Specification – HV Circuit Breakers

Standard Number: HPC-8DJ-25-0005-2023

Original Issue Date: 21st May 2024
Document Number: 44126690

Print Date: 21/05/2024

Document Control			
Author	**Name:** Paul Savig **Position:** Senior Standards & Plant Engineer		Digitally signed by Paul Savig Date: 2024.05.21 08:07:41 +08'00'
Reviewed By	**Name:** Kai Chong Jee **Position:** Senior Standards & Plant Engineer		
Endorsed By	**Name:** Johnathan Choi **Position:** Standards and Plant Manager		
Approved By *	**Name:** Victor Cheng **Position:** Senior Manager Engineering and Project Services		
Date Created/Last Updated	21 May 2024		
Review Frequency **	3 yearly		
Next Review Date **	21 May 2026		

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

*** Frequency period is dependent upon circumstances– maximum is 5 years from last issue, review, or revision whichever is the latest. If left blank, the default shall be 1 year unless otherwise specified.*

Revision Control		
Revision	**Date**	**Description**
0	21/05/2024	First issue

STAKEHOLDERS *The following positions shall be consulted if an update or review is required:*	
Manager Engineering & Project Services	Asset Managers
Manager Systems & Network Planning	Manager Assets Services
Senior Manager Safety, Health and Wellbeing	

TABLE OF CONTENTS

1 SCOPE

This Specification sets out the technical (electrical and mechanical) requirements for the performance, testing and supply of high voltage, circuit breakers for the transmission system only.

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

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

b) 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.

Tenderers 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

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]. *Technical Rules HPC-9DJ-01-0001-2012*, available at http://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.saiglobal.com.

[3]. *AS 1627.0, Metal finishing – Preparation and pre-treatment of surfaces – Method selection guide*, Standards Australia, 1997 (R2017)

[4]. *AS 2067, Substations and high voltage installations exceeding 1 kV a.c.*, Standards Australia, 2016

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

[6]. *AS/NZS 60137, Insulated bushings for alternating voltages above 1000 V*, Standards Australia, 2020

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

[8]. *AS/NZS 60529, Degrees of protection provided by enclosures (IP Code)*, Standards Australia, 2004

[9]. *AS/NZS 60947 Series, Low-voltage switchgear and controlgear*, Standards Australia*, 2021*

[10]. *AS 62271.1, High voltage switchgear and control gear – Common specification for alternating current switchgear and controlgear*, Standards Australia, 2019

[11]. *AS 62271.100, High voltage switchgear and control gear – Alternating current circuit-breakers*, Standards Australia, 2019

[12]. *AS 62271.110, High voltage switchgear and control gear – Inductive load switching*, Standards Australia, 2019

[13]. *AS 62271.301, High voltage switchgear and control gear – Dimensional standardisation of terminals*, Standards Australia, 2022

[14]. *SA TS 60815.1, Selection and dimensioning of high-voltage insulators intended for use in polluted conditions,* Standards Australia, 2020

2.1.3 International Standards

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

[15]. *IEC 60273, Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000 V,* International Electrotechnical Commission, 1990

[16]. *IEC 60376, Specification of technical grade sulphur hexafluoride (SF6) and complementary gases to be used in its mixtures for use in electrical equipment*, International Electrotechnical Commission, 2018

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

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 (AS 62271.1 [10] and AS 62271.100 [11]) with the addition of a few general definitions listed below in alphabetical order.

ARC: Auto re-closing, i.e. an open-close-open operation

C: Close – closing of circuit breaker primary contacts

***Equipment*:** High Voltage Circuit Breaker

O: Open – opening of circuit breaker primary contacts

SCADA: Supervisory Control and Data Acquisition

t: Time – set period given in seconds (s) or milliseconds (ms)

3 REQUIREMENTS

3.1 General

The *Equipment* specified in this instruction is to be used for power switching and protection applications, as well as for special purpose applications such as the restrike-free switching of (U_m) grounded shunt capacitor banks, shunt reactors and capacitor-reactor combinations duty. The circuit-breakers shall be capable of interrupting all currents from zero to the full symmetrical and asymmetrical rated fault currents at maximum system voltage (U_m) on system assets generally used in a transmission network.

Standard Horizon Power Circuit Breakers and descriptions are listed in Table 5 of Section 11.

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.

3.2 Environmental Conditions

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

3.3 Electrical Requirements

The *Equipment* shall be suitable for use on the 66 kV, 132 kV, 220 kV and 330 kV 3-phase 50 Hz effectively earthed transmission systems. The *Equipment* must be suitable for operation under the defined operating conditions and must meet the performance requirements in accordance with AS 2067 [4], AS IEC 60437 [7] AS 62271.1 [10], AS 62271.100 [11] and the Technical Rules HPC-9DJ-01-0001-2012 [2] *and* as set out in the table below:

Table 1: Electrical Requirements

Description		66 kV	132 kV	220 kV	330 kV
Maximum system voltage (U_m)	kV	72.5	145	245	362
Lightning impulse withstand	kV_{Peak}	325	650	1050	1175
Power frequency withstand (60 sec.)	$kV_{r.m.s.}$	140	275	460	520
Switching impulse withstand	kV_{Peak}	N/A	N/A	N/A	950
Rated short time withstand current	kAr.m.s.	≥25	≥40	≥40	≥50
Rated short time withstand time	s	3	1	1	1
Rated dynamic current	kA	62.5	100	100	125
Rated continuous thermal current	A	≥2500	≥3150	≥3150	≥3150
RIV level @ 1.1 $U_m/\sqrt{3}$	µV	N/A	≤2500	≤2500	≤2500
Control relays, operating coils (closing and tripping), motor and motor contactor coil. V_{DC}		110	110	110 or 220	110 or 220

3.3.1 Controlled Switching

Circuit-breakers may be required to perform controlled (point-on-wave) switching duties for shunt capacitor banks and shunt reactors, to be specified in Schedule A of Appendix C. The Vendor shall provide Horizon Power with all relevant details regarding the mechanical characteristics of the circuit-breaker which affect the mechanical operating time, e.g. influence of ambient temperature, substation DC control voltage, standing time, operating pressure, contact wear. The cause of deviations in operating times shall be indicated in all cases, e.g. arising in the operating coil/latch assembly, energy storage device.

The Vendor shall provide details of the circuit-breaker, dielectric characteristic as a function of time (closing) and as a function of SF_6, gas-filling pressure up to the maximum, rated, design pressure to be specified in Schedule B of Appendix C. This includes the upper and lower limits of the dielectric characteristic, which can be expected over the service life of the circuit-breaker.

- The critical arcing time window shall be indicated for re-ignition-free shunt-reactor switching.
- A tolerance of less than ± 1 ms shall be required for controlled closing of shunt capacitor banks as well as for controlled opening of shunt reactors.

The Vendor shall stat if there are special measures required to main operating times with the limits in their proposal.

3.3.1.1 Delayed, Current-Zero, Interrupting Capability

Interruption of short-circuit currents with a higher degree of asymmetry should be considered and shall be demonstrated by analysis and high-power test results, showing the influence of the arc voltage that will produce a current zero within the normal arcing time of the circuit breaker.

3.3.1.2 Shunt Capacitor-bank Switching

Circuit-breakers shall be switched restrike-free with maximum ratings of existing shunt capacitor banks typically:

- 8 MVAr at 132 kV
- 15 MVAr at 220 kV
- 30 MVAr at 330 kV

The shunt capacitor-bank circuit-breaker may be called upon to switch twice a day, in a single and/or back-to-back situation of the rating specified. The bank will be disconnected automatically upon operation of the unbalance, overvoltage or overcurrent protection systems.

