

Specification – MV Capacitor Bank

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STAKEHOLDERS <i>The following positions shall be consulted if an update or review is required:</i>	
<i>Senior Manager Engineering & Project Services</i>	<i>Senior Manager - Asset Services</i>
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1. Scope

This Specification sets out the technical (electrical and mechanical) requirements for the performance, testing and supply of Medium Voltage (MV) shunt capacitor bank with reactors for the transmission system only. The *Equipment* can be outdoor with a fence enclosure or indoors within a concrete building or metal kiosk. It does not include capacitor bank protection schemes, current transformers or switchgear connections to the transmission system.

The *Equipment* shall comprise of:

- 1) three single-phase reactors to both limit inrush current (damping) and harmonic filtering;
- 2) an assembly of capacitor units arranged in parallel/series phase connected groups, with each phase on a separate mounting structure; arranged into two insulated double-star connections with unearthed neutral connections;
- 3) single-phase, neutral current transformer located between the star-point neutral connections for unbalance condition detection; and
- 4) support structures and/or *Enclosures*.

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

- 1) successful completion of the appropriate tests required by this specification by an independent and accredited test authority.
- 2) 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 shall 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.

Vendors must state any non-compliance with the specification in any tender submission and any alternative offers must be submitted in full and separately from any main offer.

2. Normative References

The following reference documents have been used to prepare this standard:

2.1 Standards

2.1.1 Horizon Power Standards

- [1]. *Horizon Power Environmental Conditions*, standard number HPC-9EJ-01-0001-2013, available at <http://www.horizonpower.com.au/contractors-suppliers/contractors/manuals-and-standards/> under the 'Standards' heading.
- [2]. *Technical Rules*, standard number HPC-9DJ-01-0001-2012, available at <http://www.horizonpower.com.au/contractors-suppliers/contractors/manuals-and-standards/> under the 'Technical Rules' heading.

2.1.2 Australian Standards

The following standards are available at <http://www.i2.saiglobal.com>.

- [3]. AS 1627.0: 1997 (R2017), Metal finishing – Preparation and pre-treatment of surfaces – Method selection guide
- [4]. AS 2067: 2016, Substations and high voltage installations exceeding 1 kV
- [5]. AS/NZS 2312.1: 2014 (Amd 1: 2017), Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings – Part 1: Paint coatings
- [6]. AS 2700: 2011, Colour standards for general purposes
- [7]. AS 3600: 2018 (Sup 1: 2022, Amd 1: 2024), Concrete Structures
- [8]. AS 3610.1: 2018, Formwork for concrete Specifications
- [9]. AS 4100: 2020 (Amd 1: 2021), Steel structures
- [10]. AS/NZS 4680: 2025, Hot dip galvanised (zinc) coatings on fabricated ferrous articles
- [11]. AS 60071.1: 2024, Insulation co-ordination - Part 1: Definitions, principles and rules
- [12]. AS/NZS 60076.1: 2014, Power Transformers – Part 1: General
- [13]. AS/NZS 60076.6: 2013, Power Transformers – Part 6: Reactors
- [14]. AS/NZS 60076.10: 2023, Power Transformers – Part 10: Determination of sound levels
- [15]. AS/NZS 60137: 2020, Insulated bushings for alternating voltages above 1000V
- [16]. AS/NZS 60529: 2025, Degrees of protection provided by enclosures (IP Code)
- [17]. AS/NZS 61439.1: 2016, Low-voltage switchgear and controlgear assemblies
- [18]. AS 61869.1: 2024, Instrument transformers – Part 1: General rules

- [19]. AS 61869.2: 2021, *Instrument transformers – Part 2: Additional requirements for current transformers*
- [20]. AS 62271.301: 2022, *High voltage switchgear and control gear – Dimensional standardisation of terminals*

2.1.3 Other Standards

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

- [21]. IEC 60168: 1994 (Amd 1: 1997, Amd 2: 2000 CSV), *Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000V*
- [22]. IEC 60273: 1990, *Characteristic of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V*
- [23]. IEC 60871.1: 2014 *Shunt capacitor for a.c. power systems having a rated voltage above 1000V – Part 1: General*
- [24]. IEC 60871.4: 2014 *Shunt capacitor for a.c. power systems having a rated voltage above 1000V – Part 4: Internal fuses*
- [25]. IEEE 1036: 2020, *Guide for the Application of Shunt Power Capacitors*

2.1.4 Compliance with Standards

If the *Equipment* or any supporting or accompanying infrastructure required for the function of the *Equipment* offered is found on inspection not to conform to this Specification or the relevant standard, the *Equipment* shall be replaced by the Vendor at no cost to Horizon Power.

