Specification – Insulators

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STAKEHOLDERS *The following positions shall be consulted if an update or review is required:*	
Asset Managers	*Project Directors*
Manager Asset Services	
Manager Engineering & Project Services	

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1 SCOPE

This Specification sets out the technical (electrical and mechanical) requirements for the performance, testing and supply of low and high voltage insulators for the overhead distribution system only. This specification should not be used for zone substation insulators or insulators that form part of pole mounted equipment such as pole top switches.

This specification applies to pin, strain (shackle), line post and long rod insulators, which will be installed on 3 phase 0.4, 6.6, 11, 22, and 33 kV distribution systems, as well as 12.7 and 19.1 kV single phase distribution systems throughout the Horizon Power Network. Although Horizon Power operates several different voltage levels on its distribution networks, it standardises for all low voltage insulators to 415 V and all high voltage insulators to 33 kV level.

This Specification also covers the requirements for Guy-style stay wire insulators.

Approval in terms of this specification must be obtained by one or a combination of the following:

Successful completion of the appropriate tests (required by this specification) by an independent and accredited test authority.

Provision of test certificates (from an independent and accredited test authority) based upon an alternative specification, with test requirements at least equivalent to this specification.

NOTE: Verification of accreditation of the test authority must be provided by NATA (National Association of Testing Authorities) accredited test house or by a test house possessing accreditation from a NATA MRA (Mutual Recognition Agreement) partner.

2 NORMATIVE REFERENCES

2.1 Standards

2.1.1 Horizon Power Standards

[1]. *Horizon Power 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]. *Distribution Design Rules HPC-9DJ-01-0002-2015*, available at http://horizonpower.com.au/contractors-suppliers/contractors/manuals-and-standards/under the ‘Distribution Design heading.

2.1.2 Australian Standards

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

[3]. *AS 1154.1 Insulator and conductor fittings for overhead power lines*, Standards Australia, 2009 (R2019) Amdt 1-2020

[4]. *AS 2700 Colour standards for general purposes*, Standards Australia, 2011

[5]. *AS 2947.1 Insulators - Porcelain and glass for overhead power lines - Voltages greater than 1000 V a.c. - Test methods,* Standards Australia, 1999

[6]. *AS 3608 Insulators Porcelain and glass, pin and shackle type – Voltages not exceeding 1000 V a.c.*, Standards Australia, 2005

[7]. *AS 3609 Insulators Porcelain stay type – Voltages not exceeding 1000 V a.c.*, Standards Australia, 2005

[8]. *AS 4436 Guide for the selection of insulators in respect of polluted conditions*, Standards Australia, 1996 (R2016)

[9]. *AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*, Standards Australia, 2006

[10]. *AS 4899 Pin insulators - Porcelain and glass for overhead power lines - Voltages greater than 1000 V a.c.*, Standards Australia, 2007 (R2018)

[11]. *AS 60038 Standard voltages*, Standards Australia, 2012

[12]. *AS 60120 Ball and socket couplings of string insulator units - Dimensions,* Standards Australia, 2022

[13]. *AS IEC 60437 Radio interference test on high-voltage insulators*, Standards Australia, 2005 (R2016)

[14]. *AS IEC 60720 Characteristics of line post insulators* (Ceramic), Standards Australia, 2007

[15]. *AS 61109 Insulators for overhead lines - Composite suspension and tension insulators for a.c. systems with a nominal voltage greater than 1 000 V - Definitions, test methods and acceptance criteria,* Standards Australia, 2020

[16]. *AS 61466.1 Composite string insulator units for overhead lines with a nominal voltage greater than 1 000 V - Standard strength and end fittings,* Standards Australia, 2020

[17]. *AS 61952 Insulators for overhead lines - Composite line post insulators for a.c. systems with a nominal voltage greater than 1 000 V - Definitions, test methods and acceptance criteria,* Standards Australia, 2020

[18]. *AS IEC 62217 Polymeric HV insulators for indoor and outdoor use with a nominal voltage > 1000 V - General definitions, test methods and acceptance criteria*, Standards Australia, 2021

[19]. *SA TS 60815.3 Selection and dimensioning of high voltage insulators intended for use in polluted conditions – Part 3: Polymer insulators for a.c. systems,* Standards Australia, 2020

2.1.3 International Standards

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

[20]. *IEC 60471 Clevis and tongue couplings of string insulator units - Dimensions*, International Electrotechnical Committee, 2020

[21]. *IEC 60812 Analysis techniques for system reliability—Procedure for failure mode and effects analysis (FMEA)*, International Electrotechnical Committee, 2006

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.

BIL: Basic insulation level.

Cantilever Load: A load applied at the conductor position on the insulator, perpendicular to the conductor, and perpendicular to the longitudinal axis of the insulator. Commonly referred to as “bending load”.

Cantilever Breaking Load (CBL): A load specified by the manufacturer that represents the failing load of a non-ceramic composite post insulator. The failing load is the maximum load attainable under Cantilever load testing and is greater than or equal to the Specified Cantilever Load (SCL).

Chalking: The powder result (usually aluminium oxide) of depolymerisation by UV of elastomers.

Chips, Pits or Blisters: Surface marks on insulator shed material usually caused during the manufacturing process.

Class A Insulator: An insulator or insulator unit in which the length of the shortest puncture path through solid insulating material is at least equal to half the arcing distance. Class A insulators are considered to be unpuncturable.

Class B Insulator: An insulator or insulator unit in which the length of the shortest puncture path through solid insulating material is less than half the arcing distance. Class B insulators are considered to be puncturable.

Creepage Factor (C.F.): The ratio between the total creepage distance (*It*) of the insulator and the arcing distance (*St*) of the insulator. *It/St*.

Cycloaliphatic Epoxy Resin: A polymer material used for insulators.

De-lamination: The loss of bonding of fibres to the matrix.

End fitting: Integral component or formed part of an insulator intended to connect it to a supporting structure, or to a conductor, or to an item of equipment.

Note: Where the end fitting is metallic, the term “metal fitting” is normally used.

EPDM: Ethylene Propylene Diene Monomer. A polymer that is an elastomer (synthetic rubber).

EPM: Ethylene Propylene Monomer. A polymer that is an elastomer (synthetic rubber).

EPR: Ethylene Propylene Rubber. A general term encompassing both EPM and EPDM.

ESP™: A proprietary polymer, mainly consisting of an alloy of silicone and EPDM. It is made by Ohio Brass / Hubbell Power Systems

EVA: A proprietary polymer, mainly consisting of a co-polymer of ethylene and ethylene vinyl acetate. It is made by Tyco / Raychem.

Erosion: Irreversible but non-conducting degradation of the surface of the insulator that occurs by loss of material which can be uniform, localised or tree-shaped.

ESDD: Equivalent Salt Deposit Density

Flashover: A disruptive discharge external to the insulator, and over its surface, connecting those parts that normally have the operating voltage between them.

Note: The term “flashover” used in this part includes a flashover across the insulator surface as well as disruptive discharges by spark-over through air adjacent to the insulator.

Highest voltage for equipment: These shall be as defined in AS 60038 [11].

Hydrophobic: A property of a surface material that causes water to bead, rather than forming a film.

Maximum Design Cantilever Load (MDCL): The polymeric/composite line post insulator cantilever load rating, assigned by the manufacturer. It is the maximum load that can be applied to the line post insulator for 96 hours without damaging the core rod. Some manufacturers list this rating as the Reference Cantilever Load (RCL). Australian Standard refers this to term as “ “Mechanical load test (tensile load)” AS 61109 [15]. It forms the basis of the selection of line post insulators according to AS 62217 [18] and AS 61109 [15] (post insulator units).

Polymeric Insulator: Insulator whose insulating body consists of at least one organic based material. Polymeric insulators are also known as non-ceramic insulators. It includes both composites and cyclo-aliphatic epoxy resin insulator types. Coupling devices may be or not attached to the ends of the insulating body.