The Vendor shall specify the maximum value and frequency of inrush and outrush current ratings for the circuit-breakers.

Horizon Power shall be informed about the limitations of the switching capabilities for the particular circuit-breaker design. All circuit-breakers supplied for the specified capacitor-bank switching duty shall be capable of capacitor switching duty and shall not require controlled opening and/or closing.

3.3.1.3 Shunt Reactor Switching

Circuit-breakers shall meet the performance requirements in accordance with AS 62271.110 [12] and must be capable of re-ignition-free switching with maximum ratings of existing (earthed) shunt reactors are typically:

- 4 MVAr to 8 MVAr at 132 kV.
- 8 MVAr to 15 MVAr at 220 kV.
- 15 MVAr to 30 MVAr at 330 kV.

3.3.2 Switching Surge Control (where applicable)

Switching surge control shall be by means of precise and repeatable operating characteristics (in conjunction with an electronic controller) and/or metal oxide arresters connected in parallel with the interrupting chamber(s).

Auxiliary devices in the main circuit (i.e. switching resistors or inductors for switching surge control) though not preferred will only be considered as an alternative.

3.4 Mechanical Requirements

The *Equipment* shall be suitable for outdoor use and mounted on galvanised steel structure meeting AS 1627 [3].

The technical performance of the *Equipment* must as a minimum meet AS 62271.1 [10] and AS 62271.100 [11].

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 (see Section 3.2 Environmental Conditions paying particular attention to the wind region category). The Vendor shall submit the detailed design, materials used and manufacturing process of the *Equipment* in the Proposal.

The *Equipment* shall be suitable for use under the following conditions as set out in the table below:

Table 2: Mechanical Requirements

Description		66 kV	132 kV	220 kV	330 kV
Bushing type		Porcelain/Polymer/Composite			
Primary terminal material		Aluminium			
Creepage (≥31 mm/kV)^2	mm	≥2232	≥4495	≥7595	≥11222
Marshalling Terminal box	IP	54	54	54	54

3.4.1 Bushings

Bushings shall be interchangeable with similar insulating components and shall comply with AS /NZS 60137 [6], IEC 60273 [15] and SA TS 60815.1 [14].

The bushings shall be provided with suitable terminals in accordance with AS 62271.301 [13]. The terminals shall be constructed of an aluminium flat palm number 9 with M22 holes.

All bolts, washers and clamps attached to current carrying parts shall be manufactured from stainless steel grade 304, and all nuts and spring washers shall be from stainless steel grade 316.

3.4.2 Beam and Supports

The *Equipment* shall be supplied fully assembled ready for mounting. The beam and support shall be have a minimum height of 2.55 m and manufactured from galvanised mild steel in accordance with AS/NZS 4680 [5], with metal work done to meet AS 1627 [3] having no burrs or sharp edges. All corrosion protection measures applied to the circuit-breakers shall be 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.

The Vendor shall submit complete detail and drawings of the beam and support mounting assembly.

3.5 Marshalling Terminal Box

Mechanism enclosures shall be manufactured from marine-grade (316) stainless steel and have hinged doors allowing clear access to control levers, push-buttons, fuses, switches and secondary terminal strips. These shall be easily accessible from ground level. Doors shall be equipped with travel stops, which shall retain the door in the open position.

Upper surfaces of enclosures shall be shaped or sloped to prevent accumulation of water.

Devices requiring adjustment/periodic maintenance shall be readily accessible and any removable covers provided shall have bolt fastenings subject to Horizon Power's approval.

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

A gauze-covered drain hole with a minimum diameter of 25 mm and having no internal rim or ledge that is likely to obstruct drainage shall be provided at the lowest point of the enclosure.

Gaskets shall be made of neoprene or heavy-duty foam-plastic. Felt or natural rubber gaskets are not acceptable.

Note: Plastic or fibre-reinforced plastic materials for mechanism enclosures, or other applications where exposure to the elements is involved will be not accepted.

3.5.1 Operation

3.5.1.1 Duty Cycle

The circuit-breaker shall be capable of three-pole tripping and auto-reclosing (ARC) a specified number of times, though there may be a requirement for single-pole auto-reclosing (this would be project specific). The phases shall operate together or independently, according to the type of auto-reclosing scheme.

1) Three-pole ARC:

   O - t - CO (all poles) where t = 300 ms.

   A total of one C (close) operation and two O (open) operations shall be stored without requiring the energy source within the mechanism to be recharged.

2) Single-pole ARC:

   O - (one pole) - t - C (one pole) O (all poles) - t'- C (all poles) O (all poles) where t = 300 ms.

   t' = required mechanism recharging time for a CO operation

Where independent pole mechanisms are provided, the circuit-breakers and their control circuits shall be suitable for single-pole auto-reclosing duty even though this may not be specified in Schedule A of Appendix C.

Note: The Vendor shall state the minimum resting time after a duty cycle is carried out under the most unfavourable conditions to ensure dependable interruption capability of the circuit-breaker within its rated characteristics.

3.5.1.2 Synchronism of Primary Contacts

All interrupters in a pole and in all three poles of the circuit-breaker shall operate simultaneously on opening and closing, including infrequent operation and under extreme temperature conditions.

Contact synchronism shall be retained within rated values during the expected maintenance intervals of the circuit-breakers. As an indication of the expected degree of synchronism, the following parameters are laid down:

1) Timing difference between contact separation for all poles of the circuit-breaker shall not exceed 3 ms.
2) Time spread between contact separation for interrupters in the same pole shall not exceed 1 ms.
3) Time interval between contact touch for all poles of the circuit-breaker shall not exceed 3 ms.
4) Time spread between contact touch for interrupters in the same pole shall not exceed 1 ms.

3.5.1.3 Rated Interrupting Times

These times shall be determined by conditions of lowest control voltage and, if applicable, the operating pressure of the mechanism. The maximum break time (i.e. summation of contact separation, arc quenching and mechanical resting time) shall not exceed the value specified in Schedule A of Appendix C.

3.5.2 Control and Operation Systems

The circuit breaker control and operation systems shall comply with AS/NZS 60947 [9] and AS 62271.1 [10].

3.5.2.1 Convention

As a matter of convention, the schematic-wiring diagram for the *Equipment* shall show limit switches, pressure switches, relay contacts and so forth are in the normal condition when:

- circuit-breaker primary contacts are open
- springs are discharged
- mechanism pressure is zero
- gas compartments are without pressure
- relay coils are de-energised
- no AC or DC supplies are connected

3.5.2.2 Secondary Systems

The secondary system consists of the following components, which relate directly to the circuit-breaker concerned:

1) Control and auxiliary circuits, including circuits in central control cubicles, mounted at or adjacent to the circuit-breaker.
2) Equipment for monitoring, diagnostics, and so on that form part of the circuit-breaker.

3) Any circuits that are connected to the secondary terminals of instrument transformers and that form part of the circuit-breaker installation.

3.5.2.3 Electromagnetic Induction

Induced electromagnetic disturbances in the secondary system of the circuit-breaker shall not cause spurious operation or damage. This applies both under normal operation and under switching conditions, including interruption of fault currents in the primary system.

3.5.2.4 Control Voltage

The control relays, operating coils (closing and tripping) and motor contactor coil shall be suitable for operation at 110 V_{DC} or 220 V_{DC} as specified in Schedule A of Appendix C. However, it shall be possible to change the control voltage at which the circuit-breaker operates by merely replacing the operating coils and motor contactors.

