Specification – LV Cable Accessories

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** This person will have the power to grant the process owner the authority and responsibility to manage the process from end to end.*

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1	20/03/2023	Updated standards and remove link box
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STAKEHOLDERS *The following positions shall be consulted if an update or review is required:*	
Manager Engineering & Project Services	Asset Managers
Manager Systems & Network Planning	Manager Assets Services
Senior Manager Safety, Health and Wellbeing	

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1 SCOPE

This specification applies to low voltage distribution power cable accessories for use in Horizon Power's 415 V underground systems.

It specifies the service condition, cable types, installation method and other special requirements applicable to particular items.

Requirement for information to be supplied, samples, packaging and labelling requirement are also include within this specification.

2 NORMATIVE REFERENCES

2.1 Standards

2.1.1 Horizon Power Standards

[1]. *Horizon Power's Environmental Conditions,* standard number HPC-9EJ-01-0001-2013, available at http://horizonpower.com.au/contractors-suppliers/contractors/manuals-and-standards/ under the 'Standards' heading.

2.1.2 Australian Standards

The following standards are available at http://www.saiglobal.com.

[2]. *ADG 7, Australian Dangerous Goods Code 7th Edition*, Australian Standard,

[3]. *AS/NZS 1026, Electric cables - Impregnated paper insulated – For working voltages up to and including 19/33 (36) kV,* Australian Standard, 2004 (R2017)

[4]. *AS/NZS 3560.1, Electric cables - Cross-linked polyethylene insulated - Aerial bundled - For working voltages up to and including 0.6/1 (1.2) kV - Aluminium conductors,* Australian Standard, 2000

[5]. *AS/NZS 3808, Insulating and sheathing materials for electric cables,* Australian Standard, 2000 (R2017)

[6]. *AS 3996, Access covers and grates,* Australian Standard, 2006

[7]. *AS 4325.1, Compression and mechanical connector for power cables with copper or aluminium conductors*, Australian Standard, 1995

[8]. *AS 4961, Electric cables – Polymetric insulated – For distribution and service applications,* Australian Standard, 2003

[9]. *AS 60529, Degrees of protection provided by enclosures (IP Code)*, Australian Standard, 2004

[10]. *AS 60947.1, Low-voltage switchgear and controlgear - General rules)*, Australian Standard, 2021

[11]. *Labelling of workplace hazardous chemicals code of practice,* available at www.safeworkaustralia.gov.au

2.1.3 International Standards

The following standards are available at http://www.saiglobal.com.

[12]. *ANSI C119.1, Compression and mechanical connectors for power cables with copper or aluminium conductors, Part 1: Test methods and requirements, American National Standards Institute*, 2011

[13]. *ASTM D2240-15, Standard Test Method for Rubber Property - Durometer Hardness*, American Society for Testing and Materials

[14]. *ASTM D2671-13, Standard Test Method for Heat-Shrinkable Tubbing for Electrical use*, American Society for Testing and Materials

[15]. *BSI 3988, Wrought Aluminium for Electrical Purposes - Solid Conductors for Insulated Cables,* British Standards Institution, 1970

[16]. *BSI 6910.2, Cold pour resin compound and heat-shrink cable joints in the voltage range up to 1000 V a.c. and 1500 V d.c. Code of practice for on-site installation*, British Standards Institution, 1989

[17]. *EN 50393, Test methods and requirements for accessories for use on distribution cables of rated voltage 0,6/1,0 (1,2) kV*, European Standard, 2015

[18]. *EN 50655.1, Electrical cables - Accessories - Material characterisation - Part 1: Fingerprinting for resinous compounds*, European Standard, 2017

[19]. *EN 50655.2, Electrical cables - Accessories - Material characterisation - Part 2: Fingerprinting for heat shrinkable components for low and medium voltage applications up to 20.8/36 (42) kV*, European Standard, 2017

[20]. *EN 50655.3, Electrical cables - Accessories - Material characterisation - Part 3: Fingerprinting for cold shrinkable components for low and medium voltage applications up to 20.8/36 (42) kV)*, European Standard, 2017

[21]. *EN ISO 868, Plastics and Ebonite – Determination of Indentation Hardness by Means of a Durometer (shore Hardness),* European Standard, 2003

[22]. *IEC 60812, Failure modes and effects analysis (FMEA and FMECA)*, International Electrotechnical Commission, 2018

[23]. *IEC 61238.1*, *Compression and mechanical connectors for power cables for rated voltages up to 30 kV (Um = 36 kV) - Part 1: Test methods and requirements,* International Electrotechnical Commission, 2003

[24]. *VDE 0220.3, Specification for single and multiple cable clamps with insulating parts in electrical power cable installations up to 1000 V*, German Safety Standard,

[25]. *VDE 0271/3.69*, German Safety Standard,

2.1.4 Compliance with Standards

Various Standards are referenced in this Specification. The Standards have reference to the year they were published. If over the life of the Tender the Standards change, the Vendor is required to conform to the new edition of the Standard.

Unless otherwise specified herein, the *Equipment* shall be designed, manufactured and type and routine tested in accordance with the referenced Australian Standards, including all amendments. Where there is no Australian Standard equivalent, International Standards or Codes as defined in this specification shall be used. The specified documents contain provisions that, through reference in the text, constitute requirements of this Specification. At the

time of publication of this Specification, the editions indicated were valid. Information on currently valid national and international standards may be obtained from the Australian Standards website. http://saiglobal.com.

2.2 Definitions and Abbreviations

For the purposes of this specification, definitions shall apply as in the relevant Australian Standards with the addition of a few general definitions listed below in alphabetical order.

CSA: Cross Sectional Area

Distribution Mains: Cable used to reticulate electricity to many residential consumers.

***Equipment*:** Low Voltage (LV) distribution power cable accessories

HDPE: High Density Poly-Ethylene

HNS: Helical Neutral Screen

OD: Overall Diameter

PILC: Paper Insulated, Lead covered

PVC: Poly-Vinyl Chloride

XLPE: Cross-Linked Poly-Ethylene

3 DESCRIPTION

This document details the design, manufacturing, testing, supply and delivery of Low Voltage (LV) distribution power cable accessories (*Equipment*).

The *Equipment* must be suitable for voltages up to 1 kV and consist of:

- Jointing kits (Section 7), including:
  - Connectors (compression & mechanical) and lugs.
  - Insulation components (break out glove, zipper sleeve and insulation tubing).
  - Joints using resin compounds and jointing shell (straight, breech, transition and tee off).
  - Joints using heat shrinkable components (transition and straight).
- Terminations kits (Section 8) for pole top, pillar, transformer and pits.
- End-caps (Section 9) – push on end caps, heat shrinkable end caps and live end seals.
- Refer to Appendix B for full item list.

4 PERFORMANCE CRITERIA

4.1 Power System Properties

4.1.1 Voltage Range

The minimum voltage parameter for a nominal system voltage of 0.6/1 kV is specified as follows:

1) U_0 – 0.6 kV_{RMS}
2) U – 1.0 kV_{RMS}
3) U_m – 1.2 kV_{RMS}

Where;

- U_0 is the rated power frequency voltage between phase conductor and earth or metallic screen for which the cable accessory is designed.
- U is the rated power frequency voltage between phase conductors for which the cable accessory is designed.
- U_m is the maximum value of the highest system voltage between phase conductors for which the cable accessory may be used.
- These values must be used for the purpose of determining test voltages in accordance with EN 50393 [17].

All *Equipment*, once fully installed, must withstand faults on the LV earthing system. Faults will raise the voltage between the cable main conductor and neutral screen wire from the nominal phase to earth voltage to as high as the nominal phase to phase system voltage for indefinite time.

4.1.2 Nominal System Frequency

The nominal system frequency is 50 Hz.

4.1.3 Insulation Levels

The *Equipment* insulation levels must meet the values in Table 1: Insulation levels. Test reports for the *Equipment* must be provided.

Table 1: Insulation levels

Nominal System Voltage ø-ø (kV RMS)	1
System Highest Voltage (kV RMS)	1.2
Lightning Impulse Withstand Voltage (kV peak)	8 (for conductor CSA <= 50 mm²) 20 (for conductor CSA > 50 mm²)
Power Frequency Withstand Voltage for 1 minute (kV RMS)	4

4.1.4 Fault Levels

Maximum design fault currents are as follows:

- 46.4 kA_{RMS} for 415 V system

The fault clearance time for the above fault current is 1 second. Vendors must declare (in their submission) *Equipment* that has been tested lower than the design fault levels above.

4.2 Service Conditions

4.2.1 Environmental Conditions

The performance of the *Equipment* must meet the requirements set out in Section 4.1 of the *Horizon Power Environmental Conditions [1]*.

4.2.2 Operating Conditions

The *Equipment* must be suitable for continuous operation under the conditions outlined in Table 2.

Table 2: Operating conditions

Condition	Requirement
Cable rated temperature	90°C conductor maximum continuous operation
Depth of laying	750 mm (measured from ground surface to the top of a cable/trefoil)

4.3 *Equipment* Life

The *Equipment* must have a design life expectancy of 40 years. This is defined as 90% of an installed population reaching this age without unassisted failure. Vendors must specify how long the *Equipment* warranty is from the date of installation.

All accessory components in a kit including cold and heat shrinkable products, gel, lubricants and mastic must have a minimum remaining shelf life of 2 years from the date of delivery.

5 COMMON REQUIREMENTS OF EQUIPMENT

5.1 Jointing and Terminations Kits

The minimum requirements applicable to all cable accessories kits, unless specified for a particular kit type, are:

1) Cable accessories kits must be supplied with all components necessary to construct the specific equipment which includes connectors, insulation components, stress control mastics, void fillers, lubricant and cable preparation materials.
2) Any parts not offered that need to be supplied by Horizon Power must be stated in the proposal. Preference may be given to kits that minimise the skill and time necessary to construct the specified equipment.

3) All cables accessories kits must:
   a) be suitable for indoor and outdoor applications,
   b) be offered with insulation diameter range having 0.5 mm less than the minimum and 0.5 mm more than the maximum of each cable insulation range specified in Appendix C,
   c) have an Instruction Sheet (IS) including recyclability and disposability of materials supplied,
   d) include a Bills of Materials (BOM) containing the description, quantity and part reference number of each component in the kit,
   e) include a Material Safety Data Sheet (MSDS) or Safety Data Sheet (SDS) for all components which contain hazardous materials in the kit,
   f) include the table of cable size(s) and voltage rating for which the kit is suitable,
   g) include specific tools required to carry out the installation and/or maintenance,
   h) have packaging, marking, labelling and tagging information as specified in Section 16.
4) The LV cable accessories items must be supplied as a single or one phase kit, unless otherwise specified in the item description as “set of 3” or “3/set”.
5) All cable accessories kits must be designed and tested for continuous operation in either a single-phase system or a three-phase system without the need to modify components in the kit.
6) Cable accessories kits with supported historical installation information and evidence of its characteristics are preferred.