Note: In this document, when definition polymeric is used, it defines both composite and epoxy resin insulators, as those form the subgroup of polymeric insulators. If used separately, composite or epoxy resin terms are used to describe specific property that belongs only to that subgroup.

Power-frequency withstand voltage: A rated insulation level. The voltage is sinusoidal, with a frequency at 50 Hz, and a duration of 60 s. Unless stated otherwise this is the ‘wet’ withstand (as opposed to ‘dry’ withstand).

Profile Factor (P.F.): The ratio of the simplified leakage distance to the actual insulating creepage distance measured between the two points, which define the spacing - *s*. As defined in AS 4436 Appendix D – D6.2 [8].

Puncture Distance: The shortest distance through the insulating material between those parts which normally have the operating voltage between them.

Radio Interference Voltage (RIV): Any effect on the reception of a radio signal due to an unwanted disturbance within the Radio frequency spectrum. Radio interference is primarily of concern for amplitude modulated systems (AM radio and television video signals) since other forms of modulation (such as frequency modulation (FM) used for VHF radio broadcasting and television audio signals) are generally much less affected by disturbances that emanate from overhead lines.

Rated insulation level: A set of standardised withstand voltages used to characterise an insulator's dielectric strength.

Ratios:

s/p: Ratio between shed spacing and overhang.

Note: The ratio *s/p* describes the limitation on providing arbitrarily too high a leakage distance by either over dimensioning the shed overhang *p* or by unjustifiably increasing the number of sheds. The ratio is important for self-cleaning properties of insulators.

ld/d: Ratio between the creepage distance and clearance.

Note: The ratio *ld/d* describes the use of the creepage distance in order to avoid local short-circuiting.

Routine Test Load (RTL): The RTL is the load applied to all assembled composite suspension/strain insulators during a routine mechanical test. The load applied to composite insulators that is equal to or greater than 50 percent of the insulator Specified Mechanical Load (SML) rating for at least 10 s see AS 61109 [15]. It is also considered to be the maximum continuous working load of the insulator.

Silicone rubber: Elastomer polymer using silicone, typically polydimethylsiloxane.

Strain Insulator: An insulator placed in a structural support such as termination or PTS arrangement where insulator is subjected to tensile load.

Specified Mechanical Load (SML): A load specified by the manufacturer that represents the ultimate strength of a composite suspension/strain insulator under tension. The strength should be verified during Mechanical Load Tests, and the historical failure loads should justify the manufacturer's choice of SML. It is not the maximum working load of the insulator. See RTL. The ultimate failing load shall be higher than the SML. It forms the basis of the selection of insulators according to AS 61109 [15].

Note: The SML of an insulator may be reduced by the class of hardware used for the end fittings.

Specified Tensile Load (STL): The load specified by the manufacturer that represents the ultimate strength of a polymeric line post insulator under tension. The strength is verified by the same testing procedures used to determine the Specified Mechanical Load (SML) for composite suspension/strain insulators. It forms the basis of the selection of a line post insulator according to AS 61109 [15].

Standard lighting impulse withstand voltage: A rated insulation level. The voltage is an impulse, with a front time of 1.2 µs and a time-to-half value of 50 µs.

Television Interference Voltage (TIV) (sometimes referred to as TVI): Special case of radio interference for disturbances affecting the frequency ranges used for television broadcasting (video signal).

Tracking: Irreversible degradation consisting of the formation of conductive paths starting and developing on the surface of an insulating material. These paths are conductive even under dry conditions.

ULS: Ultimate limit state.

3 REQUIREMENTS

3.1 Compliance with the Specification

Equipment offered that is found on inspection not to conform to this Specification shall be replaced by the Vendor at no cost to Horizon Power.

3.2 Environmental Conditions

The performance of equipment must meet the requirements set out in Section 4 of the *Horizon Power Environmental Conditions* [1].

3.3 General

Horizon Power standardises its LV insulators to 0.415 kV rated pin and shackle type insulators as follows:

1) Pin Insulators: These are mounted vertically, with the conductor above the insulator. They are fixed to the crossarm by means of a threaded pin. They are also referred to as stand-off insulators.
2) Strain (Shackle) Insulators: These are mounted on a crossarm where the conductor is making significant deviation. The conductor is supported on the side of the insulator, which is supported from below by the crossarm.

Horizon Power standardises its MV insulators to 33 kV post and strain type insulators as follows:

1) Line Post Insulators: These are insulators which may be mounted vertically or horizontally. Line Post insulators may be either tie-top or clamp-top. Clamp top are further categorised into vertical and horizontal fittings (refer to Appendix G for requirements clamp top insulators). Line Post insulators differ from station post insulators in that strength is rated for both cantilever (bending) and tension.
2) Strain Insulators (Long Rod): These are suspended from a crossarm to hold a conductor at tension. These are used to terminate a conductor at a crossarm, or allow a conductor a significant deviation. Horizon Power uses a long rod insulator with insulator sheds and a Tongue and Clevis arrangement.

In addition to the above MV and LV insulators, Stay (Guy Type) insulators are also covered by this specification.

Standard Horizon Power equipment and descriptions are listed in Table 3 of Section 11.

3.4 Material Requirements

3.4.1 Cores of Composite Post and Composite Long-rod Insulators

Cores shall be solid and made of epoxy resin, reinforced with load-bearing fibres and of even cross-section.

The core, which provides the strength, shall be made of an acid resistant glass fibre reinforced rod (FRP) of high strength. Glass fibres shall be Boron free or Boron free E-Glass and shall exhibit both high electrical integrity and high resistance to acid corrosion. The matrix of the FRP rod shall be hydrolysis resistant. The FRP rod shall be manufactured through pultrusion process and shall be void free.

End fittings shall be crimped onto the fibreglass core. Shed material shall be formed such that it overlaps the end fittings and prevents moisture ingress.

3.4.2 Sheds of Composite Post and Strain Insulators

Materials for composite post and strain insulators shown in Table 1 are preferred due to their past use in Horizon Power networks.

Table 1: Preferred Composite Materials for Insulator Sheds

Material Class	Material Name	Material Manufacturer	Material Description
EPDM / Silicone alloy	ESP™	Ohio Brass / Hubbell Power Systems	Alloy of silicone and EPDM rubber
Polyolefin	EVA	Raychem / Tyco	Co-polymer of ethylene and ethylene vinyl acetate

For all composite insulators, results of the 5000 hour ageing test or accelerated ageing test (as per Annex B of AS IEC 62217 [18]) will be required.

Shed material shall be of a hardness sufficient to resist bird strike. Evidence of long term in-service use should show geographic location to demonstrate resistance to fauna.

Shed material shall be stabilised against ultraviolet radiation, and stabilised against oxidation.

Shed material shall be bonded to the core by either high-temperature vulcanisation or by injection mould, and shall use a method to minimise voids.

3.4.3 Adhesive compounds

The adhesive compound used for bonding the outer sheath to the FRP rod core and to the galvanised end fittings shall not allow the ingress of moisture for the duration of the operational design life of the insulator.

Evidence confirming the adhesive and nonporous properties for the operational design life of the insulator of the compound used shall be provided by the vendor as part of their submission.

3.4.4 Unacceptable Materials

Hybrid insulators (polymeric sheds with a ceramic core) are not acceptable.

Cast epoxy (cycloaliphatic) resin insulators are not acceptable.

3.5 Low Voltage and Stay Insulators

All Low Voltage and stay insulators shall be made of porcelain and should be free from chips, pits, blisters or cracks. All porcelain insulators shall be non-porous and pass the porosity test requirements detailed in Clause 25 of AS 2947.1 [5]. These insulators shall be of Class A.

3.5.1 Pin Insulators

Insulators shall be made suitable for mounting in the vertical plane. The insulators shall be of the top groove tie type and shall be mounted rigidly on a supporting structure by means of a pin passing up inside the insulator. The insulator shall consist of one piece and the glazing of porcelain insulators shall be light grey (N35) in colour in accordance with AS 2700 [4] and of a uniform shade.

