test reference	Test name	Test description/criteria
AS/NZS 4805.1 Table 11 Test 5	Impulse	Shall withstand 10 impulses of each polarity. The peak voltage of impulses shall be 200 kV. The test arrangement shall be: for terminations – as set out in sequence 1.1 and testing half the number of samples given in Figure 1 of AS/NZS4805.1 for joints – as set out in sequence 2.1 and testing half the number of samples given in Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 11 Test 6	AC voltage withstand	Shall withstand $2.5U_0$ a.c. for 15 min. The test arrangement shall be: for terminations – as set out in sequence 1.1 and testing half the number of samples given in Figure 1 of AS/NZS4805.1 for joints – as set out in sequence 2.1 and testing half the number of samples given in Figure 2 of AS/NZS 4805.1.
AS/NZS 4805.1 Table 11 Test 7	Examination	Accessory is examined for signs of: cracking in the filling media and/or tape or tube component; and/or a moisture path across a primary seal; and/or corrosion and/or tracking and/or erosion which could, in time, lead to failure of the accessory; and/or leakage of any insulating material. The test arrangement shall be: for terminations – as set out in sequence 1.1 and testing half the number of samples given in Figure 1 of AS/NZS4805.1 for joints – as set out in sequence 2.1 and testing half the number of samples given in Figure 2 of AS/NZS 4805.1.

4.6.2 Range of approval for 66kV and 132kV accessories

4.6.2.1 Range of type approval on the cable used in type testing the accessory

When type tests have been successfully performed on one or more cables of specific cross section(s), and of the same rated voltage and construction, the type approval shall be considered as valid for cables within the scope of IEC 60840 with other cross-sections, rated voltages and constructions provided that all the conditions of a) to e) below, which are prepared based on Clause 14.2 of IEC 60840, are satisfied:

- The voltage group is not higher than that of the tested cable(s) (See *Note 1* below).
- The conductor cross-section is not larger than that of the tested cable.
- The cable has the same or similar construction to that of the tested cable(s) (See *Note 2* below).
- The calculated nominal electrical stress at the cable conductor screen does not exceed the nominal electrical stress at the conductor screen of the tested cable(s) by more than 10 %.
- The calculated nominal electrical stress at the cable insulation screen does not exceed the nominal electrical stress at the insulation screen of the tested cable(s).

NOTE 1: In this context, accessories of the same rated voltage group are those of rated voltages having a common value of U_m , highest voltage for equipment, and the same test voltage levels (see Table 4, columns 1 and 2 of IEC 60840).

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NOTE 2: Cables of similar construction are those of the same type and manufacturing process of insulation and semi-conducting screens. Repetition of the electrical type tests is not necessary on account of the differences in the conductor type or material or of the protective layers applied over the screened cores, unless these are likely to have a significant effect on the results of the test. In some instances, it may be appropriate to repeat one or more of the type tests (for example, bending test, heating cycle test and/or compatibility test).

The non-electrical type tests on cable components (as stated in Clause 12.5 of IEC 60840) only need to be carried out on samples from cables of different voltage ratings and/or conductor cross-sectional areas if different materials and/or different manufacturing processes have been used to produce them. However, repetition of the ageing tests on pieces of completed cable to check compatibility of materials may be required if the combination of materials applied over the screened core is different from that of the cable on which type tests have been carried out previously.

4.6.2.2 Range of approvals on accessories for cables with polymeric insulation

When type tests have been successfully performed on one or more accessories with one or more cable(s) of specific cross-section(s), and of the same rated voltage and construction, the type approval shall be considered as valid for accessories within the scope of this standard with other rated voltages, constructions and with other cables, provided that all the conditions of a) to d) below, which are prepared based on Clause 15.2 of IEC 60840, are met.

- a) The voltage group is not higher than that of the tested accessory/ies (See *Note 1* below).
- b) The cable with another conductor cross-section, rated voltage and construction is within the range of type approval as stated in Clause 4.6.2.1. When the calculated nominal electrical stress at the cable insulation screen does not exceed 2,5 kV/mm, the type approval shall be considered as valid for accessories on all cables in this range.
- c) Accessories have the same or a similar construction as that of the tested accessory/ies (See *Note 2* below).
- d) The calculated nominal electrical stresses within the main insulation parts of the accessory and at the cable and accessory interfaces do not exceed those of the tested accessory/ies.

NOTE 1: In this context, accessories of the same rated voltage group are those of rated voltages having a common value of U_m , highest voltage for equipment, and the same test voltage levels (see Table 4, columns 1 and 2 of IEC 60840).

NOTE 2: Accessories of similar construction are those of the same type and manufacturing process of insulation and semi-conducting screens. Repetition of the electrical type tests is not necessary on account of the differences in the connector type or material or of the protective layers applied over the main insulation part of the accessory, unless these are likely to have a significant effect on the results of the test. In some instances, it may be appropriate to repeat one or more of the type tests (for example, partial discharge test).