5.2 Cable/Screen Wire Connector and Lugs

Cable/screen wire connector and lugs have the following requirements:

1) Mechanical connectors/lugs for cable core conductors and screen wire connections would form part of all cable accessory kits, as specified in this document,
2) All connectors/lugs, where possible, must be of the “shear off” type. The bolts shall shear off level with the connector/lug barrel with no exposed burrs or edges for the complete conductor application range. If burrs or edges exist, instructions must indicate removal and smoothing of burrs and edges with the necessary tools being supplied in the kit.
3) If connectors are not shear-off type, then the torque requirement must be specified in the instructions with the minimum required torque setting.
4) All connectors/lugs must be tinned and ensure material compatibility for the termination and connection between aluminium and copper conductors without deterioration in performance. This compatibility will also apply to the material used for the shear bolt and connector/lug body.
5) The cable accessories must be tested to the requirements of EN 50393 [17] or equivalent standards with the inclusion of the respective shear-bolt type connector or compression connector (crimp).

6) Connectors or ferrules that require soldering will not be considered.

7) Split bolt connectors are not preferred.

8) Conductor connectors applicable to LV Distribution Cables (Appendix C) must be suitable for 120° sector cable installation in any orientation (upright triangle with bottom base or inverted triangle or circular).

9) All cable core conductor connectors offered must contain a central barrier to stop any water migration between conductors and any galvanic reaction where aluminium and copper conductors are joined.

10) All cable core conductor lugs offered for cable outdoor and indoor termination kits (as specified in Section 8) must be the offset type, and fully encapsulate and seal the conductor from the external environment, preventing any moisture and water ingress.

11) Screen wire connectors having a “window” or centralising hole are preferred.

12) All connectors and lugs must be permanently and legibly marked (on the connector or lug) with the manufacturer, production batch number (capable of identifying factory of manufacturer), conductor type and cross-section range, or a manufacture part number and/or barcode that will enable this information to be obtained from the manufacturer's catalogue.

5.3 Compression Connector

All compression (crimp) connectors must be supplied as per items 1, 2 and 3 in Appendix B and must:

1) be fully compliant with Class A connector requirements of AS 4325.1 [7] or IEC 61238.1 [23] or equivalent standards as specified in Section 2.1,

2) suitable for all LV cables specified in Appendix C,

3) be prefilled with jointing compound,

4) compatible with copper or aluminium,

5) suitable for 120° sectoral solid conductors,

6) have barrel markings indicating crimping sequence, and

7) be made of aluminium alloy.

6 INSULATION COMPONENTS

6.1 Requirements

The minimum requirements applicable to insulation components are summarised below.

1) The heat shrinkable components main body must be printed with Manufacturer’s Name/Logo, Batch Number or Production Date, Component Part Number, Pre-expanded/recovered internal diameter (mm) and minimum temperature required for shrinkage on the visible outer surface (after completion).

2) Heat shrinkable insulating components must provide an adequate insulation, screen and stress control to maintain the terminated cable integrity as per the requirements of this specification.

3) All insulation components must have shelf life test for 24 months at ambient air temperature (as stated in Section 4.2).
4) Heat shrinkable insulating components must be:
    a) made from cross linked polyolefin material unless otherwise specified,
    b) certified as per applicable standards referenced in Section 2.1 and be suitable for both indoor and outdoor applications,
    c) suitable for reheating during installation (Vendors must specify the reheating quantities and temperature),
    d) compatible with copper, aluminium, XLPE, HDPE and PVC materials,
    e) resistant to abrasion (for both internal and external surfaces), corrosion, solvent, liquids, water absorption, fungi and capable of self-extinguish,
    f) impervious and pass tests to prevent the ingress of moisture and water,
    g) the material must not be adversely affected by solar radiation, UV, ozone, petrol, oil, and other airborne pollutants, and
    h) flexible to form around a cable crutch or bends while maintaining adequate grip and wall thickness and be free of voids when in the fully recovered position (wall thickness measurement is at fully recovered diameter).
5) All insulating components must be supplied in a spool with unbroken rolls. The Vendors must specify the spool length.
6) Vendors must also specify the recommended application using pre-expanded/recovered diameters as reference. (e.g.: 20% below/above the pre-expanded/recovered diameter).

6.2 Breakout Glove or Finger Glove

Breakout gloves or finger gloves must:

1) meet the requirements as specified in Section 6.1,
2) be supplied as per items 4, 5, 6 in Appendix B,
3) have 2, 3 or 4 entries in various cable accessories kits, and
4) be internally coated with heat melt adhesive that will form a moisture proof seal onto the cable upon heating.

6.3 Insulation Tube (sleeving)

Insulation tubes or sleeving must:

1) meet the requirements as specified in Section 6.1.
2) be supplied per items 7 to 15 in Appendix B, and
3) be internally coated with heat melt adhesive that will form a moisture proof seal onto the cable upon heating.

6.4 Zipper Sleeves

All zipper sleeves must:

1) meet the requirements as specified in Section 6.1.
2) be supplied as per item 16 in Appendix B.

3) be internally coated with heat melt adhesive that will form a moisture-seal onto the protected section upon heating.
4) be compatible with HDPE, PVC, XLPE, rubber, copper, lead and aluminium materials.
5) have a sleeve seam that is designed to hold the metal zipper during and after installation of the sleeve.
6) be suitable for overall outer diameter of 25 mm – 75 mm.
7) have minimum dielectric strength of 10 kV/mm.

7 JOINTING KITS

7.1 General Requirements

The requirements applicable to jointing kits are summarised below.

1) All jointing kits must meet the requirements as specified in Section 5.1.
2) All jointing kits must be resin filled or utilize heat shrinkable products as specified in the item description.
3) All jointing kits must be:
    a) supplied with all necessary tapes, mastic, fillers, grease, insulation pad, tinned copper mesh (minimum 50 mm wide), cable cleaning wipes (isopropyl alcohol min 70% cc) or other specific cable cleaning agent (to be specified by Vendor), disposable gloves and documentation packaged individually inside the kit to facilitate the CSA range of applicable cables,
    b) supplied with corresponding mechanical shear bolt connector to suit the cable core and screen wire or neutral braid CSA in accordance with Section 5.2,
    c) supplied with suitable heat shrinkable components as specified in the item description and as specified in Section 6,
    d) suitable for joining on energised/live circuit, and
    e) impervious and tested to prevent the ingress of moisture and water. The material shall not be adversely affected by acid sulphate soils and other underground pollutants.
4) Completed joint with the smallest profile occupying minimum amount of space during installation will be preferred.
5) Joint kits that can be used as a straight joint with tee-off for XLPE and PILC (transition) cables (referred to as “combo” kit) without modification of parts may be offered as “alternative offer” and not as “main offer”. These combo kits shall be labelled “combo kit” and in accordance with Section 16 clearly describe all of its functions in compliance with the requirements of Section 7.2.3 and 7.2.4. This alternative offer should not replace or influence the main offer that is required for these items.

7.2 Joints using Resin Compound and Joint Shell

7.2.1 Resin Compound

Resin compounds have the following requirements:

1) The resin compound must be:
   a) safe for use, contain no potential health hazards to personnel (Non-Methylene Diphenyl Diisocyanate),
   b) suitable for continuous cable operating temperature of 90°C,
   c) suitable for all cables specified in Appendix C,
   d) suitable for energised circuit installation including filling of the joint shell and curing,
   e) extinguishable by water spray, fog, mist, foam or powder when burning,
   f) guaranteed as a moisture seal for both joint and cable commensurate with the relevant standards, and
   g) packaged as per Section 16.1.1.
2) The resin compound when set must also provide adequate insulation, screen and stress control to maintain the jointed cable integrity as per requirements of this specification unless stated otherwise.
3) The resin compound must provide adequate mechanical protection and electrical insulation once cured for the assembled joint.
4) The proposed resin must be added to the fully assembled jointing kit as a completed joint and must be type-tested according to EN 50393 [17].
5) The resin which can be used in all resin type joints will be preferred.
6) The resin compound must have a minimum shelf life of 2 years remaining upon delivered to Horizon Power store.

7.2.2 Jointing Shell

Jointing shells have the following requirements:

1) Jointing shell must:
   a) have suitable cable entries to cover a respective range of cable sizes and number of cables as specified in the individual item description,
   b) be suitable for cable cores crossing on one end of the shell (i.e. one end of the shell is longer than the other end),
   c) be suitable for service cable connections on both ends of the shell (i.e. allow up to 2 service cable entrances) where designed to connect service cables,
   d) include adequate support foam or putty to seal the cable entries,
   e) include necessary clips and tools to assemble the shell and maintain its form without any leakage during the resin filling process until the resin has set,
   f) have a sufficiently sized filling hole to pour resin and allow air to escape, and
   g) have a recessed lid to cover the filling hole.
2) Translucent or clear shell is preferred to allow visibility of the level of resin. Horizontal split shell is preferred for ease of installation.

3) Jointing shell must be designed such that no parts of the joint will be touching the shell body before filling with resin. Resin must not leak during and after the filling process.

4) If a hard-set resin is offered, then a soft or hard shell may be acceptable. The minimum hardness of the resin must be Shore D range 30 to 60 (Hard) in accordance with EN ISO 868 [21] or ASTM D2240 [13] or equivalent standards.

5) If a soft set resin is offered, then only a hard shell will be accepted. The minimum hardness of the shell must be Shore D range 30 to 60 (Hard) in accordance with EN ISO 868 [21] or ASTM D2240 [13] or equivalent standards.