Control relays and operating coils (closing and tripping) shall not operate if a 10-µF capacitor, charged to 1,5 times the nominal DC control voltage, is discharged through the operating coil.

Coils electrically operated shall be suitable for operating at any DC voltage between 110% and 70% of the nominal control voltages measured at the device terminals.

3.5.2.5 Control Relays

All control relays shall be standard products that are freely available on the commercial market and shall be labelled in accordance with the schematic wiring diagram for the circuit-breaker.

3.5.3 Closing Devices

The circuit-breaker shall close correctly when an electrical closing pulse of 100 ms duration is applied to the closing coil. When closing all phases simultaneously, the total power drawn by the operating coils of the circuit-breaker shall not exceed 1,500 W (i.e. 500 W/pole).

Each closing coil shall be provided with a normally closed auxiliary contact in series, to allow closing only when the circuit-breaker is open. For spring-operated mechanisms, an additional normally open spring-drive limit switch in this circuit shall also be included to prevent damage to the closing coil if a sustained closing pulse is applied when the closing springs are not fully charged.

Closing coils shall be clearly marked with the operating voltage and actual resistance value at 20˚C.

3.5.3.1 Anti-pumping Relay

All circuit-breakers shall be equipped with anti-pumping circuitry, a normally closed timed switch, to prevent damage to the closing coil if a sustained closing pulse is applied manually or by the auto-reclosing relay.

Timer to range from 100 ms to 800 ms.

Anti-pumping arrangements shall be demonstrated as part of the routine and site-testing procedures.

3.5.4 Tripping Devices

When the circuit-breaker is not carrying current, satisfactory operation shall be possible at, but not lower than, 70% of the nominal supply voltage measured at the device terminals. The total power drain by the circuit-breaker opening coils (trip coils) of any one system when opening all phases simultaneously shall not exceed 1,500 W (i.e. 500 W/pole).

Normally open auxiliary contacts in series with the trip coils shall be provided to interrupt the operating current and prevent damage to trip coils if a tripping impulse is sustained.

Duplicate, normally open contacts in parallel for each trip coil shall be provided. However, each shall be electrically separate in order to facilitate fuse/protection circuitry associated with the independent control systems applied to either system. Neither trip coil shall influence the operation of the other if one is damaged.

Trip coils shall not have a particular polarity, nor shall they affect operation when energised simultaneously.

Each circuit-breaker shall be equipped with at least one electrical shunt-opening system for each mechanism. If specified in Schedule A, each circuit-breaker shall have an additional identical electrical shunt-opening system as a backup.

Trip coils shall be clearly marked with the operating voltage and actual resistance value at 20˚C.

3.5.5 Mechanism Motors

Mechanism motors shall be suitable for the control voltage of 110 V_{DC} or 220 V_{DC} as specified in Schedule A.

Contactors with thermal overload and single-phasing protection facilities shall control alternating current motors and be rated to break maximum current drawn by the motor. The contactor coils shall be able to have their current interrupted by the spring-rewind limit switches.

Motors shall be designed, rated and tested to AS 62271.1 [10] and for the operating voltage specified. The use of resistors to achieve voltage reduction from the control voltage is not acceptable.

The mechanisms shall be designed in such a way that in the case of failure to latch or of a command to trip during a closing operation, safe conditions are produced for the elements interrupting the circuit breaker.

3.5.5.1 Spring Rewind

Automatic rewinding of closing springs shall be provided by means of an interlock arranged via a normally closed spring-rewind limit switch contact, though at Horizon Power's discretion, a normally open auxiliary switch contact shall be included in the circuit to permit this operation only when the circuit-breaker is closed.

To allow local rewinding of springs when the circuit-breaker is open, a readily accessible push-button (coloured black) or spring return to "off" position switch (in parallel with the normally open auxiliary switch contact) shall be provided in each mechanism. Provision shall also be made in each mechanism for the remote rewinding of springs when the circuit-breaker is open.

A second set of normally closed spring drive limit switch contacts shall be provided in the motor circuit itself.

In addition to the spring-rewind limit switch contacts required for motor control, spare contacts of the type and quantity specified in Schedule A shall be provided. One of the normally open limit switch contacts may be used for sequential starting of spring-recharging motors in the other poles or circuit breakers. The rating of this contact shall be adequate for such duty. If the rating of this contact is not adequate, a control contactor that is under command of this contact shall be provided to achieve this capability.

Circuit-breakers equipped with independent phase-operating mechanisms and motor control contactors shall be provided with a 10 A, 800 V peak inverse voltage diode for each mechanism. This diode shall be mounted and wired to terminals.

3.5.5.2 Mechanism Lubricants

The behaviour of lubricants that are exposed to air, SF_6 gas and its arcing products shall be stable over the intervals between maintenance. The Vendor is required to identify the lubricants used and to submit details of tests carried out to prove suitability for the application.

3.5.5.3 Hydraulic-operating Mechanisms

Equipment with hydraulic-operating mechanisms or hydraulic-spring charging are **not accepted** for use in Horizon Power.

3.5.6 Manual Operation

3.5.6.1 Closing/Tripping

A means of manually tripping and closing the circuit breaker shall be provided, and the method used shall be explained clearly in the tender documents.

Appropriate warning labels shall be displayed to draw attention to the danger of performing manual operations without an adequate amount of insulating gas inside the gas compartments of the circuit-breaker.

3.5.6.2 Spring Charging

A means of manually charging the springs shall be provided, the operation thereof shall include internal limit switches preventing electrical charging.

3.5.6.3 Operational Switches

All local operation must be enabled through a “REMOTE-OFF-LOCAL” control selector switch which shall:

1) when switched to “LOCAL”, control from the local control switch must be enabled and remote close and open circuits must be disabled;
2) when switched to “REMOTE”, all external open and close circuits are enabled and all circuits to the local control switch must be disabled;
3) when switched to “OFF”, all local and remote open and close circuits must be disabled; and

4) position indication of control selector switch when in the “OFF” and “LOCAL” position must be capable of being provided to SCADA, with a normally closed (NC) contact.

3.5.7 Auxiliary Switches

Auxiliary switches shall faithfully reproduce the main contact position. In addition to the auxiliary contacts required for control interlocking, the number and type of auxiliary contacts required for each mechanism shall cover the requirement specified in Schedule A. These contacts shall be independent (i.e. not changeover contacts) and fixed. Auxiliary contacts shall reproduce main contact timing to acceptable limits approved by Horizon Power. If possible auxiliary contact timing shall permit adjustment within limits to be given by the Vendor.

All spare, auxiliary switch contacts shall be wired independently to the secondary terminals. The use of auxiliary relays to multiply the number of auxiliary contacts required is not acceptable. Auxiliary switch contacts shall be protected against ingress of dust particles. Cascading of auxiliary switches via mechanical means is acceptable provided that mechanical endurance testing has been satisfactorily carried out. Proof of this shall be submitted at the tendering stage.

