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EP 01 00 00 04 SP & EP 01 00 00 05 SP

Specification

HV Outdoor Circuit Breakers and Post Type Current Transformers

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Revision	Effective date	Summary of changes
1.1	November 2012	Previous versions with designations EP 01 00 00 04 SP and EP 01 00 00 05 SP respectively.
1.0	15 August 2022	First issue with designation TS 03763. Version recommenced in line with new designation.

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Preface

This document is the first issue as TS 03763:1.0 and supersedes EP 01 00 00 04 SP *33 kV Outdoor Live Tank Circuit Breaker and Post Type CTs*, version 1.1 and EP 01 00 00 05 SP *33 kV Outdoor Dead Tank Circuit Breaker Assembly*, version 1.1.

This document provides requirements for the procurement of outdoor circuit breakers and post type current transformers (CT), rated for system voltages of 33 kV, 66 kV and 132 kV, for use in the TAHE's heavy rail electrical distribution network.

All information required to ensure that the circuit breaker or post type CT is electrically suitable for the TAHE electrical network is contained in this document or referenced by this document.

The changes from the previous content include the following:

- inclusion of requirements for 66 kV and 132 kV circuit breakers and post type CTs
- update to type approval, whole of life and integrated support requirements
- detailed requirements for protection panel
- added information and requirements for alternate insulating medium in circuit breakers to SF_6
- updated parameters and ratings in line with the current revision of AS 62271 and AS 61869 standards
- updated lightning impulse withstand voltage for 33 kV equipment to be in line with AS 62271, AS 61869 and T HR EL 21001 ST.

The terms 'normative' and 'informative' are used in asset standards to define the application of the appendices to which they apply. A 'normative' appendix is an integral part of an asset standard, whereas an 'informative' appendix is only for information and guidance.

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1 Scope

This document provides the specifications for type tested, outdoor, live tank and dead tank circuit breaker and post type current transformers (CTs) designed for installation on railway distribution systems operating at a nominal 33 kV ac, 66 kV ac and 132 kV ac three-phase, 50 Hz.

2 Application

This document is intended for the heavy rail network and requirements of this document apply to the purchase and installation of new outdoor circuit breakers (live or dead tank) and post type CTs. These requirements apply to new TAHE substations or when an existing circuit breaker or CT is replaced in an existing substation.

The requirements of this document are not applicable to existing HV outdoor circuit breakers and post type CTs currently in service in the TAHE electrical network.

If, when using this specification, it is considered that the intent of the stated requirements is not clear, a clarification should be sought (see the following note) from the Director Energy Networks and Systems – Asset Management Branch (AMB) – Safety Environment and Regulation.

Note: Contact the TfNSW AMB by email to standards@transport.nsw.gov.au

3 Referenced documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

International standards

IEC 60051 (all parts) *Direct acting indicating analogue electrical measuring instruments and their accessories*

IEC 60815 (all parts) *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions*

IEC 61850 (all parts) *Communication networks and systems for power utility automation*

Australian standards

AS 2067 *Substations and high voltage installations exceeding 1 kV a.c.*

AS/NZS 3000 *Electrical installations (known as the Australian/New Zealand Wiring Rules)*

AS 60529:2004 *Degrees of protection provided by enclosures (IP Code)*

AS 61869.1:2021 *Instrument Transformers – Part 1: General Requirements (IEC 61869-1:2007 (ED.1.0) MOD)*

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AS 61869.2:2021 *Instrument Transformers – Part 2: Additional Requirements for Current Transformers (IEC 61869-2:2012 (ED 1.0) MOD)*

AS 62271.1:2019 *High voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear (IEC 62271-1:2017, MOD)*

AS 62271.100 *High voltage switchgear and controlgear – Part 100: Alternating-current circuit-breakers (IEC 62271-100:2008+AMD1:2012+AMD2:2017 CSV (ED. 2.2)/COR1:2018, MOD)*

AS 62271.200 *High voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV (IEC 62271-200:2011/COR1:2015, MOD)*

AS 62271.203 *High voltage switchgear and controlgear – Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV*

AS 62271.301:2005 *High voltage switchgear and controlgear – Part 301: Dimensional standardization of terminals*

Transport for NSW standards

EP 00 00 00 13 SP *Electrical Power Equipment – Design Ranges of Ambient Conditions*