7.2.3 Straight-through Joint for LV XLPE cable

Straight through joints for LV XLPE cable have the following requirements:

1) All straight-through joint kits must:
   a) meet the requirements as specified in Section 7.1,
   b) be supplied as per items 17 and 18 in Appendix B,
   c) be suitable for all LV distribution cables specified in Appendix C,
   d) have a suitable resin compound meeting the requirements as specified in Section 7.2.1 (quantity to be adequate to fully fill the supplied joint shell),
   e) have a suitable jointing shell meeting the requirements as specified in Section 7.2.2,
   f) have two screen wire connectors as specified in Section 5.2 suitably rated for each half of the largest cable screen wire CSA, and
   g) be suitable for joining cables on an energised/live circuit.
2) Kits with components which help the live jointing process will be preferred.
3) Single joint kits are preferred which cover the range of CSA of cable as per items 17 and 18 in Appendix B. For example, kits like item 17 will be preferred as it can be used to join cables having a CSA range of 185-240 mm² waveform cable.

7.2.4 Breech Joint for LV and Service Cables

Breech joints for LV and Service cables have the following requirements:

1) All breech joint kits must:
   a) meet the requirements as specified in Section 7.1,
   b) be supplied as per items 19, 20 and 21 in Appendix B,
   c) be suitable for all LV distribution XLPE and LV service PILC and cables specified in Appendix C,
   d) have a suitable w-shape connector where 2 conductors of the same phase from the joining cables are connected electrically but not physically touching,
   e) have a suitable resin compound meeting the requirements as specified in Section 7.2.1 (quantity to be adequate to fully fill the supplied joint shell),

f) have suitable jointing shell meeting the requirements as specified in Section 7.2.2,

g) two screen wire connectors as specified in Section 5.2 suitably rated for each half of the largest cable screen wire CSA (except for item 21), and

h) have a tinned copper neutral braid of minimum 120 mm² CSA suitable for lead plumbing (applicable to item 20 only).

2) Single joint kits are preferred which cover the range of CSA of cable as per items 19, 20 and 21 in Appendix B. For example, item 19 a single kit complete with components to breech cables having CSA of 120 mm² or 185 mm² is preferred.

7.2.5 Transition Joint for LV XLPE to LV Consac or LV 3½C cables

Transition joint kits for LV XLPE, Consac and LV paper insulated cables have the following requirements:

1) All transition joints must:

a) meet the requirements as specified in Section 7.1,

b) be supplied as per items 22 and 23 in Appendix B,

c) be suitable for all LV distribution and LV paper insulated cables specified in Appendix C,

d) have a suitable earth connector as specified in Section 5.2,

e) ensure material compatibility for the connection of:

- waveform cable copper screen wires and Consac cable aluminium sheath.
- waveform cable copper screen wires and solid or stranded cable copper neutral conductor.

f) have a suitable resin compound meeting the requirements as specified in Section 7.2.1 (quantity to be adequate to fully fill the supplied joint shell), and

g) have a suitable jointing shell meeting the requirements as specified in Section 7.2.2.

7.2.6 Tee-off Joint for LV Service with LV XLPE or LV Paper Insulated Cables

Tee-off joint kits for LV Service with LV XLPE or LV paper insulated cables have the following requirements:

1) All tee-off joint kits must:

a) meet the requirements as specified in Section 7.1,

b) be supplied as per items 24 to 28 in Appendix B,

c) be suitable to connect all LV service cables with LV distribution cables or LV paper insulated cables specified in Appendix C,

d) be suitable to connect up to 2 service cables per phase off the main cable,

e) have suitable cable core and two screen wire connectors as specified in Section 5.2 suitably rated for each half of the largest cable screen wire CSA.

f) include a suitable resin compound meeting the requirements as specified in Section 7.2.1 (quantity to be adequate to fully fill the supplied joint shell), and

g) include a suitable jointing shell meeting the requirements as specified in Section 7.2.2.

7.3 Joints using Heat Shrinkable Components

7.3.1 Transition Joint for LV XLPE and LV Paper Insulated Cables

Transition joint kits for LV XLPE and LV paper insulated cables have the following requirements:

1) All Transition joint kits must:

a) meet the requirements as specified in Section 7.1,

b) be supplied as per item 29 in Appendix B,

c) be suitable for all LV XLPE and LV paper insulated cables specified in Appendix C,

d) include suitable heat shrinkable break out gloves (trifurcation) and insulation sleeving that guarantees a moisture seal as specified in Section 6.1,

e) have suitable heat shrinkable transparent tubes with oil-blocking capability,

f) have a tinned copper neutral braid of minimum 120 mm² CSA suitable for lead plumbing,

g) have a suitable outer heat shrinkable jacket (zipper sleeve) to provide mechanical protection for the joint and cables commensurate with the relevant standards and as specified in Section 6.1, and

h) include a suitable mechanical earthing kit with earth braids to connect XLPE cable screen wire with PILC cable aluminium sheath.

7.3.2 Straight Joint for LV XLPE Service Cables

Straight through joints for LV XLPE cable have the following requirements:

1) All straight-through joint kits must:

a) meet the requirements as specified in Section 7.1,

b) be supplied as per items 30 and 31 in Appendix B,

c) be suitable for all LV Service Cables specified in Appendix C,

d) have a suitable heat shrinkable insulation sleeving that guarantees a moisture seal and as specified in Section 6.1, and

e) have a suitable outer heat shrinkable jacket to provide mechanical protection for the joint and cables commensurate with relevant Standards and as specified in Section 6.1.

8 TERMINATION KITS

8.1 General Requirements

All termination kits must:

1) meet the requirements as specified in Section 5.1,
2) be supplied with suitable heat shrinkable components as specified in the item description and as specified in Section 6.1,
3) be suitable for terminating on energised/live circuits, and
4) be supplied with sealing material to make it impervious and pass tests to prevent the ingress of moisture and water. The material must not be adversely affected by solar radiation, UV, ozone, petrol, oil, and other airborne pollutants. Such material shall be applied at the lug and at the cable entry (cable sheath).

8.2 Pole Termination Kits for LV ABC Cables

Pole termination kits for LV ABC cables have the following requirements:

1) All pole termination kits for LV ABC cables must:
   a) meet the requirements as specified in Section 8.1,
   b) be supplied as per items 32, 33 and 34 in Appendix B,
   c) be suitable for all LV distribution and LV ABC cables specified in Appendix C,
   d) have aluminium and bi-metal compression connectors for LV ABC and LV Distribution Mains core conductors and screen wires respectively as specified in Section 5.2,
   e) have suitable heat shrinkable break out gloves (trifurcation) and insulation sleeving that guarantees a moisture seal and provide mechanical protection for both the joint and cable as specified in Section 6.1, and
   f) have UV, weather proof, adhesive backed reflective strips for phase colour identification in colour red, white and blue irrespective if single phase or three phase kit. The length of each reflective strip must be no less than 60 mm, which will be applied to the HDPE or PVC outer sheath of the cable (permitting overlap).

8.3 Pillar and Transformer Kits

Pillar and transformer termination kits have the following requirements:

1) All pillar and transformer termination kits must:
   a) meet the requirements as specified in Section 8.1,
   b) be supplied as per items 35 and 36 in Appendix B,
   c) be suitable for all LV XLPE and LV paper insulated cables specified Appendix C,
   d) have suitable core conductor connectors as specified in Section 5.2 suitably rated to the application as specified Appendix C,
   e) have a 1 to 4 fingers heat shrinkable breakout glove,

f) be supplied with a corresponding M12 hole size mechanical shear bolt lug with offset palm to suit the cable conductor and screen wire cross section areas (CSA) in accordance with Section 5.2,

g) have suitable insulating tubes for core conductor connectors, and

h) have suitable insulating tubes for cable screen wires and neutral connectors.

8.4 Pit Termination Kits

Pit termination kits have the following requirements:

1) All pit terminations must:

a) meet the requirements as specified in Section 8.1,

b) be supplied as per item 37 and 38 in Appendix B,

c) be suitable for LV service cables with aluminium or copper conductor as specified in Appendix C,

d) comply with ANSI C119.1 [12] or equivalent standards,

e) be supplied with corresponding M12 hole size mechanical shear bolt lugs to suit the cable conductor and screen wire cross section areas (CSA) in accordance with Section 5.2,

f) be impervious and tested to prevent the ingress of moisture and water when operating in a fully flooded pit,

g) not be adversely affected by petrol, oil, acid sulphate soils and other underground pollutants, and

h) have ingress protection of IP67 rating as per AS 60529 [9].

8.4.1 Submersible Pit Connector

Pit termination kits have the following requirements:

1) All insulated busbar connector pit termination kits must and must:

a) meet the requirements specified in Section 8.4,

b) be supplied as per item 37 in Appendix B,

c) have a push on method for cable installation at the cable entry port,

d) be suitable for sealing and insulating installed cables at continuous operating condition of 90°C,

e) have an embossed cable striping dimension guide on the housing body,

f) include a suitable mechanical connector for copper and aluminium cables and comply with AS 4325.1 [7] or IEC 61238.1 [23],

g) be corrosion resistant,

h) be a one-piece housing without lose parts including hinged caps for core conductor connector,

i) include four cable entry ports (4-port) filled with suitable gel that has electrical insulation properties that prevents water and moisture ingress and encapsulates the installed cable,

j) be suitable to fit 4 pit connectors (for 3 phases and neutral) into Horizon Power pit with dimensions as specified in Appendix C, and

k) be supplied with corresponding shear bolts to suit the cable conductor and screen wire CSA in accordance with Section 5.2. Vendor must specify the torque settings required for the shear bolt.

8.4.2 Unmetered Supply Pit Termination Kit with Single Phase Service Cable

Unmetered Supply pit termination kits have the following requirements:

1) All unmetered supplied pit termination kits must:
   a) meet the requirements specified in Section 8.4,
   b) be supplied as per item 38 in Appendix B,
   c) have a suitable 1 to 2 fingers heat shrinkable breakout glove,
   d) include suitable colour insulating tubes for active and neutral phase cables. Red tube is for active phase and black tube is for neutral phase,
   e) have suitable fuse holder housing which must:
      i) be suitable for a fuse barrel size (body size is 10 mm x 38 mm) and fuse pit size of 500 mm x 270 mm x 600 mm (L x W x H).
      ii) have a compatible fuse clips.
      iii) be printed or moulded with markings on the housing for live end and load end identification and cable range.
      iv) include the necessary assembly tools and grease to enable the assembly of the fuse and cables to the housing.
   f) have a splice enclosure for the neutral connector which must be:
      i) filled with suitable gel to prevent water and moisture ingress for application in conditions as specified in Section 4.2.
      ii) suitable for neutral CSA as specified in Appendix C.
      iii) installed with snap lock capability.
      iv) inclusive of cable ties to maintain secure locking.
   g) have a neutral connector encapsulated in an insulated housing.