3.5.8 Interlocks

3.5.8.1 Sulphur Hexafluoride (SF_6)

SF_6 gas-filled *Equipment* shall be provided with densimeters, which shall operate as follows:

- On reaching the non-urgent alarm or warning level – i.e. only gas replenishment is necessary
- On reaching the lockout level – i.e. circuit-breaker to be taken out of service

The contacts of these switches, on reaching these levels, shall operate relays, which in turn shall perform the following functions:

- **Non-urgent or warning alarm level:** One set of electrically separate, normally open and normally closed contacts shall be used for indicating this condition.
- **Lockout alarm level:** One set of electrically separate, normally open and normally closed contacts shall be provided. The normally closed contact shall be wired into all tripping and closing circuits to block operation, while the normally open contact shall be wired to terminals to indicate this condition. The use of pressure switches without temperature compensation for the initiation of these functions will not be permitted.

Note: It shall be possible to verify the correct operation of gas density/pressure switches in situ without having to disconnect wiring or having to perform gas-handling operations on the *Equipment*.

3.5.8.2 Spring-operating Mechanisms

A direct means to achieve the following functions shall be provided:

- Closing operations shall be possible only when the closing springs are fully charged

- Closing springs can only be released when the primary contacts are fully open
- A device shall be employed to block overcharging of the closing springs when the manual facility is employed

One spare, normally open and one spare, normally closed spring rewind limit switch of each mechanism shall be used to block an electrical release operation and to indicate this condition.

3.5.9 Indicating Devices

A mechanical indicating device shall be provided in each mechanism to indicate whether the circuit breaker is open or closed, and shall be clearly visible from outside the mechanism enclosure.

The following symbols shall be used:

- Circuit-breaker closed “I” in white lettering on a red background
- Circuit-breaker open “O” in white lettering on a green background

Lettering size shall be at least 30 mm.

The closing spring condition (charged or discharged) shall be indicated by a mechanical device, which is clearly visible from outside the mechanism enclosure. The words “spring charged” and “spring discharged” shall be displayed in black lettering on a white background. The lettering height shall be at least 15 mm.

Pressure gauges (compensated for temperature to reflect SF_6 gas density) shall be provided and shall be sheltered from the elements to provide a correct indication and prevent degradation of the device.

All indicating devices (e.g. open, close, SF_6 gas density) shall be clearly readable by a person with normal vision standing at ground level.

3.5.10 Operation Counters

Mechanical operation counters with a capability of counting up to 99,999 operations are preferred. Circuit-breakers with independent operating mechanisms shall be equipped with a counter for each pole. The circuit-breaker operation counter shall be non-resettable.

3.5.11 Anti-condensing Heaters

Suitably rated electric heaters shall prevent moisture from condensing and being deposited inside the mechanism enclosures. Heaters shall maintain a dewpoint greater than the ambient temperature and shall circulate the air constantly to all parts of the enclosure. Heaters shall be placed to avoid damage to temperature-sensitive components.

Heater elements shall be shrouded and leads, which are heated by the conduction of heat from the element, shall be insulated by heat-resistant insulating material, e.g. ceramic beads or silicone rubber.

The electrical supply for heaters will normally be single-phase 240 V_{AC}. The circuit shall have a normally open, auxiliary contact to indicate AC fail to the heater. The contact shall be on the heater side of the fuse/miniature circuit breaker. Where single heaters are provided, these shall be permanently connected.

Heater circuits shall not be equipped with local isolating switches, but with a local fuse-link and a solid link or miniature circuit breaker.

The total power drawn by heaters shall not exceed 400 W, unless otherwise approved.

3.5.12 Wiring, Terminations and Identification

Wiring for motor circuits shall be carried out in multi-stranded conductor with a minimum area equivalent to 2,5 mm^2 and insulated to withstand a test voltage of 2 kV to earth for one (1) minute.

Wiring for control circuits shall be carried out in wire of at least 1.5 mm^2 and shall be insulated to withstand a test voltage of 500 V to earth for one (1) minute.

Secondary wiring shall be identified at both ends in an approved manner (e.g. by ferruling), and shall present a neat appearance. It shall be braced, placed in plastic troughing, clipped and/or laced to prevent damage form vibration.

All secondary and equipment terminals, labels and so on shall be completely accessible after the wiring and cabling have been completed. Wiring to equipment located on swing doors or frames shall be arranged vertically over the hinge so that the wiring is twisted and not bent.

For all wires without lug terminations, the numbered ferrule may not fall off when disconnecting the wire. In this regard, the use of one or more strands of wire to retain the ferrule is not acceptable.

Where relays, miniature circuit breakers, fuses, lamps and so on are provided with the screw-down type of terminal (where the screw comes into direct contact with the conductor), crimping wire-pin terminations shall be used.

Secondary cabling provided by the Vendor shall be UV-resistant, termite-resistant, signal screened and preferably be run in the ground, in which case steel wire, armoured cable shall be used.

3.5.13 Secondary Terminals, Strips and Gland Plate

Secondary terminals to which cables will be terminated shall be of an approved type (spring loaded terminals) and shall be suitable for use with crimped or compression-type terminations.

Auxiliary switches, internal wiring and other equipment requiring connection to external apparatus shall be wired to terminal strips in the circuit-breaker mechanism box. Horizon Power's preferred arrangement of the internal wiring to the terminals can be found in Appendix F.

Each terminal strip shall be provided with not less than 10% spare terminals and shall have a minimum of two. The arrangement of the terminal strips (vertical orientation) in the equipment shall facilitate the entry of the incoming control cables in the bottom-entry configuration.

The cabling shall be multi-core, PVC-insulated, single-wire, armoured and PVC-sheathed. It shall be complete with compression-type glands, for which a removable, undrilled, brass or aluminium gland plate of the specified minimum size (i.e. 5 mm) shall be provided at the base of the enclosure and below the terminal strip.

To facilitate control, cable entry from below and connection, the distance between any part of the terminal strip and the gland plate shall not be less than 150 mm.

3.5.14 Door Lockable Latch

The *Equipment* shall be provided with suitable/lockable latch that will prevent unauthorised access to the local operating facilities within the marshalling terminal box. The latch must have a minimum 10 mm diameter hole for attaching a padlock.

3.6 Insulation Medium

The SF_6 gas to be used as an insulating and arc-extinguishing medium shall conform to the requirements of IEC 60376 [16]. The maximum SF_6 gas leakage rate for the complete equipment shall be stated at the tendering stage. This shall be stated for all the gas in the Equipment as well as for any individual gas compartment. Only DILO DN8 gas-filling connections shall be accepted.

3.6.1 Insulation Fittings

SF6 gas-filled circuit-breakers shall be provided with the following fittings:

1) A gas density or pressure manometer shall be installed (a gas density manometer is the preferred arrangement). SF_6 gas pressure shall be numerically expressed in kPa.
2) A common gas-filling/evacuating and gas density-monitoring point for the whole circuit-breaker is preferred for voltages up to 132 kV.
3) Pressure gauges shall be marked and calibrated in Pascal (SI units). Only gauge pressure shall be indicated and rated pressure shall be no more than 80% of the full-scale reading.
4) The gas density/pressure-monitoring device shall be suitable for outdoor application and resistant to operating vibrations, UV rays, outdoor elements (hail/snow) and being stepped on accidentally. It shall also give a positive and reliable response on reaching the operating values (i.e. no contact bounce).
5) Device actuation and de-actuation differentials shall be consistent over the ambient temperature range as specified in Schedule A of Appendix C.
6) Electrical connections to the density-monitoring devices shall preferably not be the plug-in type. However, density-monitoring devices with locking facilities will be accepted.
7) The gas density monitor cable connection shall be secured and protected from the elements in an approved manner.
8) Flanges designs shall be of suitable material to prevent corrosion, Vendor to provide details including drawings of the flange arrangements, treatments and service experience.
9) The insulator flange cementing shall be protected inside and out with an application of suitable polymeric material (i.e. RTV silicone sealant of appropriate quality).
10) Any pipework shall be made of copper and mounted in such a manner that it is mechanically protected.
11) The gas density monitor functionality shall be retained (i.e. non-return valves shall be fitted and so on) when the circuit-breaker is removed without the circuit-breaker being de-energised. The Vendor shall submit details on the arrangements suggested together with the tender documents.