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://i2.saiglobal.com>.

2.1.5 Definitions and Abbreviations

For the purposes of this specification, definitions shall apply as in the relevant Australian Standards (AS 60076.6 [13], IEC 60871.1 [23] and IEC 60871.4 [24]) with the addition of a few general definitions listed below in alphabetical order.

Enclosure: Cabinet/kiosk, wire mesh fence. Both outdoor and indoor installation will have doors accessed by means of a secure interlocking system.

Equipment: Medium Voltage shunt Capacitor Bank, fittings, steel structure array, shunt reactor.

Snubber: semiconductor device used during switching transitions.

ZORC: high frequency transient overvoltage surge suppressor.

The *Equipment* covered in this Specification is outdoor three phase, star-star, ungrounded, shunt capacitor banks with series reactors, neutral unbalance sensing current transformers, support structures, *Enclosure* and spare capacitors units (cans).

3. **Equipment Requirements**

The *Equipment*, materials and components shall adhere to the design requirements as described in AS 60076.6 [13] and IEC 60871.1 [23] along with any other relevant Australian and/or international standard. The considerations provided may be subjected to change depending on the location and functional use of the *Equipment*, which will be dependent on a case-to-case basis.

The *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.

3.1 **Design Considerations**

3.1.1 **General Requirements**

The *Equipment* must be designed to:

- 1) permit operational earthing to be applied effectively without compromising safe work clearances and to allow effective capacitor discharge;
- 2) enable maintenance of the capacitor bank, including protection and control systems to be performed safely and efficiently;
- 3) allow filters and ventilation grills to be inspected, cleaned and replaced without the need for isolating and earthing;
- 4) demonstrate the incorporation of modern designs;
- 5) work in parallel with one or more existing or future capacitor banks in close electrical proximity;
- 6) interface with existing dc supplies, SCADA, mimic, alarm annunciator;
- 7) ensure heating and ventilation is provided to ensure a capacitor bank can operate at rated capacity within rated temperature limits, and
- 8) ensure position indicators, pressure monitors and rating plates are visible from ground level.

3.1.2 Environmental Requirements

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

The equipment offered shall create less than 55 dBA of sound pressure level at a distance of 2 m. Noise levels shall comply with AS 60076.10 [14].

The design and manufacturing process must confirm that the performance characteristics of the *Equipment* is not affected by changes in the ambient conditions, such as temperature or humidity, and meet forces presented during fault and environmental conditions.

The vendor shall submit the detailed design, materials used and manufacturing process of the Equipment.

3.1.3 Design Requirements

Capacitor banks must be designed such that:

- 1) individual capacitor units are appropriately sealed and finished to permit outdoor operation, exposed to both direct sunlight, pollution and wet weather conditions;
- 2) the impregnant fluid must be biodegradable and must not contain polychlorinated-biphenyl (PCB) or any derivatives;
- 3) capacitor units must utilise aluminium foil with folded edges and polypropylene di-electric film with a 'hazy' surface;
- 4) individual components and earthing system must be of robust construction and capable of withstanding the mechanical forces from thermal expansion and contraction;
- 5) the earthing system must be appropriately rated to withstand the specified minimum short-circuit withstand current rating for at least one second. Power cables, capacitor units and reactors must be appropriately rated to at least withstand the short-circuit currents that can be supplied by the existing high voltage system; and
- 6) capacitor units, conductors and fittings must have over-voltage, over-current and overload capabilities to withstand continuous operation at above rated voltage as per Section 19 and 20 of IEC 60871.1 [23].

3.1.4 Electrical Requirements

The *Equipment* shall be suitable for use on the 11 kV and 22 kV, 3-phase, 50 Hz transmission systems as per Table A13.2 of the *Technical Rules* [2].—Capacitor bank shall be sized on the estimated requirement provided in the Scope of Works and provided Load Flow and Stability studies for the transmission network.

The *Equipment* specified must be designed to:

- 1) provide VAR support to the medium voltage transmission system for the purpose of voltage regulation and power factor correction. The function for the *Equipment* may change depending on the location of implementation.
- 2) withstand back-to-back switching with other capacitor banks.