9 END-CAP

9.1 General Requirements

All end-caps must be:

1) compatible with HDPE, PVC, XLPE, rubber, copper, lead and aluminium materials,
2) suitable for all LV cables specified in Appendix C,
3) suitable for both indoor and outdoor applications,
4) compliant with fingerprinting EN 50655.2 [19] or equivalent standards as specified in Section 2.1,
5) provided with adequate mechanical protection and bonding to the protected section,
6) resistant to abrasion, corrosion, solvent, liquids, water absorption, fungi, oil, chemical and capable of self-extinguish,
7) tested for the following properties: elastic, tensile, modulus, pressure, bend, impact, ultimate elongation, thermal ageing/cycling, and split resistance, and
8) impervious and pass tests to prevent the ingress of moisture and water. The material must not be adversely affected by solar radiation, UV, ozone, petrol, oil, and other airborne pollutants.

For heat shrinkable end-caps, vendors must also specify the recommended application using pre-expanded/recovered diameters as reference. (e.g.: 20% below/above the pre-expanded/recovered diameter).

9.2 Push on End-cap

Push on end-caps have the following requirements:

1) All push on end-caps must:
   a) meet the requirements as specified in Section 9.1,
   b) be supplied as per items 39 to 42 in Appendix B,
   c) be reusable. Vendor must specify the number of times reusable or the cap conditions that are deemed to be non-usable, and
   d) be made from silicone rubber material with high elasticity and toughness against cracking.
2) Preference will be given for heat shrinkable end-caps.

9.3 Heat Shrinkable End-caps

Heat shrinkable end-caps have the following requirements:

1) All end-caps must:
   a) meet the requirements as specified in Section 9.1,
   b) be supplied as per items 43 to 46 in Appendix B,
   c) made from cross-linked polyolefin material,

d) internally coated with heat melt adhesive that will form a moisture-proof onto the protected section upon heating,

e) suitable for all Horizon Power low voltage cable sheath material including plastic, rubber, HDPE, PVC and bitumen hessian wrap, and

The vendor may offer cold applied or a cold shrinkable end-cap as an alternative offer to a heat shrinkable end-cap.

9.4 Live End Seals

Live end seals have the following requirements:

1) All live end seals must:

   a) be meet the requirements as specified in Section 9.1,

   b) be supplied as per items 47 and 48 in Appendix B,

   c) cover individual phases in a rated sealed cap and must have a further rated sealed cap over the three cores and the wave concentric screen, and

   d) have suitable energised marking on the outer cap or on a preferably yellow bag over the outer cap.

10 STORAGE

The *Equipment* shall be capable of being stored without deterioration within the temperature range of -10 °C to +45 °C for no less than 24 months.

11 RELIABILITY

Vendors shall provide information on the reliability of the *Equipment* and the performance of the materials offered over an operational life of 40 years under the specified field of application and conditions of service.

Information provided shall evidence the claimed reliability and performance for the *Equipment* offered, including details on Failure Mode and Effect Analysis, carried out in accordance with IEC 60812 [22]. Failure modes should be described; taking cantilever mechanical failure as an example, the failure may be excessive deflection, or brittle fracture. Electrical failure may be material damage such as puncture, polymer degradation, carbonisation, loss of hydrophobicity, etc.

Vendors may offer their standard *Equipment* but any variation to the foregoing standards must be clearly stated in writing at the time of the proposal. The products offered in the standing offer should be equal to or better in quality and performance than the existing items as listed under this Specification.

12 SAFETY

Material Safety Data Sheets (MSDS) applicable for each different *Equipment* or chemical ingredient in the *Equipment* which is considered harmful to personnel or environment in any manner, shall be supplied with the Proposal.

13 ENVIRONMENTAL CONSIDERATIONS

Vendors are required to provide information on the environmental soundness of the design and the materials used in the manufacture of the items offered. In

addition, provide a detailed outline of the steps that have been put in place to fulfil any obligations that may be required pursuant to the *Waste Avoidance and Resource Recovery Act 2001* and any amendments. In particular:

a) Management of waste reduction;

b) The use of re-usable packing; and

c) Extended producer responsibility for the safe disposal of materials at the end of their life.

14 TESTING

14.1 Requirements

The Vendor must, prior to first delivery, complete the type, routine, sample and special tests and inspections as required by the relevant Australian Standards.

The passing of such tests must not prejudice the right of Horizon Power to reject the cable accessories if it does not comply with the specification when installed.

14.2 Type tests

Evidence must be submitted by the Vendor indicating that all type tests required by the standards listed in Section 2 have been adequately carried out.

Where equipment has been tested to International Standards only, sufficient type test evidence must be submitted to confirm equivalence of the equipment performance to the relevant Australian Standard.

The type test report must be specifically for the ranges and intended application as specified in the item description. Unless specified by the Australian Standard, the acceptable range for testing must be the range specified in the item description.

Test assemblies information must be included in all cable accessories type test reports and shall be identified as stated in clause 6.4.2 of EN 50393 [17] comprising of:

1) Cable identification in accordance with clause 7.2 of EN 50393 [17].

2) Connectors identification in accordance with the specification with which they comply (refer to clauses 5.1 and 5.2 of AS 4325.1 [7] or IEC 61238.1 [23]).

3) Cable accessories identification with respect to:

   a) Manufacture’s name,

   b) Type, designation, manufacturing date or code,

   c) Minimum and maximum cross-sections, material and shape of cable conductor,

   d) Minimum and maximum cable insulation diameters,

   e) Connector type(s),

   f) Rated voltage,

   g) Installation instructions with reference and date,

   h) Bill of materials (BOM).

Any type tests that have not been completed must be done so prior to delivery of any equipment. Horizon Power will not accept any equipment that does not have a supporting type test relevant to the equipment supplied.

The following tests described in Sections 16.2.1 to 16.2.8 must be carried out.

14.2.1 Cable Kits

All cable accessories kits must be tested for the range of approval compliance with clause 6 of EN 50393 [17] or equivalent standards as specified in Section 2.1.

14.2.2 Cable Conductor and Screen Wire Connectors and Lugs

1) In addition to the cable accessories type test EN 50393 [17], the following connectors must meet the test requirements of AS 4325.1 [7] or IEC 61238.1 [23] as class A connectors:
   a) Mechanical shear-bolt connectors/lugs/ferrule,
   b) Compression connector (including bi-metallic),
   c) Insulation piercing connector,
   d) Branch connector (with or without service tee-off).
2) Multi-core connector (i.e.: ring connector) must meet the test requirements of VDE 0220.3 [24] (Teil 3/10.77) in addition to the cable accessories type test EN 50393 [17].
3) Screen wire connectors/lugs must be tested with a short circuit current having a Joule integral (I^2t) that is equivalent to the 1 second fault level as specified in Table 3. If a lower short circuit current is used for the test, its equivalent 1-second rating must be declared. The test short circuit duration when using a lower short circuit current must not be greater than 5 seconds.
4) If a pair of screen wire connectors is supplied to connect two half bunches of the copper screen wires of a single core cable, the test short circuit current must be equivalent to the Joule integral (I^2t) of the 1-second fault level specified in Table 3.

14.2.3 Insulation Components

1) All insulation components must be made from cross linked polyolefin material unless specified and be compliant with fingerprinting and type tests in accordance with EN 50655.2 [19] or equivalent standards as specified Section 2.1.
2) All insulation components must meet the following test requirements in addition to the fingerprinting and type tests:
   a) Long term ageing test for 3000 hours at 135°C. The test requirement is 125% minimum for elongation at break.
   b) Compliant with EN 50393 [17] or equivalent standards as specified Section 2.1 according to the intended application of the component. For example: if a break out glove is included in a joint kit then it will be tested against the requirements in the joint section of EN 50393 [17] standard.

3) Heat shrinkable insulation to be compliant with fingerprinting and type tests in accordance with ASTM D2671 [14].

14.2.4 Wrap Around Repair Sleeve

1) Wrap and repair sleeves must have compliance with fingerprinting and type tests in accordance with EN 50655.2 [19] and must be meeting ANSI C119.1 [12] requirements.

2) All zipper sleeves must be compliant with the requirements of VDE 0271/3.69 [25] or relevant standards as specified in the Section 2.1.

14.2.5 Resin Compound

1) Resin compound must be fingerprinting tested and reported in compliance with EN 50655.1 [18] or equivalent standards and classified as:

   a) low voltage compound for mechanical protection, curing at high and low temperature (LMP-HT-LT) for hard set resin.

   b) low voltage compound for insulation, curing in presence of water, curing at high and low temperature (LI-W-HT-LT) for soft set resin.

2) A resin compound that is tested in one type of joint may need to be retested if it is proposed to be used in another type of joint. For example, a type of resin compound is tested for 240 mm² waveform cable straight joint kit and is also proposed to be used in 120 mm² waveform cable straight joint kit. The assembled 120 mm² cable straight joint kit with resin may need to be type-tested.

3) Resin compound setting (hard/soft) to be compliant with hardness tests in accordance with ASTM D2240 [13].

14.2.6 Push-on End-caps

All push on end caps must be compliant with EN 50655.3 [20] or equivalent standards.

14.2.7 Heat Shrinkable End-caps

All heat shrinkable end caps must be compliant with EN 50393 [17] as type II (with Impulse test) stop end or equivalent standards as specified in Section 2.1.

14.3 Routine and Sample Tests

Routine and sample tests according to the applicable standards listed in Section 2.1 must be carried out on each item of equipment or component thereof that is supplied to Horizon Power.

Prior to first delivery of equipment, the Vendor must submit to Horizon Power for approval, all routine and sample tests performed on that batch of equipment to be supplied. Only once routine and sample tests are approved by Horizon Power, the first delivery can be despatched.

14.4 Test Documents

Type test certificates, Type test reports or any other supporting documents supplied as evidence for compliance to relevant standards must be made available

in English for review by Horizon Power and an original/copy must be retained by the Vendor for recall by Horizon Power at any time.

Non-English documents will be interpreted as non-conforming unless translated and stamped by the Vendors.

14.5 Cable Testing Conditions

All cable accessories (once fully installed), must withstand Horizon Power testing procedures of LV cables without deterioration in performance. The testing procedures are covered in this section.

14.5.1 Cable Insulation Resistance Test

Cable insulation resistance test is to ensure the cable is safe to be energised. Cable insulation is tested using 1 kV DC steady state for 1 to 5 minutes duration between phase-to-phase and phase-to-neutral.