Insulators offered shall comply with the relevant part of AS 3608 [6].

Item 2 in the Equipment Schedule will be used on Horizon Power's overhead network.

3.5.2 Strain (Shackle) Insulators

Insulators shall be made suitable for mounting in the horizontal plane. The insulators offered shall comply with the relevant part of AS 3608 [6]. The insulator shall consist of one piece and shall be secured to the construction by means of a steel spindle passing through it.

Item 3 in the Equipment Schedule will be used on Horizon Power's overhead network.

3.5.3 Stay (Guy Type) Insulators

Stay insulators shall have smooth transitions between radii, transverse holes and the longitudinal grooves. Stay insulators shall accept both 19/2.00 and 19/2.75 galvanized steel stay wire termination unit. Stay insulators shall be designed, manufactured and tested in accordance with AS 3609 [7].

Item 1 in the Equipment Schedule will be used on Horizon Power's overhead network.

3.5.4 Stud for the LV Pin Insulator

The stud shall be designed according to AS 4899 [10] for dimensions and plug designation suitable for the pin insulator offered.

The material for the stud of the pin insulator shall be 24 mm (Dia) Mild Steel Rod of minimum Grade 250 or 22 mm (Dia) Bright Steel Rod of minimum Grade CS1020.

The stud shall be hot dip galvanised in accordance with AS/NZS 4680 [9].

A combined insulator and stud package cost may be submitted. In the combined package price submission, the stud must be able to be removed/unscrewed from the insulator. The stud usage number for costing is the same as the estimated insulator usage given.

3.6 Medium Voltage Insulators (>1000 V)

3.6.1.1 Line Post Insulators

Items 5.1, 5.2 and 5.3 will be used on Horizon Power's overhead network.

Vendors shall submit one or more of the following:

- a top groove tie-top type (Item 5.1) with dimensions in accordance with the Standard head as outlined in Figure 2 and 3 of AS 60720 [14];
- a vertical clamp-top type head (Item 5.2) as outlined in Figures 4 and 6 of AS 60720 [14]; and
- a horizontal mounting clamp-top type head (Item 5.3) as outlined in Figure 5 and 6 of AS 60720 [14]

Further requirements for clamp top insulators are available in Appendix G.

The line post insulators shall be provided with a mounting end fitting to suit a M24 galvanised fixing stud. The insulators shall be tapped M24 plus 0.4 mm oversized to accept the galvanised fixing stud. The base of the insulators shall be in accordance with Figure 8 in AS 60720 [14]. The stud shall be offered separately with dimensions according to the requirements outlined in Section 3.6.2 of this Specification.

The female threads of inserts and caps shall be coated with an anti-corrosion compound and sealed with a removable cap or plug so that the threads cannot become corroded or the grease contaminated by sand or other foreign matter.

The external surface of inserts shall be galvanized steel to AS/NZS 4680 [9] or any non-corrosive material proven not to react with galvanised steel.

The line post insulator is characterized by the impulse withstand voltage levels (BIL) and specific creepage distance (SCD) in electrical terms, and with maximum design cantilever load (MDCL) and specified cantilever (bending) failing load (SCL) in mechanical terms.

Required electrical performance is given in Table 2 and section 3.9.2.

3.6.1.2 Stud for MV line post insulators

Vendors are to submit a drawing with specifications and a price for the insulator stud as a separate item based on the following requirements:

- the stud must have a collar that will sit in the insulator's body once completely screwed in, thus allowing the insulator base to sit firmly on the cross-arm;
- the stud must cater for the cross-arm thickness of 110 mm; and
- the stud must not decrease the specified mechanical performance of the insulator.

The stud shall be hot dip galvanised in accordance with AS/NZS 4680 [9].

A combined insulator and stud package cost may be submitted. In the combined package price submission, the stud must be able to be removed/unscrewed from the insulator. The stud usage number for costing is the same as the estimated insulator usage given.

3.6.2 Composite Long Rod (Strain) Insulators

Composite strain insulators shall consist of a core, housing including weather sheds and sheath and metal end fittings. Other designs will be considered providing they meet requirements outlined in Schedule A of C2.4.

The insulator shall be suitable for both the suspension and strain type of load and metal end fittings shall be of tongue & clevis type. End fittings shall be the galvanized steel crimped type. Wedge type will not be considered.

The housing and sheds are the external insulating part of the insulator and shall be designed to provide the necessary creepage distance defined in Section 3.9.2.

The insulation material covering the core and forming the sheds shall be a minimum of 3 mm thick.

The insulator design shall ensure that the core is totally sealed and no part of the core shall be exposed during normal handling and use.

End fittings transmit the mechanical load to the core. They shall be connected to the rod by means of a controlled compression technique. As the main duty of the end fittings is the transfer of mechanical loads to the core, the fittings should be properly attached to the core by a coaxial or hexagonal compression process which should not damage the individual fibres or crack the core.

Metal end fittings shall be suitable for tongue & clevis hardware of respective specified mechanical load and made of cast iron, malleable cast iron, forged steel or aluminium alloy. Ferrous fittings shall be hot dip galvanized to AS/NZS 4680 [9] after all fittings have been completed.

System of attachment of the end fittings to the rod shall provide superior sealing performance between housing, i.e. seamless sheath and metal connection. The sealing must be moisture proof. The dimensions of end fittings of insulators shall be in accordance with the standard dimensions stated in IEC 60471 [20].

The long rod insulator is characterized by the impulse withstand voltage levels (BIL) and specific creepage distance (SCD) in electrical terms, and with routine test load (RTL) and specified mechanical load (SML) in mechanical terms.

Required electrical performance is given in Table 2 and section 3.9.2 of this Specification.

The insulators shall be designed, manufactured and tested in accordance with AS 61109 [15]. Natural ageing and natural pollution performance tests will be preferable for all insulators in comparison to the artificial aging and pollution tests of housing (tracking and erosion) described in AS 61109 [15].

3.7 Acceptable Profiles

Insulators shall have sheds with an open aerodynamic profile and good self-cleaning properties, as well as the following properties:

- The insulator shed diameter shall not be greater than 255 mm;
- Insulator shed profile, spacing, projection and selection in respect of polluted conditions shall be in accordance with the recommendation of AS 4436 [8] and SA TS 60815.3 [19];
- Note: Close D5 of AS 4436 [8] Annex D is not applicable to long rods;
- Sheds shall be resistant to bird strike (biting the sheds);
- Sheds shall be strong enough to withstand the expected handling stresses. The sheds shall maintain their shape during handling, storage and in-service operation; and
- Handling, storage and precautionary installation equipment and information shall be made available for insulator products offered.

3.8 Insulator Designations and Markings

3.8.1 Pin Insulators

Pin Insulators shall be labelled with three markings according to AS 4899 [10], including for LV pin insulators, with the following:

1) Shed profile: S is standard, F is fog, A is aerodynamic, followed by ‘LP’ for ‘line pin’;
2) Two digits representing typical operating voltage; and
3) Three digits representing the nominal minimum creepage distance in mm.

For example ALP/33/710 is a line pin insulator with aerodynamic profile, for 33 kV, with a 710 mm nominal minimum creepage distance.

3.8.2 Insulator Pins

Pins shall be labelled with three markings according to AS 4899 [10]:

1) Head pattern: A, B or C;
2) Stem length in mm; and
3) Cantilever minimum failing load in kN.

For example; A/130/7 is a pin with head pattern A, a stem length of 130 mm, and a 7 kN cantilever minimum failing load.

3.8.3 Strain Insulator Couplings

Clevis and tongue couplings for strain insulator strings shall be labelled according to IEC 60471 [20], with the following:

1) The nominal diameter of the coupling pin in mm; and
2) The letter ‘C’ for cap and pin insulators, or ‘L’ for long rod insulators.

Ball and socket couplings are designated a number that is the nominal diameter of the pin in mm. The sockets are designated the same, with the addition of an ‘A’ or ‘B’ for two types of sockets for the 16 mm size.