The *Equipment* must be suitable for operation under the defined environmental conditions and must meet the required electrical performance requirements as set out in the table below:

Table 1: Electrical Requirements

Description		11 kV	22 kV
System Particulars			
Number of phases		3	
Frequency	Hz	50	
Normal operating frequency excursion band	Hz	48.8 to 52	
Power system frequency	Hz	48.8 to 52	
Nominal voltage	kV	11	22
Highest voltage	kV	12	24
Power frequency withstand voltage	kV _{peak}	95	150
Power frequency withstand voltage	kV _{rms}	28	50
Switching overvoltage peak factor		2.0 pu	
Cap Bank Particulars			
Number of phases		3	
Rated voltage	kV	12	24
Rated reactive power @ nominal voltage	MVar	2.5	5
Minimum short-circuit	kA	25	25

Description		11 kV	22 kV
Minimum short-circuit time	s	3	3
Neutral point connection		Fully Insulated	
Capacitor Particulars			
Rated capacitance	μF	62.6	31.3
Tolerance on capacitance	%	± 5	
Capacitor fusing		internal	
Discharge resistors		internal	
Maximum dielectric losses	W/kVAr	0.2	
Duty cycle		continuous	
Reactor Particulars			
Number of phases		3 x single phase units	
Rated voltage	kV	12	24
Rated reactance	mH	8	16
Reactor inductance (at rated frequency and current) %		5	
Nominal tuning frequency	Hz	225	
Rated current	A	145	
Reactor function		damping and harmonic filtering	
Neutral Current Transformer Particulars			
Rated voltage	kV	24	24
Rated short-circuit current	kA	25	25
Rated short-circuit time	s	3	3
Rated dynamic current	kA	62.5	62.5

Description		11 kV	22 kV
Nominal secondary current	A	1	
Rated secondary continuous current	%	200	
Number of measurement cores		1	
Sec. measurement windings		Fixed	
Measurement core class and burden		0.2S/5 VA	
Measurement core security factor		5	

The capacitor units and associated components shall be suitable for continuous operation at an RMS current not exceeding 1.3 times the current which occurs at rated sinusoidal voltage and rated frequency. Due to the permissible tolerances and the combined effects of harmonics and supply system conditions, the maximum current may be 1.43* times I_N as per IEC 60871.1 [23].

NOTE: $1.43^* = 1.3 \times 1.1$

I_N = current derived from the rated power and rated voltage

If the *Equipment* requires surge arrestors, *snubbers* or *ZORCs* to be installed, then the details of the protection and their price must be included in the tender. If these devices are optional then their prices shall be listed separately.

3.1.5 Mechanical Requirements

The *Equipment* shall be suitable for installation within substation and:

- 1) Be installed in a conventional outdoor open rack style or in a pre-assembled modular package (excluding circuit breakers) to conserve onsite space or reduce site works. The design to consider the number of units, the arrangement of series and parallel paths, stacking of equipment and reactors. If an asymmetric design is the optimum, then the vendor may also offer an alternative symmetrical design arrangement.
- 2) For modular packages, cages or cubicles enclosing the capacitors, the capacitors and reactors shall be arranged to permit access for maintenance without the use of cranes or other heavy lifting equipment.
- 3) Consist of an assembly of capacitor units and reactors mounted with wiring completed as far as practicable before delivery, and all necessary clamps and connectors, bus work and wiring between the point of supply and the neutral, nuts and bolts and all other devices necessary to complete the bank ready for service.

- 4) Mounted to allow adequate dissipation by convection due to the heat produced by the radiation of capacitor losses. The ventilation of any enclosure and the arrangement of the capacitor units shall provide good air circulation around each unit. This is of importance for units mounted in rows above each other. Natural ventilation must be sufficient to prevent the internal air temperature rising significantly above ambient and internal condensation shall be prevented.
- 5) Permit the easy and safe replacement of failed capacitor units with minimal disassembly of the structure. This procedure shall be detailed in the *Equipment* manuals. The price, drawings and/or pictures of any recommended lifting aids shall be provided.
- 6) Designed to reduce the risk of birds (including ravens/crows) creating electrical faults. This may include bird caps, insulated cable, insulated busbar, bird deterrents, and increased distance between exposed conductors. A description of the bird protection shall be provided by the Vendor.
- 7) *Enclosures* will be adequately secured and earthed, preferably via two M16 stainless steel bolts. Clearances shall comply with AS 2067 [4].