The insulation resistance test result of the cable accessory on the tested cable should not be less than 50 MΩ.

14.5.2 Cable Outer Sheath Integrity Test

Cable outer sheath integrity test is to ensure no damage to the cable sheath prior to energising of the cable. Cable sheath integrity is tested at 1 kV for 1 minute duration.

14.5.3 Cable End-to-end and Phasing Test

Cable end-to-end and phasing test is to identify the cable end and phases by using a resistor box in conjunction with a 500 V insulation resistance tester.

During fault finding, the cable must be subjected to 5 kV pulsing every 2 seconds on an average of 20-50 pulses. The pulse is 62 mF and has 1.5 kJ of energy.

15 DOCUMENTATION AND SAMPLES

15.1 Documentation to be provided with Proposals

Submitted proposals shall provide all documentation and information as requested in this specification, including any further relevant information on the *Equipment* offered. The proposal must be complete in all respects. Failure to comply may cause the proposal to be considered incomplete and hence informal.

The Vendor shall provide an electronic version of all documents in Adobe Acrobat (.pdf) format containing the information detailed below with their offer:

- Any non-compliance of the Specification shall be detailed in the Technical Deviation schedule;
- All information provided in Technical Requirements shall be in English and measurement units shall be in metric units;
- Material Safety Data Sheets;
- CAD drawings (Micro station preferred DGN format) of all *Equipment* showing all critical dimensions;
- *Equipment* data sheets showing the weight, material type, protective coatings, mechanical & electrical properties (Combined Load Charts shall be included);
- Installation instructions included in the packaging; and

- A copy of the Vendor's current Quality Assurance accreditation and category.

Should the preferred Vendor submit drawings for approval by Horizon Power, this will in no way exonerate it from being responsible for the correct and proper function of the *Equipment*.

15.2 Service history

Vendors shall state:

- Other Australian electricity supply authorities who have a service history of the items offered; and
- Contact details of those supply authorities who can verify the service performance claimed.

15.3 Training Materials

Training material in the form of drawings, instructions and/or audio-visuals must be provided for the items accepted under the offer.

Vendors shall state the availability of training materials which could include but is not limited to the following topics:

- Handling and storage;
- Application (particularly in areas of heavy coastal pollution);
- Installation;
- Maintenance;
- Environmental performance;
- Electrical performance;
- Mechanical performance;
- Disposal at the end of service life; and
- Production process and testing.

15.4 Samples

Samples of all proposed *Equipment* types are to be provided upon request of Horizon Power as part of the submitted proposals.

16 PACKAGING, MARKING, LABELLING AND TAGGING

16.1 Packaging Requirements

The following are the packaging requirements for all items:

1) Packaging must be adequate to ensure that any stated shelf life is maintained when the accessory is stored under covered, dry conditions within the stated ambient air temperatures, such that the performance of the components forming part of the total accessory is unaffected.
2) Packing and components inside must be dry and clean upon to delivery to Horizon Power.
3) The kit must be packaged in a cardboard carton box.
4) Individual components must be packaged individually to avoid contamination, deterioration and damage from other components and atmospheric conditions.
5) Hazardous components must be packaged and labelled as defined in the Labelling Code of Practice [11]

6) Suppliers must label and provide a requirement for the transport of hazardous substances according to the ADG 7 Code [2].

7) The box material must be durable to withstand the stacking weight of similar packaged equipment up to 1050 mm.

8) The combined height of the pallet and equipment standard pack must not exceed 1050 mm.

9) Any combined weight of a single package greater than 15 kg must have warning marking/labels.

16.1.1 Resin Packaging Requirements

The following are the packaging requirements for all resin items:

1) The resin compound package must have printed or labelled information of the supplier's name or logo, supplier part number, batch number or date of manufacture, storage conditions (if any), "use by" date, mixing and application instructions, disposal information, resinous compound categories, hazardous classification and logo and SDS/MSDS including precautionary information.

2) The resin compound must be packaged as a two-part system in a sealed foil bag with adequate toughness to prevent leakage, damage or change in chemical reaction under Environmental conditions as specified in Section 4.2.1.

3) The foil bag must have a membrane that can be broken within the bag to allow the 2 parts of the resin compound to be completely mixed entirely within the bag.

4) The resin compound must be packaged such that when following the mixing instructions before applying to the joint, it will not come in contact with personnel by any means such as breathing or physical contact.

5) The resin compound must be packaged and labelled as defined in the Labelling Code of Practice [11]. The packaging label must also provide requirement for the transport of the compound in accordance with the ADG 7 Code [2].

6) If the resin compound is a 3-part system which requires a filler (i.e. sand), then an appropriately sized plastic mixing bucket and appropriately sized stirrer or system must be provided with the resin compound. The stirrer must be of such design that personnel would not be exposed to direct inhalation of gasses released during the mixing process. In addition, adequate personal protective equipment (PPE) must be supplied in the kit, including face mask with a valve and hard rubber gloves that would be disposed of later with the rest of the packaging. The PPE must be adequate to protect staff as defined in the resin MSDS.

7) The filler must be moisture free and packaged to prevent moisture ingress. The filler must be graded to suit the type of resin compound used during the type-test.

16.2 Marking and Labelling

16.2.1 External

Individual accessory kits must contain the following information on the outside of the packaging:

1) A durable UV and moisture resistant label with the following information and sequence:
   a) Horizon Power stock code
   b) Supplier's name or logo
   c) Supplier part or reference number
   d) Product description
   e) Manufacture date and batch number
   f) Serial number
   g) Use-by date
   h) Reference to the standard(s) to which it is compliant
   i) Number of main components per package (e.g. QTY 1/pk, QTY 3/pk or Set of 3)
   j) Colour sticker indicating supplied date as in Appendix D
   k) Storage conditions (temperature range, humidity, indoor/outdoor, flat or stack (max height))
   l) Health and safety marking and handling instructions where relevant;
   m) a peel-able reusable barcode label sticker containing a) to h) information supplied separately in the kit for use by Horizon Power.

16.2.2 Internal

Individual accessory kits must contain the following information inside of the packaging:

1) Bill of materials (BOM)
2) Instruction Sheet (IS), including drawings or other information specific to the accessory
3) Each of the individual packaged components must be labelled with the part number as listed in the BOM, QR barcode (preferred) or marked with a serial/batch number that is linked to the kit serial number

If conductor connectors are included, they must be permanently and legibly marked with the conductor type and cross-section, or a reference number that will enable this information to be obtained from the manufacturer's literature.

16.3 Tagging of Equipment

1) The Vendor must supply to Horizon Power a method for indelibly tagging all joints, terminations, stop end and separable connector kits with a 6-digit number.
2) The tagging system, as well as the numbered marking, must last the life of the installed equipment.
3) There must be one blank stainless steel tag (without any marking) to be supplied per kit with dimension as specified in Figure 1.
4) Two robust cable ties (minimum 200 mm long) must be supplied by the Vendor to attach the tag to the cable through the tag holes. This method must not have any sharp edge or other means that can damage the cable.

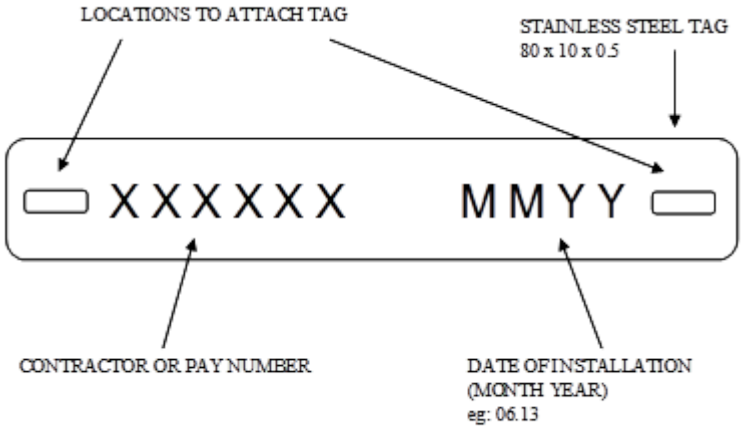

Figure 1: Installer Identification Tag

APPENDIX A REVISION INFORMATION

(Informative) Horizon Power has endeavoured to provide standards of the highest quality and would appreciate notification of errors or queries.

Each Standard makes use of its own comment sheet which is maintained throughout the life of the standard, which lists all comments made by stakeholders regarding the standard.

A comment sheet found in **DM# 4776273** can be used to record any errors or queries found in or pertaining to this standard. This comment sheet will be referred to each time the standard is updated.

Date	Rev No.	Notes
13/12/2016	0	Initial Document Creation – Based on an existing specification
20/03/2023	1	Updated standards and remove link box

APPENDIX B ITEM LIST

Item No.	Item Type	Item Description	Applicable Cables
1	Joint Box	Joint box complete with compression connector, dice; aluminium, w/crimp sequence markings & jointing compound	120 mm² 3C as per Clause C.2
2	Joint Box	Joint box complete with compression connector, dice; aluminium, w/crimp sequence markings & jointing compound	185 mm² 3C as per Clause C.2
3	Joint Box	Joint box complete with compression connector, dice; aluminium, w/crimp sequence markings & jointing compound	240 mm² 3C as per Clause C.2
4	Termination Kit	Termination kit breakout glove; heatshrink; Sealant lined for cable termination at uni pillar c/w connectors ; Black	120 mm² to 240 mm² 3C as per Clause C.2
5	Termination Kit	Termination kit breakout glove; heatshrink; Sealant lined for cable termination at mini pillar c/w connectors; Black	25 mm² 3C as per Clause C.3
6	Termination Kit	2 finger breakout glove; heatshrink; Sealant lined for cable termination at streetlights c/w connectors; Black	16 mm² 1C as per Clause C.3
7	Insulation Tube	Heatshrink; 3:1 Shrink Ratio, Black; Expanded ID 35/2.5 mm Thick Wall Recovered, 30 m Roll, Polyolefin;	For Rural Transformers, OD 12-35 mm
8	Insulation Tube	Heatshrink; 3:1 Shrink Ratio, Black, Expanded ID 25/1 mm Thick Wall Recovered, 76 m Roll, Polyolefin;	For LV Transition Joint & Terminations of Clause C.2 cables, OD 12.7-22.4 mm
9	Insulation Tube	Heatshrink; 3:1 Shrink Ratio, Black, Expanded Id 25/1 mm Thick Wall Recovered, 90 m Roll, Polyolefin	For 25 mm² 3C Cable as per Clause C.3, OD 6.4-12.5 mm
10	Insulation Tube	Heatshrink; 3:1 Shrink Ratio, Black, Expanded ID 51/1.3 mm Thick Wall Recovered, 1.2 m Long, Sealant Lined, Polyolefin	For 120-240 mm² Clause C.2 cables, OD 16-51 mm
11	Insulation Tube	Heatshrink; 2:1 shrink ratio, Red, 75 mm ID Expanded; 30 m Roll, Polyolefin	For Transformer LV Frame, OD 38-75 mm
12	Insulation Tube	Heatshrink; 2:1 shrink ratio, White, 75 mm ID Expanded; 30 m Roll; Polyolefin	For Transformer LV Frame, OD 38-75 mm
13	Insulation Tube	Heatshrink; 2:1 shrink ratio, Blue, 75 mm ID Expanded; 30 m Roll; Polyolefin	For Transformer LV Frame, OD 38-75 mm
14	Insulation Tube	Heatshrink; 3:1 shrink ratio, Black, Expanded ID 10/1 mm Thick Wall Recovered, 1.2 m Long; Sealant Lined, Polyolefin	OD 3-10 mm