3.8.4 Line Post Insulators

There is no IEC standard way of designating composite line post insulators, therefore designation shall be as for ceramic line post insulators. These shall be labelled with five markings according to AS IEC 60720 14] with the following:

1) 'R' indicating line post insulator;
2) The minimum bending failing load in kN;
3) 'E' or 'J' indicating external or internal fixing of the metal parts;
4) 'T', 'C' or 'H' indicating tie-top, vertical clamp top or horizontal clamp top;
5) The lightning withstand voltage in kVp; and
6) 'N' or 'L' indicating normal or longer creepage distance.

An example would be R 12.5 ET 170 N.

3.8.5 Strain Long Rod Composite Insulators

Composite long rod insulators shall be labelled according to with the following:

1) The letters 'CS';
2) The specified mechanical load (tension) in kN;
3) The type and size of coupling for the upper end of the insulator:
   a) 'B', 'S', 'T', 'C', 'Y', or 'E' for ball, socket, tongue, clevis, y-clevis or eye coupling, followed by the size in mm; and
4) The type and size of coupling for the lower end of the insulator (in the same format as the upper end designation).

An example designation is CS 70 S16 B16 for a 70 kN ball-and-socket composite long rod insulator.

3.8.6 Stay (Guy Type) Insulators

Stay insulators shall be labelled according to Table 4.1 of AS 3609 [7], with 'GY', followed by a type number, defining mechanical and electrical strength. It is Horizon Power practice to use GY3 stay insulators (specification item 1).

Type number 3 indicates a minimum failing load of 222 kN and a power-frequency withstand voltage of 20 kV.

The actual mechanical strength is also dependent on the steel cable used.

3.9 Electrical Performance Requirements

Electrical performance of an insulator is determined by the creepage distance. This distance must be sufficiently long as required by the pollution category and withstand voltages. The withstand voltages are standardised based on the voltage of the system.

3.9.1 Rated Voltages

It is Horizon Power practice to use insulators designed for 33 kV networks on all medium voltage networks (6.6, 11, 22 and 33 kV, as well as 12.7 and 19.1 kV single phase lines).

As a minimum, all insulators, with the exception of stay insulators, shall adhere to the following equipment basic impulse insulation levels (BIL) and power frequency withstand voltage, as shown in Table 2.

Table 2: Withstand Voltages

Nominal system voltage (kV)	Highest voltage for equipment (kV)	Power Frequency Withstand (kV)	Lightning Impulse Withstand (kVp)
0.4			40
6.6, 11, 22, 33 12.7, 19.1	36	70	200

3.9.2 Pollution Categories

Minimum creepage lengths for medium voltage insulators shall be in accordance with Pollution Level IV (Very Heavy) of Table 1 and Table 2 of AS 4436 [8], being a minimum of 1,116 mm.

3.9.3 Low Voltage Pin and Shackle Insulators

There are no specific electrical requirements for these insulators, other than that they comply with AS 3608 [6].

3.9.4 Stay (Guy Type) Insulators

The Electrical withstand strength of stay insulators (specification item 1) shall exceed 20 kV.

3.10 Mechanical Requirements

The Equipment shall be suitable for continuous connection to a power system and in line with Schedule A of the relevant tables of Section C1. Each type of insulator is subject to different mechanical loads.

Actual line loads on an insulator consist of a combination of loads. The loads involved are quite different in terms of direction and quantity for a suspension insulator (tensile) as compared to a line post insulator (cantilever, compressive and/or tensile).

3.10.1 Ceramic Insulators (Pin, Shackle, Guy)

Ceramic insulator's mechanical strength is expressed in terms of "mechanical failing load" or "minimum failing load" (MFL) in kN, and is specified by the manufacturer. This value is usually equal to the breaking force of the metal fittings or the insulating (dielectric) component, whichever is lower. These values are standardised in AS 3608 [6] and AS 3609 [7].

The minimum failing load for the stay insulator (specification item 1) shall be 222 kN.

The minimum failing load for pin insulators (specification item 2) shall be 7 kN.

The minimum failing load for the shackle insulators (specification item 3) shall be 20 kN.

3.10.2 Polymeric/Composite Post Insulators

Post insulators are subject to bending (cantilever) load and/or compression (tension) load (combined loading). Torsion loads are not dealt with in this specification as they are usually negligible in the configuration in which line post insulators are generally used. Post insulators are standardised by the means of specified cantilever load (SCL), maximum design cantilever load (MDCL) and specified tensile load (STL), as per and AS IEC 62217 [18]. If a polymeric post insulator is mounted in the horizontal plane, a “combined load chart” defines insulator’s mechanical strength.

Specified minimum cantilever (bending) failing load of line post insulator (specification items 5.1, 5.2 and 5.3) shall be at least 11 kN.

3.10.3 Composite Strain Insulators

Composite long rod insulators are subject to tensile load. Composite insulators are standardised by the specified mechanical load (SML) and standard couplings, as per AS 61466.1 [16] and AS 1154.1 [3].

Specified minimum mechanical failing load of the strain insulator (specification item 4) shall be at least 70 kN.

3.11 Dimensions

3.11.1 Stay (Guy Type) Insulators - Specification Item 1

Dimensions shall be as per type GY3 to AS 3609 [7].

All transitions between surfaces shall be smooth and provide even bearing for the steel cable.

3.11.2 Low Voltage Line Post Pin Insulators - Specification Item 2

Dimensions shall be of the type ‘LP.LV’ to AS 3608 [6].

Dimensions of the pin hole shall be to AS 4899 [10].

Insulator pins shall comply with AS 4899 [10].

3.11.3 Low Voltage Pin and Shackle Insulators (Strain) - Specification Item 3

Pin and Shackle insulators shall have a minimum failing load of 20 kN and shall comply with specifications for the ‘SH.LV.2’ in AS 3608 [6].

Dimensions of pin and shackle insulators shall be of the type ‘SH.LV.2’ to AS 3608 [6].

3.11.4 Medium Voltage Long Rod (Strain) Insulators - Specification Item 4

Shed design shall be in accordance with sections 3.6.2, 3.7, 3.9 and 3.10.3.

Dimensions of clevis and tongue couplings, including coupling pin, shall be to IEC 60471 [20].

3.11.5 Medium Voltage Line Post Insulators - Specification Items 5.1, 5.2 and 5.3

Dimensions for head end fittings shall be in accordance with the standard head (specification item 5.1) as outlined in Figure 2 of AS 60720 [14], or clamp top head (specification item 5.2 for vertical and 5.3 for horizontal) as outlined in Figure 6 of AS 60720 [14] (refer to Appendix G for further requirements clamp top insulators).

Shed design shall be in accordance with sections 3.6.2, 3.7, 3.9 and 3.10.2.

3.12 Service Requirements

3.12.1 Cleaning Requirements

Vendors shall provide information of how the insulator should be cleaned, including:

1) Recommended cleaning interval for each pollution category to AS 4436 [8];
2) Allowable water pressure; and
3) Cleaning method.

3.12.2 Coating Maintenance

Where insulators will benefit by the periodic application of a silicone compound, Vendors shall provide information on:

1) The recommended silicone compound;
2) The frequency of application for each pollution category to AS 4436 [8]; and
3) The method of application.

4 PACKAGING REQUIREMENTS

The *Equipment* shall be suitably packaged, such that it is “fit for use” at any location in Horizon Power’s operational area. Packaging shall be capable of preventing damage whilst in storage and during transit to remote locations. The Vendor is required to nominate standard pack quantities and standard packs shall be clearly marked with the following information:

1) Manufacturer’s name;
2) Manufacturer’s part reference number;
3) Batch Number;
4) Horizon Power Order Number;
5) Horizon Power Stock Number;
6) Insulator description; and
7) Package weight.

Very strong consideration shall be given to appropriate packaging provided with any *Equipment* offered under this specification, with respects to satisfying the “fit for use” criteria mentioned above.

The combined height of the pallet and equipment of a standard pack shall not exceed 1,050 mm.