Table 2: Mechanical Requirements

Description	Indoor	Outdoor
Cap Bank Particulars		
Neutral connection	double star	
Earthing arrangement	ungrounded	
Cooling	forced ventilation	air natural
Degree of protection	-	44
Maximum sound pressure level	20	46
Support structure	fully welded, mild steel fabricated to AS 4100 [9] protected to AS 1627 [3] or AS/NZS 2312.1 [5]	
Portable earth lead connection points	• one on each neutral star point • one on each phase between capacitor and reactor • one on each phase between reactor and termination	

Description	Indoor	Outdoor	
Capacitor Particulars			
Temperature range	D (Table 1 IEC 60871.1 [23])		
Minimum creepage distance	mm/kV	20	31
Bushings on capacitor	double, porcelain		
Capacitor unit (can) material	304 grade stainless steel, with leak-proof seams, welds and studs		
Surface treatment of unit (can)	Enamel paint N24 'silver grey' to AS 2700 [6]		
Lifting lugs	required		
Reactor Particulars			
Reactor core	iron	air	
Cooling method	forced air	natural air	
Lifting lugs	required		
Arrangement	side to side	side to side	
Support insulators	porcelain with anti-vibration mounts		
Neutral Current Transformer Particulars			
Mounting arrangement	free-standing	free-standing	
Construction type	block	post, bar	
Insulation medium	cast-resin	porcelain	
Degree of protection for enclosure of secondary terminal box	-	IP54	
Lifting lugs	not required		

The Vendor shall submit complete detail and drawings of the pedestal mounting assembly. Vendor is to provide adapter plates if the *Equipment's* base dimensions are different to required parameters.

3.1.6 Key Interlock System

The *Equipment* shall be protected from unauthorised access by means of a key interlock system. This system shall be installed on the access points (doors/gates) of concrete buildings, metal enclosures or fence enclosures and prevent access to the *Equipment* until at least 10 minutes after the *Equipment* was last in an energised state.

This key interlocking system may be either:

- 1) A Castell Key interlocking system.
- 2) Fortress Systems Type H31P locks.

Vendor to provide time limits for safe discharge of *Equipment*.

3.2 Capacitors

The Vendor shall specify the construction, manufacturing process and insulation oil (impregnant) for the type of capacitor unit offered and shall provide all other necessary information to enable Horizon Power to estimate the characteristics and reliability of the units offered.

3.2.1 Capacitor Bushings and Connections

Bushings for capacitors shall be subject to special agreement between the Horizon Power and Vendor, as stated in AS 60137 [15].

- 1) The units shall be fitted with two bushings for single phase. If three phase, three or four bushings shall be used for the purpose of making connections.
- 2) The bushing flange and other metal attachments shall be compatible with the material used in the containers. The Vendor shall supply sufficient information, supported by Australian and/or international standards, to show Horizon Power that the bushing chosen is suitable for the duty proposed.
- 3) Porcelain bushings and insulators shall be provided with physical protection from impact damage during transport and construction.
- 4) The creepage distance shall be determined using the principles from IEC 60871.1 [23].

3.2.2 Capacitor Units

Individual capacitor units must:

- 1) be appropriately sealed and finished to permit outdoor operation as well as exposure to both direct sunlight and wet weather conditions. The temperature of capacitors will be increased by radiation from the sun or from a high-temperature surface. Depending on the cooling-air temperature, the rate of the cooling and the intensity and duration of the radiation, it may be necessary to use one or more of the following remedies:
 - a) Protect capacitors from radiation.
 - b) Choose a capacitor design for a higher ambient temperature (refer to IEC 60871.1 [23]).
 - c) Employ capacitors with rated voltage higher than that resulting from section 27.2 of IEC 60871.1 [23].
 - d) Employ forced air cooling.
- 2) have impregnant fluid that is biodegradable and not contain any polychlorinated-biphenyl (PCB) or any of its derivatives;
- 3) utilise aluminium foil with folded edges and polypropylene di-electric film with a 'hazy' surface;
- 4) contain internal fuses and discharge devices.

The Vendor shall specify the number of elements and fuses in each unit, and also the arrangement of series and parallel paths.

3.2.3 Capacitor Fusing

- 1) External fusing is NOT acceptable. Self-healing and fuse-less types may be considered at the discretion of the Horizon Power representative.
- 2) Fuses used to protect the *Equipment* shall be designed and tested in accordance with IEC 60871.4 [24].
- 3) Full information on the degree of protection provided by fuses, fuse characteristic and details of fuse design shall be included in the proposal.

3.2.4 Capacitor Discharging Devices

The Vendor shall include in its proposal full details of the discharge devices offered. The discharge device shall comply with Section 21 of IEC 60871.1 [23].

3.3 Damping/Harmonic Filtering Reactor

The Vendor shall specify the construction, manufacturing process and insulation for the type of reactors offered and shall provide all other necessary information to enable Horizon Power to estimate the characteristics and reliability of the units offered.