Item No.	Item Type	Item Description	Applicable Cables
15	Insulation Tube	Heatshrink; 3:1 shrink ratio, Black, Expanded Id 15/0.7 mm Thick Wall Recovered, 250 m Roll; Polyolefin	For pole to pillar, 6 mm² Cable, OD 4.8-9.5 mm
16	Zipper Sleeve	Heatshrink; Overlapping Lip, Adhesive Inner Coating; Metal Zip	35-240 mm² 1C XLPE Cable Repair or Equivalent OD 25-75 mm
17	Straight Joint Kit	Straight thru Joint Kit; resin compound fill; shear-bolt connected, plastic	For XLPE Cables 185-240 mm² 3C cables as per Clause C.2
18	Straight Joint Kit	Straight Thru Joint Kit; Resin Compound Fill; Shear-Bolt Connected, Plastic Mould Box, Insulation Pad	For XLPE Cables 120 mm² 3C cables as per Clause C.2
19	Breach Joint Kit	Straight Thru Joint Kit; Resin Compound Fill; Shear-Bolt Conn, Plastic Mould Box, Insulation Pad	For LV Distribution Cables 120/120 & 120/185 & 185/185 mm² 3C cables as per Clause C.2
20	Breach Joint Kit	Breech Joint; Resin Compound Fill; Shear-Bolt Connected, Plastic Mould Box	For LV Distribution Cables 240/240 mm² 3C as per Clause C.2; OR 120-240 mm² 1x 3C Cable as per Clause C.5.1 and 240 mm² cable as per Clause C.2
21	Breach Joint Kit	Breech Joint; Resin Compound Fill; Shear-Bolt Connected, Plastic Mould Box	For LV Service Cables 10/16 mm² 1C as per Clause C.3;
22	Transition Joint Kit	Transition Joint; Resin Compound Fill; Kit Form, mechanical connected, Plastic Mould Box	For LV 120-300 mm² Al Sheath 3C Cable as per Clause C.5.2; and 120-240 mm² XLPE Insulated 3C Cable as per Clause C.2
23	Transition Joint Kit	Transition Joint; Resin Compound Fill; Kit Form, mechanical connected, Plastic Mould Box	For LV 185-240 mm² 3C cable as per Clause C.2 and 120 mm² 3½C Cu Stranded Cable as per Clause C.5.1;
24	Tee-off Joint	Tee off Joint Box, Resin Compound Fill; W/Ring Connector, Mould Box, Constant F/Spring, Earth Braid	For XLPE Cables 120-185 mm² as per Clause C.2 Main and, 2x 25 mm² 3C XLPE Branch Cable as per Clause C.3
25	Tee-off Joint	Tee off Joint Box, Resin Compound Fill; W/Ring Connector, Mould Box, Constant F/Spring, Earth Braid	For XLPE Cables 240 mm² as per Clause C.2 Main and 2x 25 mm² 3C XLPE Branch Cable as per Clause C.3

Item No.	Item Type	Item Description	Applicable Cables
26	Tee-off Joint	Tee off Joint Box Resin Compound Fill; W/Ring Connector, Mould Box, Constant F/Spring, Earth Braid	Paper Insulated Cables 240 mm² 4C Ply(E) W/120 mm² Neutral Main as per Clause C.5.1 and 25 mm² 3C XLPE Branch cable as per Clause C.3;
27	Tee-off Joint	Tee off Joint Box Resin Compound Fill; W/Ring Connector, Mould Box, Constant F/Spring, Earth Braid	Paper Insulated Cables 150 mm² 4C Ply(E) W/70 mm² Neutral Main as per Clause C.5.1 and 25 mm² 3C XLPE Branch cable as per Clause C.3
28	Tee-off Joint	Tee off Joint Box Resin Compound Fill; W/Ring Connector, Mould Box, Constant F/Spring, Earth Braid	Paper Insulated Cables 70 mm² 4C Ply(E) Main W/25 mm² Neutral as per Clause C.5.1 and 25 mm² 3C XLPE Branch cable as per Clause C.3
29	Transition Joint	Transition Joint Box Resin Compound Fill; Heatshrink; Shear-Bolt Connected, Breakout Glove, Insulation Sleeve, Tinned Cu Mesh, Neutral Braid, Outer Jacket, W/Mech Earth Kit	LV Paper Insulated Cables 240 mm² Pilc as per Clause C.5.1 and 240 mm² 3C Cable as per Clause C.2
30	Straight Through Joint	Straight thru joint; Heatshrink; shear-bolt conn, insulating sleeve, tinned cu mesh, o/jacket	For XLPE 10-16 mm² 1C Service Cable as per Clause C.3
31	Straight Through Joint	Straight thru joint; Heatshrink; kit form, shear-bolt conn, insulating sleeve, tinned cu mesh, o/jacket	25 mm² 3C Service Cable as per Clause C.3
32	Termination Kit for Pole Termination	Termination Kit Heatshrink; W/Crimp Connector; Bi-Metal Link; Breakout Glove; Insulating Sleeve; Phase Colour Id	120 mm² 3C cable as per Clause C.2 with 95 mm² LV ABC as per Clause C.4
33	Termination Kit for Pole Termination	Termination Kit Heatshrink; W/Crimp Connectors; Bi-Metal Link; Breakout Glove; Insulation Sleeve; Phase Colour Id	185 mm² 3C cable as per Clause C.2 with 150 mm² LV ABC as per Clause C.4
34	Termination Kit for Pole Termination	Termination Kit Heatshrink; W/Crimp Connectors; Bi-Metal Link; Breakout Glove; Insulation Sleeve; Phase Colour Id	240 mm² 3C cable as per Clause C.2 with 150 mm² LV ABC as per Clause C.4
35	Mini Pillar Termination Kit	Termination, Mini Pillar; Heatshrink; Breakout Glove Item 5; Insulation Sleeving Item 9	25 mm² 3C XLPE Cable as per Clause C.3
36	Transformer Termination Kit	Termination, Transformer LV Busbar & Uni Pillar; Heatshrink; Breakout Glove, Insulating Sleeves, Shear-Bolt Conn, Phase Colour ID	120-240 mm² cable as per Clause C.2

Item No.	Item Type	Item Description	Applicable Cables
37	Pit Termination Kits	Termination, Pit; 0.6/1 kV; 400 A; Push Fit; Gel Sealed; 4 Ports, Hinged Cap; W/Insulation Piercing Conn; Water Sealant;	6-25 mm² 1C PVC and XLPE Cable as per Clause C.3
38	Pit Termination Kits	UMS Termination Pit; Heatshrink; Breakout Glove, Red & Black Sleeving, Flood Seal Fuse Holder, Gelwrap Neutral Enclosure, Neutral Conn	10 & 16 mm² 1C PVC Cable
39	End Caps	Push On; Water & UV Resistance, Opaque, Re-Usable	25 mm² 3C XLPE Cable (23-30 mm) as per Clause C.3
40	End Caps	Push On; Protective; Water & UV Resistance, Opaque, Re-Usable,	10-16 mm² 1C Service Cable (11-16 mm) as per Clause C.3
41	End Caps	Push On; Water & UV Resistance, Opaque, Re-Usable, W/Mastic	150 mm² LV ABC cable (20-26 mm) as per Clause C.4
42	End Caps	Push On; Water & UV Resistance, Opaque, Re-Usable, W/Mastic	95 mm² LV ABC cable (16-22 mm) as per Clause C.4
43	Heat Shrinkable End Caps	End Cap; Heatshrink; Sealant Lined; Polyolefin; Black; Water & UV Resistance	Cores Of 120-240 mm² cable (15-35 mm) as per Clause C.2
44	Heat Shrinkable End Caps	End Cap; Heatshrink; Sealant Lined; Polyolefin; Black; Water & UV Resistance	120 mm² 3C LV Cable as per Clause C.2 and 35-185 mm² HV Cable (25-55 mm)
45	Heat Shrinkable End Caps	End Cap; Boot; Heatshrink; Sealant Lined; Polyolefin; Black; Water & UV Resistance	185-240 mm² 3C LV Cable as per Clause C.2 and 240-400 mm² 1C HV Cable (32-75 mm)
46	Heat Shrinkable End Caps	End Cap; Boot; Heatshrink; Sealant Lined; Polyolefin; Black; Moisture Resistance	Cover All 3 Cable Ends On Drum; 35-95 mm² 3C HV Cable (45-100 mm)
47	Live Cable End Seals	LV Cable End Seal; XLPE 70-120 mm² 1 x 3C	Cores Of 70-120 mm² Cable as per Clause C.2
48	Live Cable End Seals	LV Cable End Seal; XLPE 185-240 mm² 1 x 3C	Cores Of 185-240 mm² Cable as per Clause C.2

APPENDIX C CABLE TYPES

C1 GENERAL

The types of underground cables to be used with the cable accessories listed are as follows.

1) LV XLPE underground distribution power cable
2) LV XLPE underground service power cable
3) LV aerial bundled distribution cable
4) LV paper insulated cables

C2 LV XLPE UNDERGROUND DISTRIBUTION POWER CABLE

C2.1 Construction

The main type of LV underground distribution cables in Horizon Power distribution network are three phase cable rated at 1 kV.

The cables size ranges from 120 mm² to 240 mm². The cables are used as main LV feeders running from transformers to pillars.