12) Complete details of all gas-monitoring devices, including drawings, manufacturers specifications, performance and test data, details of production tests and a quality control programme, shall be included.

3.7 IP Rating

Circuit-breaker mechanisms, local control facilities and all parts requiring lubrication shall be protected by weatherproof enclosures. The degree of protection afforded by these enclosures shall, as a minimum requirement, comply with AS/NZS 60529 [8] according to the following classifications.

Enclosures containing exposed bearings, auxiliary switches, motors and other electrical devices shall comply with IP 55, whilst all other enclosures provided shall comply with IP 53.

3.8 Earthing Terminals

The main earth terminal shall comprise a stainless steel (grades 304 and 316) plate, welded to the beam. The plate shall be a minimum of 40 mm deep and shall be fitted with a stainless-steel bolt, washer and spring washer.

The stainless steel (304) bolt shall be a M16 x 35 mm bolt, threaded through.

The main earth terminal shall be located directly above one of the support legs.

A suitably rated connector (not copper) shall be provided between the plate and the support leg. (The beam and support structure shall provide continuity between the breaker and the holding down bolts.)

3.9 Corrosion Protection

Corrosion protection shall be in accordance with AS/NZS 4680 [5]. The mechanism box shall be manufactured from marine-grade (316) stainless-steel. The breaker beam may be manufactured from galvanised mild steel. For all SF_6 gas-filled circuit-breakers, the insulator flange cementing shall be protected inside and out with an application of suitable polymeric material (i.e. RTV silicone sealant of appropriate quality). All corrosion protection measures applied to the circuit-breakers shall be detailed and submitted at the tendering stage.

3.10 Name Plate

Equipment shall be provided with a nameplate incorporating details in accordance with clause 6.11.2 and table 9 of AS 62271.1 [10]. These details shall be stamped on laser etched stainless steel plate and attached to every circuit-breaker and each associated device. If the switchgear and controlgear consist of several independent poles, each pole shall be provided with a nameplate. All the letters and figures on the nameplates shall be permanently marked. The nameplates shall be securely fastened to the equipment in a reliable manner, in a position where a person with normal vision standing at ground level could easily read it. The marking shall be permanent, weatherproof and corrosion proof.

The following minimum information shall be provided:

1) Manufacturer's name or trademark, type, and identification.
2) Type designation and arrangement.
3) Serial number and year of manufacture.

4) Order number.
5) Rated voltage.
6) Rated lightning impulse withstand voltage.
7) Rated switching impulse withstand voltage.
8) Rated power-frequency withstand voltage.
9) Rated normal current.
10) Rated short-time withstand current and duration.
11) Rated peak withstand current.
12) Rated short-circuit making current.
13) Rated frequency.
14) Rated supply (auxiliary) voltage.
15) Rated gas pressure for operation, warning level and lockout level.
16) Rated density of gas for insulation.
17) Rated gas-filling mass in kilograms.
18) Contract number.
19) Standard to which tested (AS/NZS, IEC, BSI, etc.).
20) Rated operating cycle duty.
21) First pole-to-clear factor.
22) Maximum rated capacitive breaking current.
23) Maximum rated out of phase 50 Hz voltage across contacts.

Actual ratings to which the circuit-breaker has been type-tested (and not merely the values specified in Schedule A of Appendix C) shall be displayed.

3.11 Labels

All labels shall be English and shall be as follows:

1) Labels associated with local operation of the circuit-breaker:
   - Instructions for opening and closing the circuit-breaker. These instructions are “TO TRIP and “TO CLOSE” respectively.
   - Instructions for recharging closing springs. The instruction is “SPRING CHARGE”.
   - Additional information required to perform these functions shall be referred to Horizon Power.
2) Rating labels inside operating mechanism shall state at least the following:
   - Type designation
   - Trip-coil voltage, current, DC resistance (at 20 ˚C)
   - Close-coil voltage, current, DC resistance (at 20 ˚C)
   - Motor voltage and current (starting peak current and nominal running current)

- These shall be the nominal values (with tolerances) according to the routine test parameters.
- Rating labels shall be either engraved aluminium or stainless steel and are subject to approval by Horizon Power.

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 and specifically include all accessories needed. 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 reference number;
3) Horizon Power Order Number;
4) Horizon Power Stock Number (if applicable);
5) *Equipment* description (voltage rating); and
6) 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.

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:

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

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 details on Failure Mode and Effect Analysis, carried out in accordance with IEC 60812 [17]. 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.

Vendor shall provide disposal and recycling instructions for used SF_6 gas and eventual disposal of the whole circuit breaker.

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

a) Management of waste reduction;

b) The use of re-usable packing; and

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

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.

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.

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 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.

9.3 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, these type tests shall include those outlined in AS 62271.1 [10] and AS 62271.100 [11]. The Vendor shall, in their evaluation submission, state which tests the *Equipment* have passed.

Table 3: Type Tests

Description	Standard
	AS 62271-1 & -100 (Clause/s)
Dielectric tests	-1 (7.2)/-100 (6.2)
Radio interference voltage (RIV) tests	-1 (7.3) /-100 (6.3)
Resistance measurement test	-1 (7.4)
Temperature-rise tests	-100 (6.5)
Continuous current tests	-1 (7.5)
Short-time and peak withstand current tests	-1 (7.6) /-100 (6.6)
Verification of the degree of protection	-1 (7.7)
Tightness tests	-1 (7.8)
Electromagnetic compatibility (EMC) tests	-1 (7.9) /-100 (6.9)
Auxiliary and control circuit tests	-1 (7.10) /-100 (6.10)
X-radiation vacuum interrupter tests	-1 (7.11)
Mechanical and environmental tests	-100 (6.101)
Miscellaneous provisions for making & breaking tests	-100 (6.102)
Test circuits for short-circuit making & breaking tests	-100 (6.103)
Short-circuit making current	-100 (6.104)
Short-circuit test procedure	-100 (6.105)
Basic short-circuit test duties	-100 (6.106)

Description	Standard
Critical current tests	-100 (6.107)
Single phase and double-earth fault tests	-100 (6.108)
Short-line fault test	-100 (6.109)
Out-of-phase making and breaking tests	-100 (6.110)
Capacitive current switching tests	-100 (6.111)
Shunt reactor switching	AS 62271-110

9.4 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 *Equipment* and should not consist of visual examination only, these routine tests shall include those outlined in AS 62271.1 [10] and AS 62271.100 [11].

The Vendor shall supply duly certified copies of the routine tests performed on the *Equipment* to Horizon Power, either prior to or upon delivery.

Table 4: Routine Tests

Description	Standard
	AS 62271-1 & -100 (Clause/s)
Dielectric test on primary terminals	-1 (8.2)/ -100 (7.1)
Auxiliary and control circuit tests	-1 (8.3)
Resistance measurement test	-1 (8.4)
Tightness tests	-1 (8.5)
Design and visual checks	-1 (8.6) / -100 (7.1) “Manufacturer’s Standard”
Mechanical operating tests	-100 (7.101)

10 DOCUMENTATION

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 D;
- 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 Drawings

The Vendor shall submit complete details and drawings of the circuit breakers.