4.6.3 Range of approval for connectors/links and lugs for all cable accessories

The tests made on one type of connector (including a lug) / conductor combination applies to that arrangement only. However, as given in Clause 5.3 of AS/NZS 4325.1, to limit the number of tests the following shall apply:

- a) A connector which covers a range of cross-sections shall be accepted, if satisfactory results are obtained on the smallest and largest sections (see *Note* below).
- b) A connector which can be used on round conductors or sector shaped conductors that are to be rounded, is accepted for both types if satisfactory results are obtained on any one type of conductor
- c) If a connector is a through connector for two conductors of different sectional areas, shapes or materials and if the technique and the connector barrels used have already been tested separately for each cross-section, no additional test is necessary. If not then additional tests shall be made using the smaller of the two conductors for the control.

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NOTE: In case of connectors of which one or both sides are designed for a range of cross-sections, and a common clamping arrangement serves for the connection of the different cross sections, then a mechanical test on all area combinations is carried out according to Clause 7 of AS/NZS 4325.1

4.7 Specialised tooling

Information on product specific specialised tooling required for installation of **accessory** offered shall be provided. This shall include but not limited to:

- description, drawing or picture;
- manufacturer / supplier and relevant part numbers
- appropriate quantity required to assemble a product; and,
- life expectancy of the item.

4.8 Product training and technical support

The supplier / manufacturer shall detail the training requirements of each **accessory** offered.

Adequate training (including documentations) for installation of the products shall be offered as and when required by Endeavour Energy. The training will be carried out in Endeavour Energy training school at Hoxton Park, NSW or at an Endeavour Energy transmission depot.

The supplier shall also make training available to accredited service providers (ASPs) if the supplier chooses to supply the products to ASPs after obtaining a product approval from Endeavour Energy.

The supplier shall nominate a technical representative readily available for product failure investigations that are generally carried out at Endeavour Energy's training centre located at Hoxton Park.

The supplier's technical representative shall also assist Endeavour Energy employees in resolving any other product related issues that arise within the life span of the product.

4.9 Occupational health and safety

Material safety data sheet (MSDS), where applicable, shall be supplied for each of the components that make up each kit. MSDS shall also be supplied for associated chemicals proposed to use in the installation processes. Safety precautions such as use of personal protective clothing and equipment relevant to the end user of offered products shall also be included in the installation instruction prominently.

Preference shall be given to products that are less hazardous and require less personal protective equipment.

4.10 Shelf life and requirement of special storage

Accessories shall not contain any component having shelf life less than 12 months.

If the product or any of the integral components of the product has a limited shelf life, the expiry or the use-by date for the kit shall be specified. Such information shall be provided on the labelling outside of the package. Where special storage requirements such as temperature-controlled environment are necessary, such information shall be clearly stated on outside of the packaging.

4.11 Product samples

The suppliers who have passed the technical assessment shall be prepared to submit at least one sample kit from each type of joint / termination offered, within reasonable time of notice with no cost to Endeavour Energy. The samples shall be used in the evaluation process and will not be returned.

4.12 Disposal

If not recyclable, all products offered shall be suitable for disposal in regular land fill. If special disposal requirements exist for any product offered, details of such requirements shall be provided with the submission by the supplier.

5 Authorities and Responsibilities

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

- approving technical specifications, including any variations
- making all decisions concerning compliance with this Specification
- 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:

- reviewing technical specifications and making recommendations to the **Chief Safety Asset & Operating Officer**
- making recommendations concerning compliance with this Specification; and

Engineering Delivery Manager has the authority and responsibility for:

- assessing the manufacturing facilities and their capability to perform the specified tests
- reviewing all test reports submitted and making recommendations to the **Head of Asset Planning & Performance**
- product approval and allocation.

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

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

Manufacturers/suppliers are responsible for:

- being aware of their responsibilities under this document
- providing suitable training for contractor/s under their control
- implementing an effective quality auditing system
- implementing this instruction
- keeping Endeavour Energy or other responsible equivalent officers informed of any factors that may prevent them from accepting responsibility for its full implementation.

6 Appendix A: List of required cable accessories

Table A.1. Straight Through Joints

[illegible]

Table A.2. Outdoor, Indoor and Plugin Terminations

Cable Details (Voltage, CSA)		Outdoor Termination	Indoor Terminations	Plugin Terminations
33 kV	300	✓	✓	✓
	630	✓	✓	✓
	800	✓	✓	✓
	1200	✓	✓	✓
66 kV	630	✓	-	✓
132 kV	300	✓	-	✓
	400	✓	-	✓
	630	✓	-	✓
	800	✓	-	✓
	1200	✓	-	✓
	1600	✓	-	✓
	2000	✓	-	✓
	2500	✓	-	✓