All 1 kV low voltage underground cables comply with AS 4961 [8] unless otherwise specified.

The construction of the cable is as follows:

1) Core conductor is solid sector shaped aluminium laid up helically. The 3 cores are laid-up with a right-hand direction lay.
2) The insulation is XLPE compound with red, white, blue colour for phase identification.
3) Binder tapes and bedding are used to ensure circular profile of the cable and are made of elastomeric material.
4) The neutral copper wires are uniformly distributed and applied with a waveform concentric lay.
5) Sheath is V-90 insulating material in accordance with AS/NZS 3808 [5]. The sheath contains 1% carbon black.
6) Some cables will have protection from insect attack in the form of one or a combination of:
    a) Double Brass Tape (DBT): consists of two overlapping layers of tape having the same width, helically applied under the cable outer sheath. Outer sheath is HDPE material containing a minimum of 2% carbon black. The minimum average thickness of the HDPE outer sheath is 1.8 mm.
    b) chemical protection incorporated into the HDPE outer sheath.

C2.2 Dimensions

LV distribution cable dimensions are summarised in Table 3

Table 3: LV underground distribution cable dimensions

Attribute		120 mm² Al	185 mm² Al	240 mm² Al
Nominal Voltage [Ø-e/Ø-Ø] (kV)		0.6/1	0.6/1	0.6/1
Cable Type (Conductor, Insulation)		Al, XLPE	Al, XLPE	Al, XLPE
Nom. Cond. CSA (mm²)		120	185	240
Core Insulation Thickness (mm)	Min	0.98	1.34	1.43
	Max	1.3	1.68	1.8
Waveform Screen Wires CSA (mm²)	Min	63.6	91.6	113
	Max	66.8	96.8	119
Total Cable Diameter (mm)	Min	37.4	48.3	50.9
	Max	39.7	52.5	54.1
Fault Current [kA/1s] Copper Screen wires		9.4	14.3	16.8
Joule integral (I^2t) [$kA^2.s$] for 1 second		88.36	204.5	282.3

The solid sector shaped cable core conductor area shall be calculated in accordance with BSI 3988 [15] as shown in Table 4 and Figure 2.

Table 4: LV underground distribution cable core dimensions

Attribute		120 mm² Al	185 mm² Al	240 mm² Al
Nom. Cond. CSA (mm²)		120	185	240
Solid Sector Shaped Conductor Width (mm)	Min	17.29	21.51	24.66
	Max	17.78	22.07	25.29
Solid Sector Shaped Conductor Depth (mm)	Min	10.02	12.46	14.31
	Max	10.35	12.84	14.73
Solid Sector Shaped Conductor Back radius (degree)	Min	11.41	14.17	16.2
	Max	11.47	14.24	16.29
Solid Sector Shaped Conductor Corner radius (degree)	Min	1.14	1.41	1.62
	Max	1.15	1.42	1.63

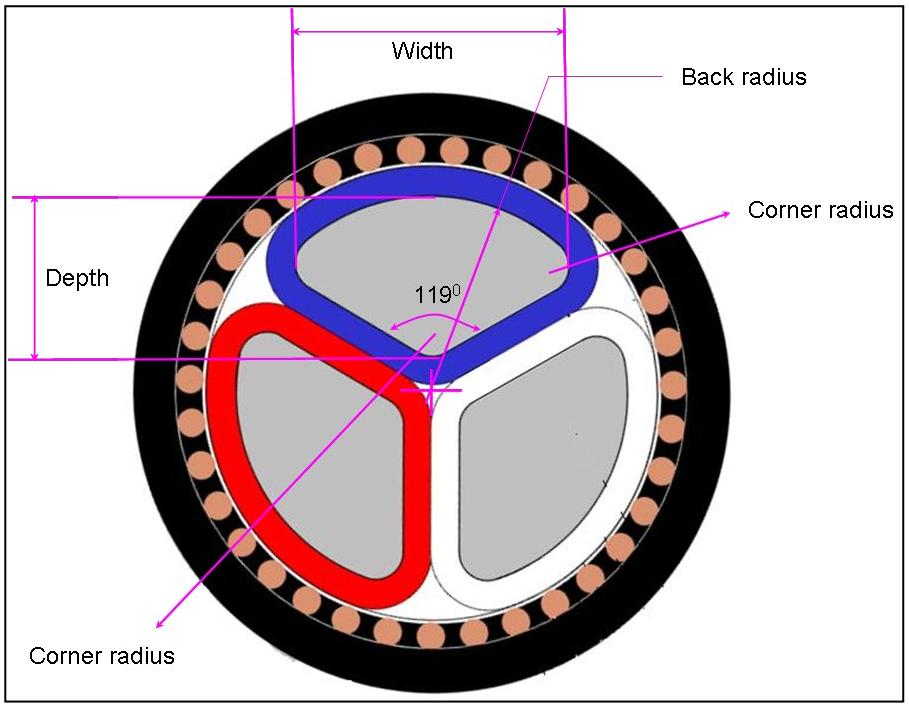

Figure 2: Sector shaped cable core measurement based on BSI 3988 [15]

C3 LV XLPE UNDERGROUND SERVICE POWER CABLE

C3.1 Construction

The two main types of LV underground service cables in Horizon Power distribution network are single core and 3 cores, both rated at 1 kV.

The cables sizes ranges from 10 mm² to 25 mm². The cables are used to connect between the pillar and customer point of supply.

All 1 kV LV underground service cables comply with AS 4961 [8] unless otherwise specified.

The construction of the cable is as follows:

1) Core conductor is circular stranded copper.
2) Active cores are surrounded by a helically applied concentric neutral wire screen and sheathed consisting of:
   a) Two conductor cable size 10 mm² to 16 mm²
   b) Four conductor cable size 25 mm²
3) The insulation is X-90.
4) Filler and binder tapes are used to ensure circular profile of the cable.
5) Screen wires are annealed copper
6) Sheath is V-90 insulating material in accordance with AS/NZS 3808 [5]. The sheath material is orange colour.
7) Some cables will have protection from insect attack in the form of one or a combination of:
   a) DBT: consists of two overlapping layers of tape having the same width, helically applied under cable outer sheath. Outer sheath is HDPE material containing a minimum of 2% carbon black. The minimum average thickness of the HDPE outer sheath is 1.8 mm.
   b) chemical protection incorporated into the HDPE outer sheath.

C3.2 Dimensions

LV service cable dimensions are specified in Table 5

Table 5: LV underground service cable dimensions

Attribute		10 mm² Cu	16 mm² Cu	25 mm² Cu
Nominal Voltage [Ø-e/Ø-Ø] (kV)		0.6/1	0.6/1	0.6/1
Cable Type (Conductor, Insulation)		Cu, XLPE	Cu, XLPE	Cu, XLPE
Nom. Cond. CSA (mm²)		10	16	25
	Min	4.1	5.1	6.4

Attribute		10 mm² Cu	16 mm² Cu	25 mm² Cu
Nom. Main Cond. Diameter (mm)	Max	4.2	5.4	6.6
Single core diameter over insulation (mm)	Min	5.5	6.5	8.3
	Max	5.7	6.7	8.5
Helical Screen Wires CSA (mm²)	Min	10.0	16.0	26.0
	Max	13.1	17.1	28.7
Total Cable Diameter (mm)	Min	11.8	13.5	24.6
	Max	16.2	17.0	29.1
Fault Current [kA/1s] Copper Screen wires		195	2.54	3.88
Joule integral (I^2t) [$kA^2.s$] for 1 second		3.8	6.45	15.1

C4 LV AERIAL BUNDLED DISTRIBUTION CABLE

C4.1 Construction

There are two sizes of LV ABC cable used in the Horizon Power LV network, 95 mm² and 150 mm².

All LV ABC distribution cables comply with AS/NZS 3560.1 [4] and are as specified in Table 6.

Table 6: LV ABC distribution cable construction

Cross-sectional area of core conductor (mm²)	Number of cables
95	4-core (3 active, 1 neutral)
150	4-core (3 active, 1 neutral)

Core conductors are stranded compacted circular aluminium. Cores are laid-up with a left-hand direction of lay.

The insulation is X-90 UV compound with a minimum of 2% carbon black.

C4.2 Dimensions

LV ABC distribution cable dimensions are specified in Table 7

Table 7: LV ABC distribution cable dimensions

Attribute		95 mm² Al	150 mm² Al
Nominal Voltage [Ø-e/Ø-Ø] (kV)		0.6/1	0.6/1
Cable Type (Conductor, Insulation)		Al, XLPE	Al, XLPE
Nom. Cond. CSA (mm²)		95	150
Nom. Main Cond. Diameter. (mm)	Min	11.5	14.2
	Max	11.5	14.4
Single core diameter over insulation (mm) (excluding ribs)	Min	15.1	17.8
	Max	15.9	18.9
Diameter circumscribing over laid up (mm)	Min	36.4	42.9
	Max	38.4	45.6

C5 LV PAPER INSULATED CABLES

LV paper insulated cables have been superseded by polymeric XLPE insulated cables as a standard. However, installed LV paper insulated cables are still in service as LV feeder cables. Existing LV paper insulated cable will be joined with new LV XLPE three cores sector shape cable as specified in Table 3.

Maximum operating temperature of LV Paper Insulated cables is 80°C.

Horizon Power has two main types of LV paper insulated cables:

1) Low Voltage Paper Insulated Lead Alloy Sheathed Steel Wire Armoured and Served (PLY(E)SWS).
2) Low Voltage Consac Cable.

C5.1 LV PLY(E)SWS cable

All 1 kV low voltage paper insulated underground cables comply with AS/NZS 1026 [3] as shown in Figure 3 unless otherwise specified.

1) The 4 core conductors are either solid or stranded aluminium. The 4th core is a reduced size conductor to half of the other three main conductors to function as a neutral phase.
2) The insulation is layers of Mass Impregnated Non-draining Paper (MIND) helically applied over each core. The cores are numbered 1, 2, and 3 for phase identification by numbered paper.

3) Paper or jute fillers between cores form a circular cable.
4) The 3 core assembly is belted with MIND tapes.
5) Lead alloy E sheath to prevent the ingress of moisture and provide electrical and mechanical protection. Alloy E contains:
   a) 0.4% Tin
   b) 0.2% Antimony
   c) Remainder Lead
6) Bedding can be lapped or extruded. Lapped bedding consists of paper and textiles pre-impregnated with bitumen.
7) Steel wire armour or steel tape armour comprises two steel tapes coated with compound to provide mechanical and electrical protection.
8) The over sheath is steel wire armour with bitumen hessian wrap (in some cases is PVC).