Each shipment shall be provided with box labels stating the part, stock and contract number as well as the routine test reports.

Each package is to have an identifying bar code and number which identifies as a minimum the:

- Manufacturers part number;
- Manufacturer;
- Factory of manufacture; and
- Month and year of manufacture.

The bar code should be code 128 and can be applied either by spray or on a plastic tag. The bar code and number does not have to be indelible beyond installation.

Note: The vendor is required to identify the cost of providing bar coding as specified in this section separately from the other cost requirements of this specification.

5 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.

6 RELIABILITY

Vendors shall provide information on the reliability of the *Equipment* and the performance of the materials offered over an operational life of 50 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 information on Failure Mode and Effect Analysis, carried out in accordance with IEC 60812 [21]. 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.

7 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.

8 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. Vendors shall 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.

9 TESTS

9.1 Test Requirements

The Vendor shall prior to first delivery, complete the design, type, routine, sample and special tests and inspections as required by the relevant Australian or IEC standard. For sample tests, samples shall be selected using the method described in the referenced standard.

The passing of such tests does not prejudice the right of Horizon Power to reject the insulator or fitting if it does not comply with this Specification when installed.

Note: A condition of acceptance on imported products shall be to perform landing routine and sample tests completed in Australia on each batch imported. In these cases each batch must obtain a passed landing test in order that the batch acceptance will be reflected on an acceptance list.

9.2 Test Certificates

At the time of submitting the offer on the tender, single copies of test certificates, in English, shall be provided and shall be clearly marked and contain a reference number. If all the required test certificates are not submitted the tender will be rated incomplete and may not be considered.

Electronic copies of type test certificates shall be arranged in the order set out in this Specification and shall be marked clearly with the identifier and description in the contents section. Any extra test certificates shall be marked with “extra tests” and kept separate from the required test certificates.

All test certificates shall be submitted in electronic format and shall be in Adobe Acrobat (.pdf) format.

9.3 Required Tests

Tests that shall be performed on the insulators with follow-up documentation are as follows:

- Design tests;
- Type tests;
- Routine tests; and
- Sampling tests.

All tests required by the relevant Australian or International standards shall be carried out. The requirements for these are outlined in Appendix F Test Certificates

Additionally the following optional tests on strain and post insulators shall be undertaken:

a) Radio interference voltage test (AS IEC 60437 [13]); and

b) Impulse overvoltage puncture test.

9.4 Design Tests

Composite insulators shall be design tested as defined in with the 1000 h a.c. tracking and erosion of AS IEC 62217 [18] is used to establish a minimum requirement test replaced with the ageing test under Annex B of AS IEC 62217 [18], using a duration of 5000 hours or accelerated ageing test.

Polymeric insulators shall be design tested as defined in AS IEC 62217 [18].

The design tests are intended to verify the suitability of the design, materials and method of manufacture (technology). When a composite/polymeric insulator is subjected to the design tests, the results shall be considered valid for the whole class of insulators which are represented by the one tested and having the following characteristics:

a) same materials for the core, and housing and same manufacturing method;

b) same material for the end fittings, same design, and same method of attachment;

c) same or greater minimum layer thickness of the housing material over the core (including a sheath where used) *;

d) same or smaller ratio of all mechanical loads to the smallest core diameter between fittings *;

e) same or smaller ratio of the highest system voltage to insulation length *; and

f) same or greater diameter of the core.

The tested composite/polymeric insulators shall be identified by a drawing giving all the dimensions with the manufacturing tolerances. Subsequently, if there are small variations in the design data of not more than 15 % for characteristics marked with *, the design tests do not need to be repeated.

Certified design test results shall be submitted with the Proposal. The Vendor shall, in their evaluation submission, state which tests the insulator/s have passed.

9.5 Type Tests

Type tests verify the main characteristics of the insulator, which depend mainly on its shape and size. Certified type test results shall be submitted with the Proposal.

Ceramic pin and shackle insulators shall be type tested as defined in AS 3608 [6].

Stay insulators shall be type tested according to AS 3609 [7].

Composite insulators shall be type tested according to AS 61109 [15]

Polymeric insulators shall be type tested as defined in AS IEC 62217 [18].

In addition to this, composite insulators that use fibre rods shall be subjected to the following tests:

- Brittle fracture resistance test (as set out in clause 9.8 of this Specification);
- Electrical routine testing (as set out in clause 9.9 of this Specification); and
- Interface integrity test (as set out in clause 9.10 of this Specification).

9.6 Sample Tests

Insulators shall be sample tested to the relevant Australian Standard. Two percent or two insulators, whichever is the greater, shall be selected as samples for lot sizes of less than 300 insulators. For lot sizes greater than 300, the sample sizes specified in the relevant Australian Standard shall be applicable.

Ceramic pin and shackle insulators shall be sample tested as defined in AS 3608 [6].

Stay insulators shall be sample tested according to AS 3609 [7]. Composite insulators shall be sample tested according to AS 61109 [15].

Polymeric insulators shall be sample tested as defined in AS IEC 62217 [18].

In addition, all composite/polymeric insulators shall be subjected to an interface integrity test (refer section 9.10) and the following additional tests shall be performed on composite post insulators:

9.6.1 Torque test

Post insulators shall be torque tested with studs and nuts approved for use on the Horizon Power distribution system. The studs shall be subjected to a torque of 50 Nm relative to the insulator. The stud shall then be removed. The insulator insert shall be examined to ensure that there is no visible deformation of the screw threads of the insert or the stud.

9.6.2 Cantilever test

The *Equipment* shall be mounted on a fixed frame. The mechanical load shall be applied on the neck perpendicular to the axis of the insulator. The *Equipment* shall withstand 90 % of the specified failing load determined in the insulator's type test. The insulator shall be tested in 4 perpendicular directions.

9.7 Routine Tests

Routine tests are intended to eliminate defective units and shall be carried out during the manufacturing process. Routine tests shall be carried out on every insulator and should not consist of visual examination only.

Ceramic pin and shackle insulators shall be routine tested as defined in AS 3608 [6].

Stay insulators shall be routine tested according to AS 3609 [7]. Composite insulators shall be routine tested according to AS 61109 [15].

Polymeric insulators shall be routine tested as defined in AS IEC 62217 [18]. The Vendor shall supply duly certified copies of the routine tests performed on the insulators to Horizon Power, either prior to or upon Delivery.

9.8 Brittle Fracture Resistance Test

A brittle fracture test shall be applied to composite insulators with fibre reinforced glass core rod.

9.8.1 Procedure

Brittle fracture test shall be carried out on a naked rod along with end fitting by applying "1N HNO_3 acid" (63 g concentrated HNO_3 added to 937 g of water) to the rod. The rod should be held at 80% of SML for the duration of the test. Test arrangement should ensure continuous wetting of the rod with Nitric acid.

The temperature shall be held at 20°C ± 5°C for the duration of testing.

9.8.2 Acceptance Criteria

The rod should not fail within the 96-hour test duration, and the de-lamination of the rod should not occur.

9.9 Electrical Routine Testing

Electrical testing is required to confirm the integrity of the insulation across the insulator.

9.9.1 Procedure

Apply the nominal AC voltage between the two ends of the insulator. With the voltage applied measure the leakage current or impedance across the insulator. The test is to be conducted until an acceptable constant reading is acquired.

9.9.2 Acceptance Criteria

Impedance above 1000 MΩ is required or as agreed to with the manufacturer.

9.10 Interface Integrity

The test applies to insulator designs with an interface between the insulator housing and an insulators mechanical element. A test procedure relevant to the technology must be set up by the manufacturer as part of the manufacturing process to prove interface integrity. Testing for composite insulators is to include life cycle and fire exposure tests to ensure no debonding or permeability of the outer sheath from the FRP core or galvanised end fitting occurs. This test procedure must be submitted for technical evaluation.

10 DOCUMENTATION AND SAMPLES

10.1 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*.

10.2 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.

10.3 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.