3.3.1 Reactor Requirements

The Reactors shall:

- 1) Comply with AS/NZS 60076.6 [13] and any other relevant Australian and/or international standard.
- 2) Be installed in series with capacitors for the purpose of back-to-back switching, reducing the risk of harmonic resonance issues and reducing inrush currents.
- 3) Be able to filter and/or damp peak currents that may occur in all recognised cases of switching the associated capacitor and any nearby capacitors or due to system faults. The estimated number of switching operations per day and possible system faults shall be specified by the purchaser in the inquiry.
- 4) Be of dry-type air-core design and classified as:
 - Single phase or three phase
 - For outdoor installation
 - With each phase mounted side-by-side or in a vertical stack
 - With or without taps
- 5) Maintain the insulation between phases and to earth during conditions of the system in which the reactor is to be installed. The voltage level shall be chosen with regards to the voltage developed across the reactor when the short-circuit current of the maximum voltage developed during switching, discharge or continuous operation, whichever is greater.

3.3.2 Reactor Windings

- 1) The windings shall be adequately braced and supported to withstand the mechanical stresses due to short circuit currents, and the continuous stress of 50 Hz and 100 Hz vibrations on the insulation. The insulation levels of the reactor shall be in accordance with AS 60071.1 [11].
- 2) The reactor rating shall match or exceed the capacitor bank rating. This current may be 1.43 times I_N as per IEC 60871.1 [23].
- 3) Noise levels shall comply with AS 60076.10 [14].
- 4) The Vendor shall include in its proposal a full description of its winding manufacturing process, including details of the impregnating treatment and coil clamping methods.

3.3.3 Reactor Bushings

Reactor bushings shall comply to AS/NZS 60137 [15], special requirements and tests for transformer bushings.

3.3.4 Reactor Insulators

Support insulators shall comply to AS/NZS 60076.6 [13] and designed according to IEC 60273 [22] and tested according to IEC 60168 [21].

3.3.5 Reactor Earthing

Earthing of the reactors shall have the provision to attach two M16 stainless-steel bolts at separate location.

3.4 Neutral Unbalance Current Transformer

The Vendor shall specify the construction, manufacturing process and insulation for the type of neutral unbalance current transformer offered and shall provide all other necessary information to enable Horizon Power to estimate the characteristics and reliability of the unit offered.

- 1) The current transformer (CT) shall comply with AS 61869.1 [18] and AS 61869.2 [19], it shall be either out-door post-pedestal type or indoor block type having two cores of 1 amp secondary.
- 2) The CT shall be capable of withstanding the rated and peak momentary current as specified and maintain sufficient accuracy under all overload and short circuit conditions, ensuring proper protection relay operation, maintaining the discrimination as required.
- 3) The rated output of the CT shall be selected to match to the actual burden, taking into account all possible impedances, including the external cabling.
- 4) The selected CT ratio/s shall be applicable to the size of *Equipment* selected/offered and the Vendor shall provide a table detailing calculated currents due to either open circuit or short circuit faults in several capacitor elements. The table shall include the number of element failures up to those that produce approximately 1.1 Vpu stress on capacitor units and 2 Vpu stress on capacitor elements. The CT ratio should be selected so that these worst-case conditions should not produce more than 1 A in the CT secondary and should produce at least 100 mA for an ALARM setting.
- 5) The current transformer shall have thermal and mechanical ratings and insulation class not less than those of the associated equipment. Accuracy shall be as specified herein or as determined by the Vendor's design approved by Horizon Power.
- 6) Individual cores of the current transformer in the same enclosure shall be magnetically independent of each other.
- 7) A weatherproof CT terminal box shall have provision for sealing facilities with the terminals clearly marked. A suitably sized earthing stud shall be provided in the terminal box which shall be electrically connected to the main structural earthing of the CT.
- 8) Provisions shall be made whereby the current transformer may be removed with ease. Vendors shall give details of the methods to be used to mount the CT.
- 9) Earthing provision shall be made for attaching two M16 stainless-steel bolts.

3.5 Support Structures

Equipment support structures (racking) shall be designed to carry safely all the required capacitor units, conductors, insulators and other fittings. Allowance for additional loading during erection, equipment maintenance and access shall be made.

Where metal racking is used, all metal work fabricated to AS 4100 [9] and done to meet AS 1627 [3] having no burrs or sharp edges. All corrosion protection measures applied to the *Equipment* shall be

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detailed and submitted at the tendering stage. All ferrous nuts, bolts, washers and clamps used for any purpose other than for current carrying shall be hot dip galvanised.

Each rack shall be uniquely numbered in a secure and permanent manner and in a way that is readable from a point on the ground to which access is permitted with the bank energised.