The schematic-wiring diagram for the *Equipment* shall show limit switches, pressure switches, relay contacts and so forth are in the normal condition when:

- Circuit-breaker primary contacts are open.
- Springs are discharged.
- Mechanism pressure is zero.
- Gas compartments are without pressure.
- Relay coils are de-energised.
- No AC or DC supplies are connected.

10.5 Maintenance Manual

The Vendor shall supply maintenance information in the form of maintenance manuals, field service bulletins and visual material covering the following aspects:

1) Extent and frequency of maintenance: For this purpose, the following factors shall be considered:
   - Switching operations (accumulated switching amperage).
   - Total number of operations.
   - Environmental conditions.
   - Measurement and diagnostic tests (if any).
2) Scope of work to be performed: It shall include the following:
   - Recommended place for the maintenance work (indoor, outdoor, in factory, on-site, etc.).
   - Procedures for inspection, diagnostic tests, examination overhaul.
   - Reference to drawings.
   - Reference to part numbers or standard kit of parts.
   - Tools required, including special equipment or tools.
   - Precautions to be observed (e.g. cleanliness and possible effects of harmful arcing by-products).
   - Lubrication procedures.
   - Cleaning materials.
3) Graphical information:

- Detailed drawings and sketches of the circuit-breaker components, with clear identification (part number and description) of assemblies, sub-assemblies and essential components.
- Expanded detail drawings, which indicate the relative position of components in assemblies and subassemblies, are expected as a preferred illustration method.
- Graphs and similar means of portraying important information shall also be included.

4) Specified operational values: Values and tolerances pertaining to which, when exceeded, make corrective action necessary, for example:
   - Pressure, density levels.
   - Switching resistor and grading capacitor.
   - Operating times and contact velocities.
   - Motion damping action.
   - Resistance of the main current carrying circuits.
   - Insulating liquid or gas characteristics.
   - Quantities and quality of liquid or gas.
   - Torque settings for fasteners.
   - Important dimensions.
5) Specifications for materials: This includes warnings of known non-compatibility of materials.
   - Oil.
   - Fluid.
   - Cleaning and degreasing agents.
6) Special tools, lifting and access equipment.
7) Tests after the maintenance work: All tests shall be clearly described and shall include the parameters to be observed.
8) Spare parts: Description, reference number, quantities and advice for storage.
9) Time estimates: Of active scheduled maintenance time.
10) Detailed information:
    - This relates to the recommended makes and types of transducers (linear or rotary) to facilitate the measurement of travel curves. Such transducers (as well as the brackets, fittings and so forth that are needed to apply them on the circuit-breaker) are part of the special maintenance tools for the circuit-breaker. The manual shall show clearly how the transducer, together with any brackets, fittings, etc, shall be mounted and applied on the circuit-breaker.
    - Mechanism heaters shall be working. If a thermostat is fitted ensure that the cut-out is set at approximately 25 °C.

10.6 Operational Instruction Manual

The operational instruction manual shall cover erection, assembly, operation and maintenance and shall fulfil the following specification:

1) It shall be specifically compiled for the circuit-breaker with which it has been supplied.
2) Torque wrench settings, clearances, settings and other important statistics shall be listed, e.g. the typical operating times, speed curves and tolerances in synchronism.
3) It shall give a clear description of the operation, and the diagrams and description shall be easily read together.
4) Routine minor and major maintenance procedures shall be given together with a list of lubricants, recommended spares and/or special tools and so on, required for these operations.
5) It shall contain high-quality diagrams showing details of operating components of the circuit breaker, which also identify and list separately each component making up the diagram.
6) Seals and gaskets requiring replacement during overhaul shall be detailed and the suppliers of these components, together with the stock number(s), shall be listed.
7) The names and addresses of supplies of lubricants, oils, gases, compounds and so on shall be listed.

11 *EQUIPMENT* LIST AND DESCRIPTION

Table 5: Standard *Equipment* list and descriptions

Specification Item No.	Description
1	CIRCUIT BREAKER 72kV 3 POLE, 2500A, 25kA/3sec HEAVY POLLUTION (31mm/kV)
2	CIRCUIT BREAKER 145kV 1 POLE, 3150A, 40kA/1sec HEAVY POLLUTION (31mm/kV)
3	CIRCUIT BREAKER 145kV 3 POLE, 3150A, 40kA/1sec HEAVY POLLUTION (31mm/kV)
4	CIRCUIT BREAKER 245kV 1 POLE, 3150A, 40kA/1sec HEAVY POLLUTION (31mm/kV)
5	CIRCUIT BREAKER 362kV 1 POLE, 3150A, 50kA/1sec HEAVY POLLUTION (31mm/kV)

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# 44131310** 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
21/05/2024	0	Initial Document Creation

APPENDIX B QUALITY ASSURANCE (TO BE COMPLETED BY STORES)

DOCUMENT NUMBER	HPC-8DJ-25-0005-2023		**QUALITY ASSURANCE**	**DM NUMBER**	
DEVICE DESCRIPTION	**LABEL MATERIAL NO.**		**HV CIRCUIT BREAKER 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	Horizon Power Order Number					*******		
1.4	Horizon Power Stock Number					*******		
1.5	Circuit Breaker description					*******		
1.6	Package Weight					*******		
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		
2.4	Accessories (if required)					As per Bill of Materials		

ITEM	OPERATION/EQUIPMENT/FACILITY	DOCUMENT REF.	WHO CHECKS	INITIAL	DATE/ TIME	QUALITY ASSURANCE CRITERIA	PASS Y/N	COMMENTS
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	Circuit Breaker/s in suitable packaging					Strong enough to prevent mechanical damage		
3.4	Packaging clearly labelled					Each package easily identifiable		
3.5	Items Individually Marked					Items clearly designated and marked		

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 below 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 D", provided in Appendix E 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 66 kV Circuit Breakers

HORIZON POWER	**SPECIFICATION ENQUIRY**	**HPC-8DJ-25-0005-2023**
	VENDOR'S NAME	
	DATE	

TECHNICAL SCHEDULES A & B

ITEM 1: 66 kV 3-Pole Circuit Breaker

SCHEDULE A: Horizon Power's specific requirements
SCHEDULE B: Particulars of *Equipment* to be supplied (to be completed by Vendor)

Item	Sub-clause	Description		Schedule A	Schedule B
1.1		Manufacturer/ Vendor of Circuit Breaker		xxxxxx	
1.2		Manufacturer's/ Vendor's catalogue number		xxxxxx	
1.3		Manufacturer's/ Vendor's drawing number		xxxxxx	
2		Circuit Breaker Type (3-Pole)		xxxxxx	
3.	3.3	Electrical Requirements			
3.1		Max. system voltage (U_m)	kV	72.5	
3.2		Lightning impulse withstand	kV_{Peak}	325	
3.4		Switching impulse withstand	kV_{Peak}	N/A	
3.3		Power frequency withstand (60 $_{sec.}$)	$kV_{r.m.s.}$	140	
3.4		System frequency	Hz	50	
3.5		Rated continuous thermal current	A	≥2500	
3.5		Rated short time withstand current	kA	25	
3.6		Rated short time withstand time	s	3	