10.4 Samples

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

11 EQUIPMENT LIST AND DESCRIPTION

Table 3: Standard equipment list and descriptions

Specification Item No.	Description
1.	STAY INSULATOR GUY STYLE (GY3) 20 kV 222 kN (MFL)
2.	LV LINE POST INSULATOR PIN TYPE (LP.LV) 440 V 7 kN (MFL)
3.	LV STRAIN INSULATOR SHACKLE TYPE (SH.LV.2) 440 V 20 kN (MFL)
4.	LONG-ROD INSULATOR HEAVY-VERY HEAVY POLLUTION 33 kV NOM 70 kN (SML) STRENGTH TONGUE & CLEVIS
5.1	LINE POST INSULATOR TIE TOP HEAVY-VERY HEAVY POLLUTION 33 kV NOM 11 kN (SCL) STRENGTH
5.2	LINE POST INSULATOR VERTICAL CLAMP TOP HEAVY-VERY HEAVY POLLUTION 33 kV NOM 11 kN (SCL) STRENGTH
5.3	LINE POST INSULATOR HORIZONTAL CLAMP TOP HEAVY-VERY HEAVY POLLUTION 33 kV NOM 11 kN (SCL) STRENGTH

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# 3904502** 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
3/04/2016	0	Initial Document Creation
14/10/2022	1	Review and update to latest standards

APPENDIX B QUALITY ASSURANCE (TO BE COMPLETED BY STORES)

DOCUMENT NUMBER	HPC-8DJ-07-0004-2016		**QUALITY ASSURANCE**	**DM NUMBER**	
DEVICE DESCRIPTION	**LABEL MATERIAL NO.**		**INSULATOR PURCHASE**	**ASSET OWNER**	
	ASSET ID/ STOCK NO				
MANUFACTURER		**DIMENSION**			

ITEM	OPERATION/EQUIPMENT/FACILITY	DOCUMENT REF.	WHO CHECKS	INITIAL	DATE/ TIME	QUALITY ASSURANCE CRITERIA	PASS Y/N	COMMENTS
1	LABELLING							
1.1	Name of Manufacturer					*******		
1.2	Manufacturer's part reference number					*******		
1.3	Batch Number					*******		
1.4	Horizon Power Order Number					*******		
1.5	Horizon Power Stock Number					*******		
1.6	Insulator description					*******		
1.7	Package Weight					< 20 kg		
2	CONTENTS							
2.1	Installation Instructions					Clear, Legible and in English		
2.2	Bill of Materials					Clear, Legible and in English		
2.3	Material Safety Data Sheets (if required)					Clear, Legible and in English of all materials		

ITEM	OPERATION/EQUIPMENT/FACILITY	DOCUMENT REF.	WHO CHECKS	INITIAL	DATE/ TIME	QUALITY ASSURANCE CRITERIA	PASS Y/N	COMMENTS
2.4	Accessories (if required)					As per Bill of Materials		
2.5	Test and Inspection Reports					As per Standards referenced in the specification.		
3	PACKAGING							
3.1	Suitably stacked and secured on pallet					Packages suitably packed and prevented from coming loose		
3.2	Physical damage					Packages do not show puncture marks or other signs of damage		
3.3	Insulator/s in suitable packaging					Strong enough to prevent mechanical damage		
3.4	Packaging clearly labelled					Each package easily identifiable as per Section 4		
3.5	Items Individually Marked					Items clearly designated and marked as per Section 3.8		

SYMBOLS AND ABBREVIATIONS								
H = HOLD POINT	S = SUPERVISOR							
W = WITNESS POINT	T = TECHNICIAN, EL = ELECTRICIAN	REVISION						
V = VERIFICATION POINT	E = ENGINEER	DATE						
S/C = SUBCONTRACTOR	PM = PROJECT MANAGER	APPROVED BY						

APPENDIX C SCHEDULES A & B: ENQUIRY DOCUMENT

C1 Technical Schedules

Completion of the listed schedules in Appendix C2 by the vendor shall indicate the product offered is fully compliant with the nominated Clauses in this specification. All information provided shall be in English and measurement units shall be in metric units.

Any deviation from the specification shall be listed on the "Technical Deviation Schedule", provided in Section C3 with motivation to Horizon Power for consideration and written approval.

C2 Technical Requirements

Schedule A: Purchaser's specific requirements.

Schedule B: Particulars of equipment to be supplied.

C2.1 Technical schedules A and B for Stay insulators

HORIZON POWER	**SPECIFICATION ENQUIRY**	**HPC-8DJ-07-0004-2016**
	VENDOR'S NAME	
	DATE	

TECHNICAL SCHEDULES A & B

ITEM 1: Stay insulators (GY3)

Item	Sub-clause	Description	Schedule A	Schedule B
1.		Manufacturer/vendor of insulator	xxxxxx	
2.		Manufacturer's/ vendor's catalogue number	xxxxxx	
3.		Manufacturer's/ vendor's drawing number	xxxxxx	
4.		Wet power frequency withstand voltage(kV) compliant with AS 3609, Table 4.1	20	
5.		Minimum Failing Load (kN) compliant with AS 3609, Table 4.1	222	
6.		Insulator material	Porcelain	
7.		Mass of insulator(kg)	xxxxxx	
8.	3.12.1	Insulator dimensions compliant with AS 3609, Figure 4.3	YES	
9.	3.12.1	All transition radii compliant with AS 3609	YES	
10.		Compliance with AS 3609	YES	

C2.2 Technical schedules A and B for Low Voltage Line Post (Pin) Insulators (LP.LV)

HORIZON POWER	**SPECIFICATION ENQUIRY**	**HPC-8DJ-07-0004-2016**
	VENDOR'S NAME	
	DATE	

TECHNICAL SCHEDULES A & B

ITEM 2: Low Voltage Line Post (Pin) Insulators (LP.LV)

Item	Sub-clause	Description	Schedule A	Schedule B
1.		Manufacturer/ vendor of insulator	xxxxxx	
2.		Manufacturer's/ vendor's catalogue number	xxxxxx	
3.		Manufacturer's/ vendor's drawing number	xxxxxx	
4.		Wet power frequency withstand voltage (kV)	xxxxxx	
5.		Lightning impulse withstand voltage @ STP (kV) compliant with Table 2	40	
6.		Minimum Failing Load (kN) compliant with AS 3608, Table 4.1	7	
7.	3.6.1	Insulator material	Porcelain	
8.		Mass of insulator (kg)	xxxxxx	
9.		Insulator dimensions compliant with AS 3608, Figure 4.1	YES	
10.		All transition radii compliant with AS 3608, Figure 4.1	YES	
11.		Compliance with AS 3608	YES	

C2.3 Technical schedules A and B for Low Voltage Strain (Shackle) insulators (SH.LV.2)

HORIZON POWER	**SPECIFICATION ENQUIRY**	**HPC-8DJ-07-0004-2016**
	VENDOR'S NAME	
	DATE	

TECHNICAL SCHEDULES A & B

ITEM 3: Strain (Shackle) insulators (SH.LV.2)

Item	Sub-clause	Description	Schedule A	Schedule B
1.		Manufacturer/ vendor of insulator	xxxxxx	
2.		Manufacturer's/ vendor's catalogue number	xxxxxx	
3.		Manufacturer's/ vendor's drawing number	xxxxxx	
4.		Wet power frequency withstand voltage (kV)	xxxxxx	
5.	3.10.1	Lightning impulse withstand voltage @ STP (kV) compliant with Table 2	40	
6.		Minimum Failing Load (kN) compliant with AS 3608, Table 4.1	20	
7.	3.11.1	Insulator material	Porcelain	
8.		Mass of insulator (kg)	xxxxxx	
9.	3.12.3	Insulator dimensions compliant with AS 3608, Figure 4.3	YES	
10.	3.12.3	All transition radii compliant with AS 3608, Figure 4.3	YES	
11.		Compliance with AS 3608	YES	