Each rack shall be supplied with the position of each capacitor unit numbered in a permanent manner which shall be readable from a point on the ground, to which access is permitted with the bank energised.

Earthing provision shall be made for attaching two M16 stainless-steel bolts to each metal rack.

3.6 Enclosures

Enclosures shall be designed to provide limited access to the *Equipment*, see section 3.1.7. Enclosures may be manufactured from mild steel and galvanised in accordance with AS/NZS 4680 [10] or protected as per AS 1627 [3]. All corrosion protection measures applied to the *Enclosures* shall be detailed and submitted at the tendering stage.

All Cabinets, Cages or Containers shall meet IP44 as per AS 60529 [16]. Hinged doors shall be removable, and it shall be designed to prevent the accumulation of water and the entry of rodents, flying insects (wasps, bees) and birds.

Upper surfaces shall be shaped or sloped to prevent accumulation of water, whilst doors/gates shall be equipped with travel stops, which shall retain the door/gate in the open position.

All bolts shall have hexagon heads. Self-tapping screws, captive head nuts or cage nuts are not acceptable.

Note: Plastic or fibre-reinforced plastic materials used on *Enclosures*, or other applications where exposure to the elements is involved will be not accepted.

Earthing provision shall be made for attaching two M16 stainless-steel bolts to the *enclosure*.

3.7 Terminals

The *Equipment* shall be provided with suitable terminals to connect to the line and earth in concordance with AS 62271.301 [20].

Provision shall be made for attaching two M16 stainless-steel bolts for earthing.

3.8 Capacitor Bank Rating Plate

The *Equipment* shall be provided with a nameplate incorporating details in accordance with section 26 of IEC 60871.1 [23]. These details shall be stamped on laser etched stainless steel plate and attached to the capacitor support structures. The marking shall be clearly visible, permanent, weatherproof and corrosion proof.

- 1) Manufacturer name
- 2) Rated output (total output) (MVar)
- 3) Rated voltage (kV)
- 4) Rated insulation level and rated lightning impulse withstand voltage (kV)
- 5) Connection symbol
- 6) Minimum time required between disconnection and reclosure (s)
- 7) Time to discharge to 75 V (s)
- 8) Weight of complete capacitor bank
- 9) Reference to IEC 60871.1 (year).

3.8.1 Capacitor Unit Rating Plate

Each capacitor unit shall be provided with a nameplate incorporating details in accordance with clause 25.1 of IEC 60871.1 [23]. These details shall be stamped on laser etched stainless steel plate and attached to each cap. The details shall be clearly visible and preferably marked on the housing. The marking shall be permanent, weatherproof and corrosion proof.

The following minimum information shall be provided:

- 1) Manufacturer name.
- 2) Manufacturing year and manufacturer's identification number.
- 3) Rated output (kVAr) (for 3 phase units' total output shall be given – see Appendix D of IEC 60871.1 [23]).
- 4) Rated voltage (V or kV).
- 5) Rated frequency (Hz).
- 6) Temperature category.
- 7) Measured capacitance, corrected to 20°C (µF).
- 8) Discharge device, if internal, shall be described in words and the rated ohmic value stated. Capacitor units without an internal discharge device shall be clearly identified.
- 9) Time in minutes, for discharge to 50 V.
- 10) Rated insulation level (kV).
- 11) Connection symbol – all capacitor units, except for single phase having one capacitor only, shall have their connection indicated.
- 12) Internal Fuses, capacitor units shall be marked with words to indicate the presence of internal fuses.
- 13) Chemical or trade name of impregnant (this information may be stated on the warning plate.
- 14) Reference to IEC 60871.1 (year).

3.8.2 Reactor Rating Plate

Each reactor shall be provided with a nameplate incorporating details in accordance with clause 7.7 of AS/NZS 60076.6 [13]. These details shall be stamped on laser etched stainless steel plate and attached to either each reactor or reactor support structure. The details shall be clearly visible and preferably marked on the supporting structure. The marking shall be permanent, weatherproof and corrosion proof.

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The following minimum information shall be provided:

- 1) Reactor type and arrangement.
- 2) Outdoor/indoor application.
- 3) Manufactures name.
- 4) Manufacturing year and manufacturer's identification number.
- 5) Rated insulation level (kV).
- 6) Number of phases.
- 7) Rated reactive power.
- 8) Rated frequency (Hz).
- 9) Rated voltage (V or kV).
- 10) Rated current (A).
- 11) Maximum operating voltage (kV).
- 12) Inductance at rated voltage (H).
- 13) Thermal class of insulation.
- 14) Total mass (kg).
- 15) Reference to AS/NZS 60076.6 (year).