T HR EL 00002 PR *Electrical Power Equipment – Integrated Support Requirements*

T HR EL 03001 ST *Controls and Protection for 1500 V dc Rectification Equipment*

T HR EL 11004 ST *Electrical SCADA Interface Requirements*

T HR EL 19002 ST *Protection System Requirements for the High Voltage Network*

T HR EL 21001 ST *Lightning Protection and Insulation Coordination*

T MU AM 01001 ST *Life Cycle Costing*

T MU AM 01002 MA *Maintenance Requirements Analysis Manual*

T MU HF 00001 ST *Human Factors Integration – General Requirements*

T MU MD 00005 GU *Type Approval of Products*

T MU MD 00006 ST *Engineering Drawings and CAD Requirements*

TS 00011:1.0 *Common Requirements for Electric Power Equipment*

4 Terms, definitions and abbreviations

The following terms, definitions and abbreviations apply in this document:

ac alternating current

ACCB alternating current circuit breaker

AMB Asset Management Branch

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CT current transformer

dc direct current

dead tank circuit breaker a circuit breaker with interrupters in an earthed metal tank

ELV extra low voltage; a voltage not exceeding 50 V ac or 120 V ripple-free dc

emf electromotive force

HV high voltage, a voltage exceeding 1000 V ac or 1500 V dc

ICON infrastructure control

live tank circuit breaker a circuit breaker with interrupters in a tank insulated from earth

LV low voltage, a voltage exceeding 50 V ac or 120 V ripple-free dc but not exceeding 1000 V ac or 1500 V dc

RFT request for tender

rms. root-mean-square, refers to the most common mathematical method of defining the effective voltage or current of an ac wave

RTU remote terminal unit

SCADA supervisory control and data acquisition system

TAHE Transport Asset Holding Entity

TAO Technically Assured Organisation (formerly known as Authorised Engineering Organisation (AEO))

TfNSW Transport for New South Wales

5 TfNSW type approval

All 33 kV, 66 kV and 132 kV outdoor circuit breakers and post type CTs procured in accordance with this document require type approval by the TfNSW Asset Management Branch prior to being connected to the TAHE's electrical network.

The type approval process is contained in T MU MD 00005 GU.

6 Outdoor circuit breaker

Circuit breakers covered by this specification are outdoor, live or dead tank, rated for 33 kV, 66 kV and 132 kV high-voltage ac systems. The circuit breakers shall comply with AS 62271 and ratings in accordance with Table 1, Table 2 and Table 3 within this document.

Circuit breakers supplied under this specification shall be suitable for use in TAHE's electrical network comprising of both aerial lines and cables. The design and construction shall be in

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accordance with the technical requirements stated in this document. All materials shall be of a type and quality that will ensure reliability of the circuit breaker over its complete design life.

Each circuit breaker shall consist of three separate pole units mounted on a single piece frame. Pole units shall be mechanically interconnected. Support structures and any special tools required for operation or maintenance of the circuit breaker shall be provided.

This section provides the functional and detailed requirements for circuit breakers.

6.1 Functional requirements

The 33 kV, 66 kV and 132 kV outdoor circuit breakers shall provide for the following:

- connection of feeders, system transformer, rectifier transformers, harmonic filters or adjacent bus-sections to the 33 kV, 66 kV and 132 kV busbar
- isolation of feeders, system transformer, rectifier transformers, harmonic filters or bus-sections from the 33 kV, 66 kV and 132 kV busbar
- protection, local control, supervisory controlled and data acquisition (SCADA) control for HV feeders, system transformers, rectifier transformers, harmonic filters and bus-sections on the 33 kV, 66 kV and 132 kV busbar.

6.2 Detailed requirements and ratings

The 33 kV, 66 kV and 132 kV outdoor circuit breakers shall be designed and manufactured in accordance with the suite of applicable AS 62271 standards, in particular the following:

- AS 62271.1 *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear (IEC 62271-1:2017, MOD)*
- AS 62271.100 *High-voltage switchgear and controlgear – Part 100: Alternating-current circuit-breakers (IEC 62271-100:2008+AMD1:2012+AMD2:2017 CSV (ED. 2.2)/COR1:2018, MOD)*
- AS 62271.200 *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV (IEC 62271-200:2011/COR1:2015, MOD)*
- AS 62271.203 *High-voltage switchgear and control gear – Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV*.

Table 1 provides details of general requirements for 33 kV, 66 kV and 132 kV outdoor circuit breakers.

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Table 1 – Circuit breaker general requirements

Parameter	Designation
Circuit breaker type	Metal enclosed
Tank design	Live or dead
Class	Outdoor
Ingress protection (minimum)	IP54
Site pollution severity (SPS) class (minimum)	Medium – see Section 10.1
Type of system neutral earthing	Effectively earthed and non-effectively earthed (see Note 1)
Insulation medium	Pressurised gas – see Section 6.7
Ambient temperature range	In accordance with EP 00 00 00 13 SP (see Note 2)
Maximum altitude	1000 m (see Note 3)
Interrupting medium	SF_6, vacuum or alternative dielectric gas – see Section 6.7
Number of trip coils	Two independently operated coils
Number of close coils	One
Rated operating sequence	O – 0.3 s – CO – 3 min – CO

Note 1: TAHE's heavy rail network has both effectively earthed and non-effectively earthed systems.