C2.4 Technical schedules A and B for 33 kV Long Rod (Strain) insulators

HORIZON POWER	**SPECIFICATION ENQUIRY**	**HPC-8DJ-07-0004-2016**
	VENDOR'S NAME	
	DATE	

TECHNICAL SCHEDULES A & B

ITEM 4: 33 kV Long Rod (Strain) insulators

Item	Sub-clause	Description	Schedule A	Schedule B
1.		Manufacturer/ vendor of insulator	xxxxxx	
2.		Manufacturer's/ vendor's catalogue number	xxxxxx	
3.		Manufacturer's/ vendor's drawing number	xxxxxx	
4.	3.10.1	Rated Voltage (kV) compliant with Table 2	36	
5.	3.10.1	Wet power frequency withstand voltage (kV) compliant with Table 2	70	
6.	3.10.1	Lightning impulse withstand voltage @ STP (kV) compliant with Table 2	200	
7.	3.10.2	Minimum Specific creepage length @ Umax (mm)	1,116	
8.	3.11.3	Insulator Minimum Tensile Failing load (SML) (kN)	70	
9.		Minimum Arcing distance (mm)	280	
10.		Insulator Length ± 10mm (mm)	620	
11.		Average shed spacing (mm)	xxxxx	
12.		Alternating shed minimum diameter difference (if applicable) (mm)	15	
13.		Minimum spacing between sheds of the same diameter (mm)	20	
14.	3.8	Maximum Shed Diameter (mm)	≤ 255	
15.		Ratio s/p (minimum)	0.8	
16.		Ratio Id/d (maximum)	5	
17.		Creepage factor (C.F) (maximum)	4	
18.		Profile Factor (P.F) (minimum)	0.7	
19.	3.7.2	Metal used for end fittings	xxxxxx	
20.	3.7.2 3.12.4	Live end fitting – tongue – IEC 60471 16L 70 kN	Compliant	
21.	3.7.2 3.12.4	Earth end fitting – clevis – IEC 60471 16L 70 kN	Compliant	

Item	Sub-clause	Description	Schedule A	Schedule B
22.		Orientation of end fitting relative to each other	In line	
23.		Mass of insulator (kg)	xxxxxx	
24.	3.5.2	Shed Material	xxxxxx	
25.	3.5.1	Core Material	xxxxxx	
26.		Minimum insulation material thickness (if polymeric insulation (mm))	3.0	

C2.5 Technical schedules A and B for 33 kV Line Post insulators

HORIZON POWER	**SPECIFICATION ENQUIRY**	**HPC-8DJ-07-0004-2016**
	VENDOR'S NAME	
	DATE	

TECHNICAL SCHEDULES A & B

ITEM 5.X: 33 kV Line Post Insulators

Item	Sub-clause	Description	Schedule A	Schedule B
1.		Manufacturer/ vendor of insulator	xxxxxx	
2.		Manufacturer's/ vendor's catalogue number	xxxxxx	
3.		Manufacturer's/ vendor's drawing number	xxxxxx	
4.	3.10.1	Rated Voltage (kV) compliant with Table 2	36	
5.	3.10.1	Wet power frequency withstand voltage (kV) compliant with Table 2	70	
6.	3.10.1	Lightning impulse withstand voltage @ STP (kV) compliant with Table 2	200	
7.	3.10.2	Minimum Specific creepage length @ Umax (mm/kV)	1,116	
8.		Minimum Specified Cantilever Load (kN)	11	
9.		Minimum arcing distance (mm)	380	
10.		Average sequential shed spacing (mm)	xxxxx	
11.		Alternating shed minimum diameter difference (if applicable) (mm)	15	
12.		Minimum spacing between sheds of the same diameter (mm)	20	
13.	3.8	Shed Diameter (mm)	≤ 255	
14.		Ratio s/p (minimum)	0.8	
15.		Ratio ld/d (maximum)	5	
16.		Creepage factor (C.F) (maximum)	4	
17.		Profile Factor (P.F) (minimum)	0.7	
18.		Insert, M24, plus 0.4 mm oversize compliant with AS IEC 60720	YES	
19.		Mass of insulator (excluding stud) (kg)	xxxxxx	
20.	3.5.2	Shed Material	xxxxxx	
21.	3.5.1	Core Material	xxxxxx	
22.		Insulator length (mm)	≤ 550	

Item	Sub-clause	Description	Schedule A	Schedule B
23.	3.8	Insulator shed design according to AS 4436	YES	
24.	3.7.1.1	Compliance with Standard top according to the following figures of AS IEC 60720: Figure 2 for Tie Top Figures 4, 5 & 6 for Clamp Top	YES	

C3 Technical Deviation Schedule

Table 4: Technical Deviation Schedule

Any deviations from this specification shall be listed below with reasons for deviation. In addition, evidence shall be provided that the proposed deviations will at least be more cost-effective than that specified by Horizon Power.		
Item	**Clause**	**Proposed Deviation**

APPENDIX D TECHNICAL SCHEDULE C: COMPLIANCE DOCUMENT

The Vendor shall indicate below whether this offer is fully compliant with the nominated clause in this Specification. A YES shall ONLY be indicated if the offer is 100% compliant with the relevant Clause. If NO is indicated and supporting documents are submitted, then mark the ATT box with the attachment number. Details of departure shall be provided in Appendix E.

CLAUSE NUMBER		YES	NO	ATT.
3	Requirements			
3.1	Compliance with the Specification	☐	☐	
3.2	Environmental Conditions	☐	☐	
3.3	General			
3.4	Material Requirements			
3.4.1	Cores of Composite Post and Composite Long-rod Insulators	☐	☐	
3.4.2	Sheds of Composite Post and Strain Insulators	☐	☐	
3.4.4	Unacceptable Materials	☐	☐	
3.5	Low Voltage and Stay Insulators	☐	☐	
3.5.1	Pin Insulators	☐	☐	
3.5.2	Strain (Shackle) Insulators	☐	☐	
3.5.3	Stay (Guy Type) Insulators	☐	☐	
3.5.4	Stud for the LV Pin Insulator	☐	☐	
3.6	Medium Voltage Insulators (>1000 V)			
3.6.1.1	Line Post Insulators	☐	☐	
3.6.1.2	Stud for MV line post insulators	☐	☐	
3.6.2	Composite Long Rod (Strain) Insulators	☐	☐	
3.7	Acceptable Profiles	☐	☐	
3.8	Insulator Designations and Markings			
3.8.1	Pin Insulators	☐	☐	
3.8.2	Insulator Pins	☐	☐	
3.8.3	Strain Insulator Couplings	☐	☐	
3.8.4	Line Post Insulators	☐	☐	
3.8.5	Strain Long Rod Composite Insulators	☐	☐	
3.8.6	Stay (Guy Type) Insulators	☐	☐	
3.9	Electrical Performance Requirements			
3.9.1	Rated Voltages	☐	☐	
3.9.2	Pollution Categories	☐	☐	
3.9.3	Low Voltage Pin and Shackle Insulators	☐	☐	

CLAUSE NUMBER		YES	NO	ATT.
3.9.4	Stay (Guy Type) Insulators	☐	☐	
3.10	Mechanical Requirements	☐	☐	
3.10.1	Ceramic Insulators (Pin, Shackle, Guy)	☐	☐	
3.10.2	Polymeric/Composite Post Insulators	☐	☐	
3.10.3	Composite Strain Insulators	☐	☐	
3.11	Dimensions			
3.11.1	Stay (Guy Type) Insulators - Specification Item 1	☐	☐	
3.11.2	Low Voltage Line Post Pin Insulators - Specification Item 2	☐	☐	
3.11.3	Low Voltage Pin and Shackle Insulators (Strain) - Specification Item 3	☐	☐	
3.11.4	Medium Voltage Long Rod (Strain) Insulators - Specification Item 4	☐	☐	
3.11.5	Medium Voltage Line Post Insulators - Specification Items 5.1, 5.2 and 5.3	☐	☐	
3.12	Service Requirements			
3.12.1	Cleaning Requirements	☐	☐	
3.12.2	Coating Maintenance	☐	☐	
4	Packaging Requirements	☐	☐	
5	Storage	☐	☐	
6	Reliability	☐	☐	
7	Safety	☐	☐	
8	Environmental Considerations	☐	☐	
9	Tests			
9.1	Test Requirements	☐	☐	
9.2	Test Certificates	☐	☐	
9.3	Required Tests	☐	☐	
9.4	Design Tests	☐	☐	
9.5	Type Tests	☐	☐	
9.6	Sample Tests	☐	☐	
9.6.1	Torque test	☐	☐	
9.6.2	Cantilever test	☐	☐	
9.7	Routine Tests	☐	☐	
9.8	Brittle Fracture Resistance Test	☐	☐	
9.8.1	Procedure	☐	☐	