3.9 Labels

- 1) Warning labels are to be traffolyte, with black text on yellow background.
- 2) Danger labels are to be traffolyte, with black text on red background.
- 3) Device number labels are to be traffolyte, with black text on white background.

3.10 Spare Capacitors

The spare capacitor units (cans) that are supplied to this specification are to be identical to those units in each of the capacitor banks. If possible, the same units should be used for several items to minimise the number of different types of spare capacitor units required for maintenance.

The spare capacitors shall be capable of being stored without deterioration within the temperature range of -10 °C to +55 °C for no less than 24 months.

Spare capacitor cans shall be packaged for long term storage > 5 years.

4. 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:

- 1) Management of waste reduction;
- 2) The use of re-usable packing; and
- 3) Extended producer responsibility for the safe disposal of materials at the end of their life.

5. Test Requirements

The Vendor shall prior to first delivery, complete the design, type, routine and special tests and inspections as required by the relevant Australian or IEC standard.

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

5.1 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 tests required by the relevant Australian or International standards shall be carried out. Test certificates shall be submitted in electronic format and shall be in Adobe Acrobat (.pdf) format.

5.2 Type Tests

The tests are intended to verify the main characteristics and suitability of the design, dimensions, materials, and method of manufacture (technology).

Certified type test results shall be submitted with the Proposal, the Vendor shall, in their evaluation submission, state which tests the *Equipment* have passed.

Table 3: Type Tests

Description	Standard
Capacitor Units	IEC 60871.1 [23]
Thermal stability	Clause 13
Measurement tangent of the loss angle ($\tan \delta$)	Clause 14
Voltage test (a.c.)	Clause 15.1

Description	Standard
Lightning impulse test	Clause 15.2
Overvoltage test	Clause 16
Short-circuit discharge test	Clause 17
	IEC 60871.4 [24]
Disconnecting test on internal fuses	Clause 5.3
Reactors	AS/NZS 60076.6 [13]
Measurement of inductance	Clause 9.10.5
Measurement of loss and quality factor	Clause 9.10.6
Temperature rise test	Clause 9.10.8
Lightning impulse test	Clause 9.10.9
Neutral Current Transformer	AS 61869.2 [19]
Temperature-rise test	Clause 7.2.2
Impulse voltage withstand test on primary terminals	Clause 7.2.3
Wet test for outdoor type transformers	Clause 7.2.4
Electromagnetic compatibility	Clause 7.2.5
Tests for accuracy	Clause 7.2.6
Verification of the degree of protection by enclosure	Clause 7.2.7
Enclosure tightness test at ambient temperature	Clause 7.2.8
Pressure test for enclosure	Clause 7.2.9
Short-time current tests	Clause 7.2.201

5.3 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 capacitor unit, reactor and current transformer should not consist of visual examination only.

The Vendor shall supply duly certified copies of the routine tests performed on the capacitor units and reactors to Horizon Power, either prior to or upon delivery.

Table 4: Routine Tests

Description	Standard
Capacitor Units	IEC 60871.1 [23]
Capacitance measurement	Clause 7
Measurement of tangent of the loss angle ($\tan \delta$)	Clause 8
Voltage test between terminals	Clause 9
AC voltage test between terminals and container	Clause 10
Test of internal discharge device	Clause 11
Sealing test	Clause 12
	IEC 60871.4 [24]
Discharger test on internal fuses	Clause 5.1.2
Reactors	AS/NZS 60076.1 [12]
Measurement of winding resistance	Clause 10.2.2
	AS/NZS 60076.6 [13]
Measurement of inductance	Clause 9.10.5
Measurement of loss and quality factor	Clause 9.10.6
Winding overvoltage test	Clause 9.10.7
Neutral Current Transformer	AS 61869.2 [19]

Description	Standard
Power-frequency voltage withstand test on primary terminals	Clause 7.3.1
Partial discharge measurement	Clause 7.3.2
Power-frequency voltage withstand test between sections	Clause 7.3.3
Power-frequency voltage withstand test on secondary terminals	Clause 7.3.4
Tests for accuracy	Clause 7.3.5
Verification of markings	Clause 7.3.6
Enclosure tightness test at ambient temperature	Clause 7.3.7
Pressure test for enclosure	Clause 7.3.8
Determination of the secondary winding resistance	Clause 7.3.201
Determination of the secondary loop-time constant	Clause 7.3.202
Test for rated knee point e.m.f. and exciting current at E_k	Clause 7.3.203
Inter-turn overvoltage test	Clause 7.3.204

5.4 Special Tests

The Vendor shall supply duly certified copies of the special tests performed on the capacitor units and reactors to Horizon Power, either prior to or upon delivery.