Note 2: Where the circuit breaker does not meet the ambient temperature requirements of EP 00 00 00 13 SP, the applicable derating factors need to be provided by the manufacturer and assured by the Design TAO.

Note 3: Locations west of Penrith on the Blue Mountains line have a maximum altitude of 1200 m.

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The circuit breaker and interrupter shall comply with the ratings specified in Table 2.

Table 2 – Circuit breaker ratings

Parameter	Rating	Rating	Rating
Nominal Voltage	33 kV	66 kV	132 kV
Number of phases	3	3	3
Rated voltage (Ur) (minimum)	36 kV	72.5 kV	145 kV
Rated frequency (fr)	50 Hz	50 Hz	50 Hz
Rated continuous current (Ir)	≥800 A (see Note 1)	≥800 A (see Note 1)	≥800 A (see Note 1)
Rated lightning impulse withstand voltage (Up):			
Common value	170 kV (peak)	325 kV (peak)	650 kV (peak)
Across the isolating distance	195 kV (peak)	375 kV (peak)	750 kV (peak)
Rated short-duration power-frequency withstand voltage (Ud):			
Common value	70 kV (rms)	140 kV (rms)	275 kV (rms)
Across the isolating distance	80 kV (rms)	160 kV (rms)	315 kV (rms)
Rated short time withstand current (Ik)	≥25 kA (rms)	≥25 kA (rms)	≥25 kA (rms)
Rated duration of short-circuit (tk)	≥1 sec	≥1 sec	≥1 sec
Rated first-pole-to-clear factor (kpp)	1.5	1.5	1.5
Rated peak withstand current (Ip)	≥62.5 kA (peak)	≥62.5 kA (peak)	≥62.5 kA (peak)
Rated supply voltage of auxiliary and control circuits (Ua)	125 V dc (see Note 2)	125 V dc (see Note 2)	125 V dc (see Note 2)
Auxiliary supply voltage for heaters and lights.	240 V ac (see Note 3)	240 V ac (see Note 3)	240 V ac (see Note 3)

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Note 1: Rated continuous current shall be the higher of 800 A or the continuous current rating of the equipment that the circuit breaker is proposed to be connected to. This information shall be provided with the RFT in accordance with Appendix E.

Note 2: Standard supply voltage for auxiliary and control circuits used within TAHE's heavy rail network is 125 V dc as specified in Section 5.10 of TS 00011:1.0. There are certain existing locations where a 50 V dc supply voltage is used instead. This information shall be provided with the RFT in accordance with Appendix E.

Note 3: Standard auxiliary supply voltage for heaters and lights used within TAHE's heavy rail network is 240 V ac as specified in Section 5.10 of TS 00011:1.0. At existing locations where available supply differs from 240 V ac, information regarding available supply shall be provided with the RFT in accordance with Appendix E.

Circuit breaker class requirements shall be as specified in Table 3. For specific applications such as circuit breakers for harmonic filters, additional requirements shall be included in the RFT in accordance with Appendix E.

Table 3 – Circuit breaker designated class

Designation	Class
Electrical endurance class	E2
Mechanical endurance class	M2
System class	S2

6.3 Operating mechanism

The circuit breaker operating mechanism shall be an integral part of the circuit breaker.

Auxiliary switches shall provide indication of each position of the circuit breaker.

Any part of the circuit breaker mechanism that requires routine inspection and maintenance shall not be enclosed in any gas tight compartment.

Circuit breaker operating mechanism shall be of the stored energy type by means of energy stored in a motor-charged spring with manual and electrical release. The circuit breaker closing mechanism shall be electrically operated and trip-free.

Circuit breaker in the closed position shall be able to trip-close-trip before the spring needs to be charged again.

A provision for manually charging the spring type operating mechanism shall be supplied including any necessary operating accessories or tools.

The circuit breaker shall close without delay when the close command signal is applied. While this command signal is applied, the circuit breaker shall not make a second attempt to close if it fails to close on the first attempt or if it trips following the initial close. The circuit breaker shall

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only attempt closing once if the close signal remains energised. This shall be achieved through the use of an anti-pumping relay.

The circuit breaker shall open without delay when the open command signal is applied independently to any of the trip coils or to all trip coils simultaneously.

Continuously rated control equipment including operating coils shall be provided to ensure successful operation of circuit breaker is achieved independent of the length of time that the control switch is actuated.

Magnetic actuator type operating mechanisms will be considered, provided that full technical details of the proposed arrangement are supplied to TfNSW. Typical details shall include principle of operation, auxiliary power supply requirements, details on manual operation and how the requirement for duplicate trip coils is addressed.