Item	Sub-clause	Description		Schedule A	Schedule B
3.7		Rated breaking current	kA	62.5	
3.8		DC component	%	xxxxxx	
3.9		Rated making current	kA	xxxxxx	
3.10		First-pole-to-clear-factor		xxxxxx	
3.11		RIV level @ 1.1 $U_m/\sqrt{3}$	µV	N/A	
3.12		Shunt capacitor/reactor switching	MVAr	N/A	
4.	3.4	Mechanical Requirements			
4.1		Bushing type		Porcelain/ Polymer/ Composite	
4.2		Primary terminals			
		Material		Aluminium	
		Type		Flat Palm No9 M22	
4.3		Minimum creepage distance	mm	≥2232	
4.4		Beam/support height	mm	≥2550	
4.5		Weight	kg	xxxxxx	
5.	3.5	Operational Requirements			
5.1		Operating sequence		O-0.3s-CO-3min-CO	
5.2		Secondary control voltage	V_{DC}	110	
5.3		Spring rewind motor voltage	V_{DC}	110	
5.4		Temperature class	deg. ˚C	-5 to 55	
5.5		Marshall terminal box IP		55	

C2.2 Technical Schedules A and B for 132 kV Circuit Breakers

HORIZON POWER	**SPECIFICATION ENQUIRY**	**HPC-8DJ-25-0005-2022**
	VENDOR'S NAME	
	DATE	

TECHNICAL SCHEDULES A & B

ITEM 2: 132 kV 1-Pole Circuit Breaker

SCHEDULE A: Horizon Power's specific requirements
SCHEDULE B: Particulars of *Equipment* to be supplied (to be completed by Vendor)

Item	Sub-clause	Description		Schedule A	Schedule B
1.1		Manufacturer/ Vendor of Circuit Breaker		xxxxxx	
1.2		Manufacturer's/ Vendor's catalogue number		xxxxxx	
1.3		Manufacturer's/ Vendor's drawing number		xxxxxx	
2		Circuit Breaker Type (1-Pole)		xxxxxx	
3.	3.3	Electrical Requirements			
3.1		Max. system voltage (U_m)	kV	145	
3.2		Lightning impulse withstand	kV_{Peak}	650	
3.4		Switching impulse withstand	kV_{Peak}	N/A	
3.3		Power frequency withstand (60 $_{sec.}$)	$kV_{r.m.s.}$	275	
3.4		System frequency	Hz	50	
3.5		Rated continuous thermal current	A	≥3150	
3.5		Rated short time withstand current	kA	40	
3.6		Rated short time withstand time	s	1	
3.7		Rated breaking current	kA	40	
3.8		DC component	%	xxxxxx	
3.9		Rated making current	kA	xxxxxx	
3.10		First-pole-to-clear-factor		xxxxxx	
3.11		RIV level @ 1.1 $U_m/\sqrt{3}$	µV	≤2500	
3.12		Shunt capacitor/reactor switching	MVAr	8	
4.	3.4	Mechanical Requirements			
4.1		Bushing type		Porcelain/ Polymer/ Composite	

Item	Sub-clause	Description	Schedule A	Schedule B
4.2		Primary terminals		
		Material	Aluminium	
		Type	Flat Palm No9 M22	
4.3		Minimum creepage distance mm	≥4495	
4.4		Beam/support height mm	≥2550	
4.5		Weight kg	xxxxxx	
5.	3.5	Operational Requirements		
5.1		Operating sequence	O-0.3s-CO-3min-CO	
5.2		Secondary control voltage V_{DC}	110	
5.3		Spring rewind motor voltage V_{DC}	110	
5.4		Temperature class deg. ˚C	-5 to 55	
5.5		Marshall terminal box IP	55	

TECHNICAL SCHEDULES A & B
ITEM 3: 132 kV 3-Pole Circuit Breaker

SCHEDULE A: Horizon Power's specific requirements
SCHEDULE B: Particulars of *Equipment* to be supplied (to be completed by Vendor)

Item	Sub-clause	Description	Schedule A	Schedule B
1.1		Manufacturer/ Vendor of Circuit Breaker	xxxxxx	
1.2		Manufacturer's/ Vendor's catalogue number	xxxxxx	
1.3		Manufacturer's/ Vendor's drawing number	xxxxxx	
2		Circuit Breaker Type (3-Pole)	xxxxxx	
3.	3.3	Electrical Requirements		
3.1		Max. system voltage (U_m) kV	145	
3.2		Lightning impulse withstand kV_{Peak}	650	
3.4		Switching impulse withstand kV_{Peak}	N/A	
3.3		Power frequency withstand (60 $_{sec.}$) $kV_{r.m.s.}$	275	
3.4		System frequency Hz	50	

Item	Sub-clause	Description		Schedule A	Schedule B
3.5		Rated continuous thermal current	A	≥3150	
3.5		Rated short time withstand current	kA	40	
3.6		Rated short time withstand time	s	1	
3.7		Rated breaking current	kA	40	
3.8		DC component	%	xxxxxx	
3.9		Rated making current	kA	xxxxxx	
3.10		First-pole-to-clear-factor		xxxxxx	
3.11		RIV level @ 1.1 $U_m/\sqrt{3}$	µV	≤2500	
3.12		Shunt capacitor/reactor switching	MVAr	8	
4.	3.4	Mechanical Requirements			
4.1		Bushing type		Porcelain/ Polymer/ Composite	
4.2		Primary terminals			
		Material		Aluminium	
		Type		Flat Palm No9 M22	
4.3		Minimum creepage distance	mm	≥4495	
4.4		Beam/support height	mm	≥2550	
4.5		Weight	kg	xxxxxx	
5.	3.5	Operational Requirements			
5.1		Operating sequence		O-0.3s-CO-3min-CO	
5.2		Secondary control voltage	V_{DC}	110	
5.3		Spring rewind motor voltage	V_{DC}	110	
5.4		Temperature class	deg. ˚C	-5 to 55	
5.5		Marshall terminal box IP		55	

C2.3 Technical Schedules A and B for 220 kV Circuit Breakers

HORIZON POWER	**SPECIFICATION ENQUIRY**	**HPC-8DJ-25-0005-2022**
	VENDOR'S NAME	
	DATE	

TECHNICAL SCHEDULES A & B

ITEM 4: 220 kV 1-Pole Circuit Breaker

SCHEDULE A: Horizon Power's specific requirements
SCHEDULE B: Particulars of *Equipment* to be supplied (to be completed by Vendor)

Item	Sub-clause	Description		Schedule A	Schedule B
1.1		Manufacturer/ Vendor of Circuit Breaker		xxxxxx	
1.2		Manufacturer's/ Vendor's catalogue number		xxxxxx	
1.3		Manufacturer's/ Vendor's drawing number		xxxxxx	
2		Circuit Breaker Type (1-Pole)		xxxxxx	
3.	3.3	Electrical Requirements			
3.1		Max. system voltage (U_m)	kV	245	
3.2		Lightning impulse withstand	kV_{Peak}	1050	
3.4		Switching impulse withstand	kV_{Peak}	N/A	
3.3		Power frequency withstand (60 $_{sec.}$)	$kV_{r.m.s.}$	460	
3.4		System frequency	Hz	50	
3.5		Rated continuous thermal current	A	≥3150	
3.5		Rated short time withstand current	kA	40	
3.6		Rated short time withstand time	s	1	
3.7		Rated breaking current	kA	40	
3.8		DC component	%	xxxxxx	
3.9		Rated making current	kA	xxxxxx	
3.10		First-pole-to-clear-factor		xxxxxx	
3.11		RIV level @ 1.1 $U_m/\sqrt{3}$	µV	≤2500	
3.12		Shunt capacitor/reactor switching	MVAr	15	
4.	3.4	Mechanical Requirements			
4.1		Bushing type		Porcelain/ Polymer/ Composite	