CLAUSE NUMBER		YES	NO	ATT.
9.8.2	Acceptance Criteria	☐	☐	
9.9	Electrical Routine Testing	☐	☐	
9.9.1	Procedure	☐	☐	
9.9.2	Acceptance Criteria	☐	☐	
9.10	Interface Integrity	☐	☐	
10	Documentation and Samples			
10.1	Documentation to be provided with Proposals	☐	☐	
10.2	Service history	☐	☐	
10.3	Training Materials	☐	☐	
10.4	Samples	☐	☐	

APPENDIX E SCHEDULE D: DEPARTURES FROM TECHNICAL SPECIFICATION

The Vendor shall nominate the Clause and describe the departure:

CLAUSE NO.	DEPARTURE

APPENDIX F TEST CERTIFICATES

F1 Tests For Stay Insulators

Certificates and test results shall be provided showing successful tests carried out as shown in Table 5.

Table 5: Required Tests for Stay Insulators

Test Type	Type	Sample	Routine
Wet power-frequency voltage test	R		
Mechanical strength test		R	
Porosity test (porcelain only)		R	
Verification of dimensions		R	
Visual examination			R
R = Required to AS 3609 [7]			

Three insulators shall be used for the mechanical strength and wet power-frequency type tests.

Porosity tests may be carried out on ceramic fragments of similar size to the insulators under test.

Where the lot size is less than 300, the sample size shall be five. Regardless of the lot size, the samples shall be selected in a random manner, in consultation with Horizon Power.

A lot that is rejected shall not be resubmitted for retesting.

F2 Tests For LV Line Post Insulators

Certificates and test results shall be provided showing successful tests carried out as shown in Table 6:

Table 6: Required Tests for LV Pin and Shackle Insulators

Test Type	Type	Sample	Routine
Mechanical strength test	R	R	
Porosity test (porcelain only)		R	
Verification of dimensions		R	
Visual examination			R
R = Required to AS 3608 [6]			

Three insulators shall be used for the mechanical strength type test.

Porosity tests may be carried out on ceramic fragments of similar size to the insulators under test.

Where the lot size is less than 300, the sample size shall be five. Regardless of the lot size, the samples shall be selected in a random manner, in consultation with Horizon Power.

A lot that is rejected shall not be resubmitted for retesting.

F3 Tests For LV Pin and Shackle (Strain) Insulators

Certificates and test results shall be provided showing successful tests carried out as shown in Table 7:

Table 7: Required Tests for LV Pin and Shackle Insulators

Test Type	Type	Sample	Routine
Mechanical strength test	R	R	
Porosity test (porcelain only)		R	
Verification of dimensions		R	
Visual examination			R
R = Required to AS 3608 [6]			

Three insulators shall be used for the mechanical strength type test.

Porosity tests may be carried out on ceramic fragments of similar size to the insulators under test.

Where the lot size is less than 300, the sample size shall be five. Regardless of the lot size, the samples shall be selected in a random manner, in consultation with Horizon Power.

A lot that is rejected shall not be resubmitted for retesting.

F4 Tests for Medium Voltage Long Rod (Strain) Insulators

Certificates and test results shall be provided showing successful tests carried out as shown in Table 8:

Table 8: Required Tests for Composite MV Long Rod (Strain) Insulators

Test Type	Design	Type	Sample	Routine
Electrical tests				
Reference dry power-frequency voltage test	R1			
Sudden-release pre-stressing	R1			
Thermal-mechanical pre-stressing	R1			
Water immersion pre-stressing	R1			
Dry lightning impulse voltage test		R2		
Steep-front impulse puncture test	R1			
Dry power-frequency voltage test	R1			
Wet power-frequency voltage test		R2		
Wet switching impulse voltage test		R2		
Mechanical tests				
Tension load test	R1	R2	R1	R1
Verification of locking system			R1	
Material property tests				
Dye penetration test	R1			
Water diffusion test	R1			
Tracking and erosion test (1000 hour salt fog)	R1*			
Galvanising test			R2	
Other Tests				
Verification of dimensions			R1	
Visual examination				R1

R1 = Required to AS 61109 [15]

R2 = Required to AS 2947.1 [5]

*For all composite insulators the 1000 hour salt fog test shall be replaced with the ageing test under Annex B of AS IEC 62217 [18], using a duration of 5000 hours.

F5 Tests for Medium Voltage Line Post Insulators

Certificates and test results shall be provided showing successful tests carried out as shown in Table 9:

Table 9: Required Tests for Composite MV Line Post Insulators

Test Type	Design	Type	Sample	Routine
Electrical tests				
Thermal-mechanical pre-stressing	R1			
Water immersion pre-stressing	R1			
Dry lightning impulse voltage test		R2		
Steep-front impulse puncture test	R1			
Dry power-frequency voltage test	R1			
Wet power-frequency voltage test		R2		
Mechanical tests				
Cantilever load test	R1	R1	R1	
Tension load test	R1			R1
Material property tests				
Hardness test	R1			
Dye penetration test	R1			
Water diffusion test	R1			
Accelerated weathering test	R1			
Tracking and erosion test (1000 hour salt fog)	R1*			
Flammability test	R1			
Galvanising test			R2	
Other Tests				
Interface Integrity test	R3		R3	
Verification of dimensions		R1	R1	
Visual examination				R1

R1 = Required to AS 61109 [15]

R2 = Required to AS 2947.1 [5]

R3 = Required by Horizon Power in accordance with Section 9.10

*For all composite insulators the 1000 hour salt fog test shall be replaced with the ageing test under Annex B of AS IEC 62217 [18], using a duration of 5000 hours or accelerated ageing test.

F6 Tests For Insulator Fittings

Certificates and test results shall be provided showing successful tests carried out as shown in Table 10:

Table 10: Required Tests for Insulator Fittings

Test Type	Type	Sample	Routine
Mechanical strength test	R		
Verification of dimensions		R	
Tension test		R	R
Hardness test		R	
Electrical heat cycle test		R	
R = Required to AS 1154.1 [3]			

Dimensions are to be verified against drawings (supplied by either purchaser or vendor)

APPENDIX G CLAMP TOP LINE POST INSULATORS

Clamp top insulators shall comply with all sections of this specification applicable to Line Post Insulators, in particular:

3	Requirements
3.6.1.1	Line Post Insulators
3.6.1.2	Stud for MV line post insulators
3.8	Insulator Designations and Markings
3.8.4	Line Post Insulators
3.10.1	Ceramic Insulators (Pin, Shackle, Guy)
3.11	Dimensions
C1	Technical Schedules
C2.5	Technical schedules A and B for 33 kV Line Post insulators
Appendix F	Test Certificates
F5	Tests for Line Post Insulators

Composite Line Post Insulators shall comply with AS 61109 [15].

Only vertical and horizontal clamp tops in accordance with AS IEC 60720 [14], Figure 4 (Type R-EC) for vertical mounting, and Figure 5 (Type R-EH) for horizontal mounting, will be considered. Dimensions of the clamp top shall be in accordance with AS IEC 60720 [14], Figure 6.

Seats (clamp body) shall be ferrous and galvanised to AS/NZS 4680 [9].

Saddles (clamp top) shall be available in both ferrous and aluminium options. Ferrous parts shall be galvanised to AS/NZS 4680 [9].