Table 5: Special Tests

Description	Standard
Reactors	AS/NZS 60076.6 [13]
Short-circuit current test	Clause 9.10.10
Measurement of acoustic sound level	Clause 9.10.11
Separate source A.C withstand voltage test	Clause 9.10.12
Inrush current withstand test for filter and damping reactor	Clause 9.10.13

Description	Standard
Discharge current test for discharge reactors	Clause 9.10.14
Modified short-circuit/discharge current test for discharge reactors	Clause 9.10.15
Mechanical resonance test	Clause 9.10.16
Neutral Current Transformer	AS 61869.2 [19]
Measurement of capacitance and dielectric dissipation factor	Clause 7.4.3
Internal arc fault test	Clause 7.4.6

6. Packaging Requirements

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) Equipment description (voltage rating);
- 7) Package weight.

The Spare Capacitors shall be suitably packaged, such that it is "fit for use" at any location in Horizon Power's operational area and specifically include all accessories needed. Very strong consideration shall be given to appropriate packaging provided with any Spare Capacitors offered under this specification, with respects to satisfying the "fit for use" criteria mentioned above.

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

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. Documentation

8.1 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:

- 1) Any non-compliance of the Specification shall be detailed in the Technical Deviation schedule;
- 2) All information provided in Technical Requirements shall be in English and measurement units shall be in metric units;
- 3) Material Safety Data Sheets;
- 4) CAD drawings (Micro station preferred DGN format) of all equipment showing all critical dimensions;
- 5) Cap replacement and balancing procedures;
- 6) 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
- 7) 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*.

8.2 Service History

Vendors shall state:

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

8.3 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:

- 1) Handling and storage;
- 2) Application (particularly in areas of heavy coastal pollution);
- 3) Installation;
- 4) Maintenance;
- 5) Environmental performance;
- 6) Electrical performance;
- 7) Mechanical performance;
- 8) Disposal at the end of service life; and
- 9) Production process and testing.

APPENDIX A – Revision Information

(Informative) Horizon Power has endeavoured to provide standards of the highest quality and would appreciate notification if any errors are found or even any queries raised.

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

The following comment sheet **DM# 48755459** can be used to record any errors or queries found in or pertaining to this standard, which will then be addressed whenever the standard is reviewed.

Date	Rev No.	Notes
05/11/2025	0	Original Issue

APPENDIX B – Technical Deviation Schedule

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.

CLAUSE NUMBER		YES	NO	ATT.
3.	Equipment Requirements			
3.1	Design Considerations			
3.1.1	General Requirements	☐	☐	
3.1.2	Environmental Requirements	☐	☐	
3.1.3	Design Requirements	☐	☐	
3.1.4	Electrical Requirements	☐	☐	
3.1.5	Mechanical Requirements	☐	☐	
3.1.6	Key Interlock System	☐	☐	
3.2	Capacitor			
3.2.1	Capacitor Bushings and Connections	☐	☐	
3.2.2	Capacitor Units	☐	☐	
3.2.3	Capacitor Fusing	☐	☐	
3.2.4	Capacitor Discharging Devices	☐	☐	
3.3	Damping/Harmonic Filtering Reactor			
3.3.1	Reactor Requirements	☐	☐	
3.3.2	Reactor Windings	☐	☐	
3.3.3	Reactor Bushings	☐	☐	
3.3.4	Reactor Insulators	☐	☐	
3.3.5	Reactor Earthing	☐	☐	
3.4	Neutral Unbalance Current Transformer	☐	☐	
3.5	Support Structures	☐	☐	
3.6	Enclosures	☐	☐	
3.7	Terminals	☐	☐	
3.8	Capacitor Bank Rating Plate	☐	☐	

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CLAUSE NUMBER		YES	NO	ATT.
3.8.1	Capacitor Unit Rating Plate	☐	☐	
3.8.2	Reactor Rating Plate	☐	☐	
3.9	Labels	☐	☐	
3.10	Spare Capacitors	☐	☐	
4	Environmental Considerations	☐	☐	
5	Test Requirements			
5.1	Test Certificates	☐	☐	
5.2	Type Tests	☐	☐	
5.3	Routine Tests	☐	☐	
5.4	Special Tests	☐	☐	
6	Packing Requirements	☐	☐	
7	Safety	☐	☐	
8	Documentation			
8.1	Documentation to be provided with Proposal	☐	☐	
8.2	Service History	☐	☐	
8.3	Training Materials	☐	☐	