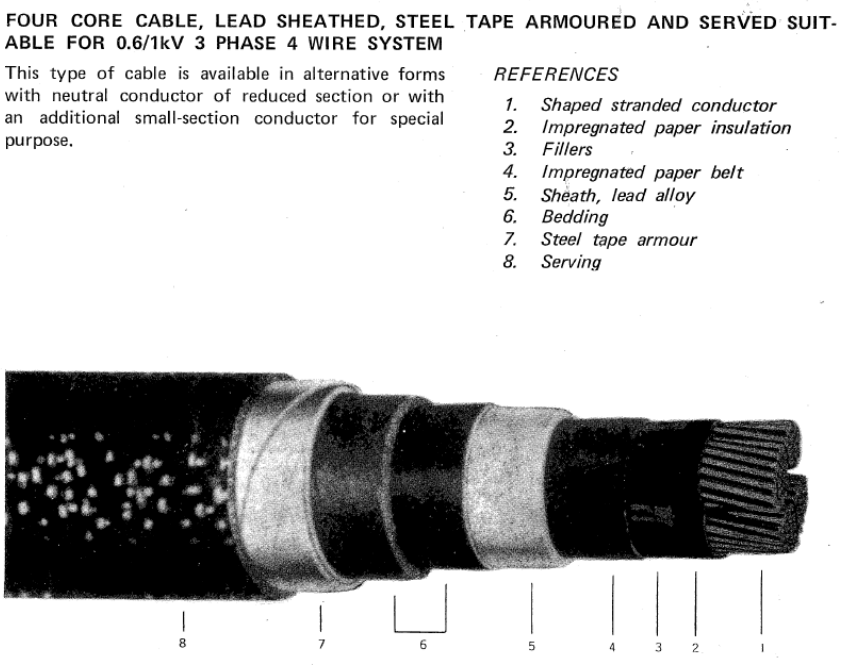

Figure 3: LV PLY(E) SWS cable Australia [Courtesy of Power Cable Australia]

LV PLY(E)SWS cable dimensions are specified in Table 8.

Table 8: LV PLY(E) SWS cable dimensions

Attribute	25 mm² Cu	150 mm² Al	240 mm² Al
Nominal Voltage [Ø-e/Ø-Ø] (kV)	0.6/1	0.6/1	0.6/1
Cable Type (Conductor, Insulation)	CU, PLY(E)SWS	AL, PLY(E)SWS	AL, PLY(E)SWS
Nom. Cond. CSA (mm²)	25	150	240

Attribute	25 mm² Cu	150 mm² Al	240 mm² Al
Nom. Main Cond. Diameter. (mm)	7.04	12.8	15.9
Nom. Neutral Cond. Diameter. (mm)	5.6	9.1	13.3
Min Insulation. Thickness Between Conductor. & Sheath (mm)	1	1.4	1.6
Nom. Thickness of Lead Alloy Sheath (mm)	1.2	1.9	2.3
Min Lead Alloy Sheath Overall Diameter (mm)	20.2	38.9	46.7
Max Lead Alloy Sheath Overall Diameter (mm)	20.4	40.1	47.9
Min Overall Cable Diameter. (mm)	29	53.3	61.2
Max Overall Cable Diameter. (mm)	30.6	55	65.4

C5.2 Low Voltage Consac Cable

All 1 kV low voltage paper insulated underground service cables comply with AS/NZS 1026 [3] as shown in Figure 4 unless otherwise specified.

1) The 3 core conductors are solid sector shaped aluminium.
2) The insulation is layers of Mass Impregnated Non-draining Paper (MIND) helically applied over each core. The cores are numbered 1, 2, and 3 for phase identification by numbered paper.
3) Paper or jute fillers between cores form a circular cable.
4) The 3 cores assembly is belted with MIND tapes.
5) Aluminium sheath (99.5% grade) to function as neutral phase as well as providing mechanical protection (also referred to as Common Neutral earth – CNE).
6) Sheath coating is bitumen/zinc chromate mix to prevent corrosion.
7) Serving/Outer sheath is extruded PVC.

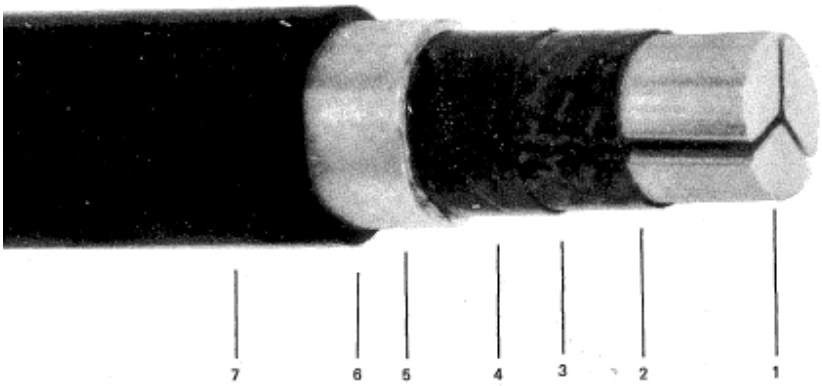

Figure 4: LV Consac cable construction [Courtesy of Power Cable Australia]

LV Consac cables dimensions are specified in Table 9.

Table 9: LV Consac cable dimensions

Attribute	Al Consac	Cu Consac
Nominal Voltage [Ø-e/Ø-Ø] (kV)	0.6/1	0.6/1
Cable Type (Conductor, Insulation)	Al, MIND	Cu, MIND
Nom. Conductor CSA (mm²)	120	185
Nom. Conductor Diameter. (mm)	12.4	15.4
Min Insulation. Thickness Between Cond. & Sheath (mm)	1.4	1.4
Nom. Thickness of Lead Alloy Sheath (mm)	1.4	1.9
Min Lead Alloy Sheath Overall Diameter (mm)	31	41.1
Max Lead Alloy Sheath Overall Diameter (mm)	34.1	45.3
Min Overall Cable Diameter. (mm)	36	56.1
Max Overall Cable Diameter. (mm)	37.8	58.7

C6 LOW VOLTAGE PLANT (NON CABLE)

This section covers the technical details and dimension of interfaces between cables and transformers, pillars and pits. Cable terminations must mate with these interfaces and comply with the relevant standards associated with these interfaces.

C6.1 Distribution transformer feeder cubicle

The LV feeder cubicle contains an ABB Fuse Switch Disconnector (FSD) type SLBM. Each FSD has 3 terminals for three phase cable connection.

The distance between:

- the lowest terminal to the ground is 550 mm.
- phase to phase terminals (on the same FSD) is 50 mm.
- cable to cable terminals (on neighbouring FSD's) is 100 mm.

C6.2 Uni pillar construction

The following dimensions are important for cable accessories terminated inside a uni pillar:

- Distance between the phase to phase busbar terminals is 95 mm. This means the overall width of a single lug (including offsetting of the palm and insulation) must not be greater than 45 mm to avoid phase to phase contact during live installation.
- Uni-pillar busbar terminal has size M11 hole for cable connection.
- Distance of lowest busbar terminal to ground is 600 mm.
- Distance between the hole centres on the earth bar is 30 mm. The hole size is M11.
- Earth bar nominal thickness is 6 mm.
- Refer to Figure 5 for a diagrammatic representation.

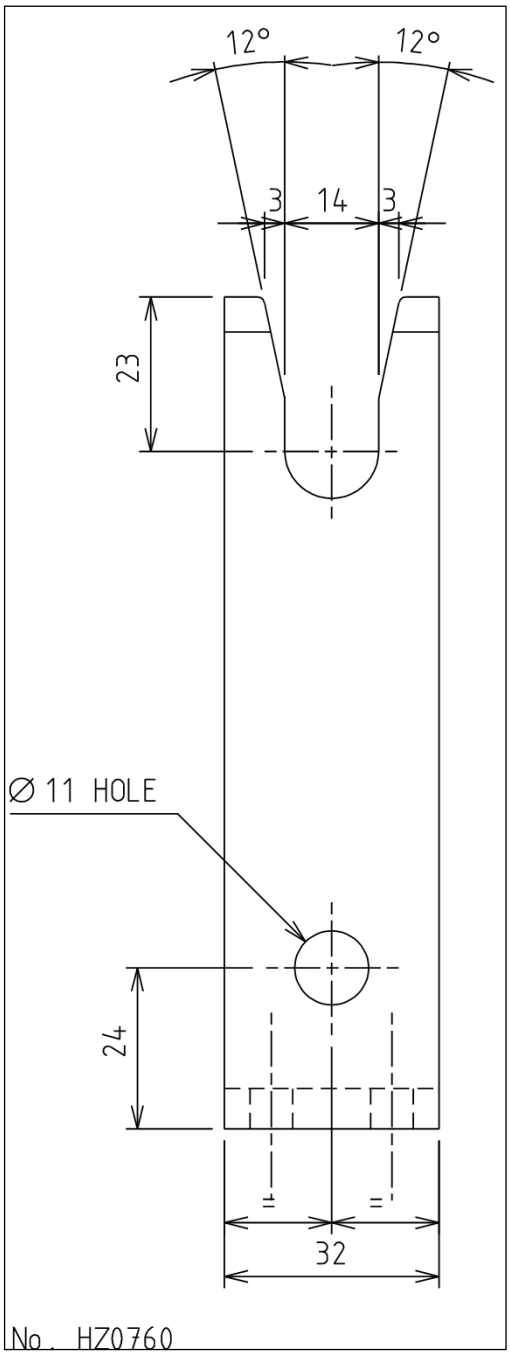

Figure 5: Uni pillar busbar

C6.3 Pit construction

The available dimension for equipment installation in a pit is 470 mm x 240 mm x 540 mm (L x W x H). Cable accessories (single or multiple set) used in the pit must fit within the above dimension.

APPENDIX D COLOUR CODE INDICATING SUPPLIED DATE

The colour code table below is used for the circular sticker (minimum 24 mm diameter) to be attached onto the packaging label for each item.

Colour	Equipment supplied to store between Financial Years
Red	July 2013 - June 2015
Blue	July 2015 - June 2017
Black	July 2017 - June 2019
Green	July 2019 - June 2021
Pink	July 2021 - June 2023
Yellow	July 2024 - June 2026

The colour will rotate back to Red at July 2027