Item	Sub-clause	Description	Schedule A	Schedule B
4.2		Primary terminals		
		Material	Aluminium	
		Type	Flat Palm No9 M22	
4.3		Minimum creepage distance mm	≥7595	
4.4		Beam/support height mm	≥2550	
4.5		Weight kg	xxxxxx	
5.	3.5	Operational Requirements		
5.1		Operating sequence	O-0.3s-CO-3min-CO	
5.2		Secondary control voltage V_{DC}	110/220	
5.3		Spring rewind motor voltage V_{DC}	110/220	
5.4		Temperature class deg. ˚C	-5 to 55	
5.5		Marshall terminal box IP	55	

C2.4 Technical Schedules A and B for 330 kV Circuit Breakers

HORIZON POWER	**SPECIFICATION ENQUIRY**	**HPC-8DJ-25-0005-2022**
	VENDOR'S NAME	
	DATE	

TECHNICAL SCHEDULES A & B

ITEM 5: 330 kV 1-Pole Circuit Breaker

SCHEDULE A: Horizon Power's specific requirements
SCHEDULE B: Particulars of *Equipment* to be supplied (to be completed by Vendor)

Item	Sub-clause	Description	Schedule A	Schedule B
1.1		Manufacturer/ Vendor of Circuit Breaker	xxxxxx	
1.2		Manufacturer's/ Vendor's catalogue number	xxxxxx	
1.3		Manufacturer's/ Vendor's drawing number	xxxxxx	
2		Circuit Breaker Type (1-Pole)	xxxxxx	
3.	3.3	Electrical Requirements		
3.1		Max. system voltage (U_m) kV	362	
3.2		Lightning impulse withstand kV_{Peak}	1175	

Item	Sub-clause	Description		Schedule A	Schedule B
3.4		Switching impulse withstand	kV_{Peak}	950	
3.3		Power frequency withstand (60 sec.)	$kV_{r.m.s.}$	520	
3.4		System frequency	Hz	50	
3.5		Rated continuous thermal current	A	≥3150	
3.5		Rated short time withstand current	kA	50	
3.6		Rated short time withstand time	s	1	
3.7		Rated breaking current	kA	50	
3.8		DC component	%	xxxxxx	
3.9		Rated making current	kA	xxxxxx	
3.10		First-pole-to-clear-factor		xxxxxx	
3.11		RIV level @ 1.1 $U_m/\sqrt{3}$	µV	≤2500	
3.12		Shunt capacitor/reactor switching	MVAr	30	
4.	3.4	Mechanical Requirements			
4.1		Bushing type		Porcelain/ Polymer/ Composite	
4.2		Primary terminals			
		Material		Aluminium	
		Type		Flat Palm No9 M22	
4.3		Minimum creepage distance	mm	≥11222	
4.4		Beam/support height	mm	≥2550	
4.5		Weight	kg	xxxxxx	
5.	3.5	Operational Requirements			
5.1		Operating sequence		O-0.3s-CO-3min-CO	
5.2		Secondary control voltage	V_{DC}	110/220	
5.3		Spring rewind motor voltage	V_{DC}	110/220	
5.4		Temperature class	deg. ˚C	-5 to 55	
5.5		Marshall terminal box IP		55	

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 Schedule D Appendix E.

CLAUSE NUMBER		YES	NO	ATT.
3	Requirements			
3.1	General	☐	☐	
3.2	Environmental Conditions	☐	☐	
3.3	Electrical Requirements			
3.3.1	*Controlled Switching*	☐	☐	
3.3.1.1	*Delayed, Current-Zero, Interrupting Capability*	☐	☐	
3.3.1.2	*Shunt Capacitor-bank Switching*	☐	☐	
3.3.1.3	*Shunt Reactor Switching*	☐	☐	
3.3.2	*Switching Surge Control (where applicable)*	☐	☐	
3.4	Mechanical Requirements			
3.4.1	*Bushings*	☐	☐	
3.4.2	*Beam and Supports*	☐	☐	
3.5	Marshalling Terminal Box	☐	☐	
3.5.1	*Operation*	☐	☐	
3.5.1.1	*Duty Cycle*	☐	☐	
3.5.1.2	*Synchronism of Primary Contacts*	☐	☐	
3.5.1.3	*Rated Interrupting Times*	☐	☐	
3.5.2	*Control and Operation Systems*	☐	☐	
3.5.2.1	*Convention*	☐	☐	
3.5.2.2	*Secondary Systems*	☐	☐	
3.5.2.3	*Electromagnetic Induction*	☐	☐	
3.5.2.4	*Control Voltage*	☐	☐	
3.5.2.5	*Control Relays*	☐	☐	
3.5.3	*Closing Devices*	☐	☐	
3.5.3.1	*Anti-pumping Relay*	☐	☐	
3.5.4	*Tripping Devices*	☐	☐	
3.5.5	*Mechanism Motors*	☐	☐	
3.5.5.1	*Spring Rewind*	☐	☐	
3.5.5.2	*Mechanism Lubricants*	☐	☐	

CLAUSE NUMBER		YES	NO	ATT.
3.5.5.3	*Hydraulic-operating Mechanisms*	☐	☐	
3.5.6	*Manual Operation*	☐	☐	
3.5.6.1	*Closing/Tripping*	☐	☐	
3.5.6.2	*Spring Charging*	☐	☐	
3.5.6.3	*Operational Switches*	☐	☐	
3.5.7	*Auxiliary Switches*	☐	☐	
3.5.8	*Interlocks*	☐	☐	
3.5.8.1	*Sulphur Hexafluoride (SF_6)*	☐	☐	
3.5.8.2	*Spring-operating Mechanisms*	☐	☐	
3.5.9	*Indicating Devices*	☐	☐	
3.5.10	*Operation Counters*	☐	☐	
3.5.11	*Anti-condensing Heaters*	☐	☐	
3.5.12	*Wiring, Terminations and Identification*	☐	☐	
3.5.13	*Secondary Terminals, Strips and Glang Plate*	☐	☐	
3.5.14	*Door Lockable Latch*	☐	☐	
3.6	Insulation Medium	☐	☐	
3.6.1	*Insulation Fittings*	☐	☐	
3.7	IP Rating	☐	☐	
3.8	Earthing Terminals	☐	☐	
3.9	Corrosion Protection	☐	☐	
3.10	Name Plate	☐	☐	
3.11	Labels	☐	☐	
4	Packaging Requirements	☐	☐	
5	Storage	☐	☐	
6	Reliability	☐	☐	
7	Safety	☐	☐	
8	Environmental Considerations	☐	☐	
9	Tests			
9.1	Test Requirements	☐	☐	
9.2	Test Certificates	☐	☐	
9.3	Type Tests	☐	☐	
9.4	Routine Tests	☐	☐	
10	Documentation			
10.1	Documentation to be provided with Proposals	☐	☐	

CLAUSE NUMBER		YES	NO	ATT.
10.2	Service History	☐	☐	
10.3	Training Materials	☐	☐	
10.4	Drawings	☐	☐	
10.5	Maintenance Manual	☐	☐	
10.6	Operational Instruction Manual	☐	☐	

APPENDIX E SCHEDULE D: DEPARTURES FROM TECHNICAL SPECIFICATION

The Vendor shall nominate the Clause and describe the departure:

CLAUSE NO.	DEPARTURE

APPENDIX F TERMINAL CONFIGURATION