6.4 Indications

The circuit breaker shall have indications clearly visible from the front of the low voltage panel. The method of indicating the position of the circuit breakers shall be in accordance with AS 62271.

Where the position is implemented by a mechanically operated indicator, it shall be indelibly marked, to show whether the circuit breaker is open or closed. The word OPEN shall be visible only if the circuit breaker is open. The word CLOSED shall be visible only if the circuit breaker is closed. An alternative would be to replace the word OPEN by ‘O’ and the word CLOSED by ‘I’. If colours are used in addition to words, then the colour green shall indicate the open condition and the colour red shall indicate the closed condition.

The circuit breaker’s low voltage panel shall have the following definite indications:

- circuit breaker open/closed
- stored energy device charged/discharged
- non-resettable operation counter (normally mechanical indicating the number of open operations)
- gas monitoring alarms (Level 1 and Level 2) for gas insulated circuit breaker/s.

6.5 Auxiliary contacts

A minimum of four spare normally open and a minimum of four spare normally closed voltage free auxiliary contacts of Class 1 in accordance with Section 6.4.3.4.5 of AS 62271.1-2019 shall be provided. These auxiliary contacts are required for the implementation of protection and control schemes.

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6.6 Padlocking

Facilities shall be provided to padlock the circuit breaker in the open position.

All padlocking facilities shall be suitable for padlocks with a 6 mm shank diameter.

6.7 Insulating medium

At the time of publication of this standard, industry is developing and trialling alternate insulating gases to SF_6.

TfNSW would prefer an alternative to SF_6 and procurement of outdoor circuit breakers to this specification requires the assessment of commercially available and proven equipment; both circuit breakers with insulating medium of SF_6 and circuit breakers with alternate insulating gasses.

The design TAO shall provide an assessment with detailed technical analysis and comparison between products and a detailed life cycle costing in accordance with T MU AM 01001 ST for each option. Life cycle costing for the circuit breaker shall include the disposal, management and environmental costs.

TfNSW as part of the type approval process will review and advise its preference in line with NSW Government and TfNSW policies at that time.

Where the insulating medium is SF_6, the supplier of the circuit breaker shall have a policy whereby they will accept responsibility for disposal of the SF_6 circuit breaker and any remaining SF_6 gas or by-products. The supplier shall also accept SF_6 gas, if evacuated during maintenance for the whole life of the circuit breaker. SF_6 management, environmental and disposal costs will be considered in the evaluation process.

6.8 Gas insulated circuit breakers

6.8.1 General

Gas insulated circuit breakers shall comply with the requirements of AS 62271 and of this section.

The circuit breaker shall be guaranteed to have a maximum leakage rate of 0.5% mass per year of the quantity of insulated gas used for filling over its lifetime. Means shall be provided to check the internal pressure of the units.

The gas tightness shall not deteriorate due to ageing or wear.

Certificates and details of tests for gas tightness carried out on circuit breakers shall be provided.

The manufacturer is required to demonstrate compliance with AS 62271 and in particular with requirements for degassing to conduct maintenance activities if needed.

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The design of the interrupting mechanism and contacts shall be such that the energy dissipated in the insulating gas is low and does not cause appreciable degradation of gas. Each pole shall be provided with a separate and independent set of main and arcing contacts to minimise degradation of main contacts during fault interruption. The arcing contacts shall be terminated by tungsten or similar tips. Arcing contacts shall be high electrical endurance. The main contacts shall be capable of carrying the rated short-time withstand current without damage.

Enclosures shall withstand normal and transient pressures in operation. Internal pressure built up due to arc fault shall be released with pressure relief devices.

6.8.2 Gas monitoring

6.8.2.1 General

Gas density monitoring devices shall be provided for gas insulated circuit breakers while in service. Gas density monitoring devices shall be temperature compensated, electrically isolated and independently adjustable.

This device shall provide indication of the minimum permissible pressure level for safe operation. The device shall provide two levels of alarms; Level 1 alarm and Level 2 alarm. The specific densities for Level 1 and Level 2 alarms shall be provided by the manufacturer.

A gas density gauge, indicating the gas density within the circuit breaker shall be provided in the low voltage panel; the gauge shall be clearly marked with both Level 1 and Level 2 densities.

The alarm contacts shall be voltage free and fail-safe (that is, closed when gas pressure levels are normal).

The blocking of the circuit breaker's operation (opening or closing) at gas densities below Level 1 and Level 2 thresholds is subject to manufacturer's recommendation.

6.8.2.2 Level 1 alarm

This level shall indicate a condition that the pressure of the insulating gas has dropped and the circuit breaker needs attention. A gas pressure alarm both locally at the respective circuit breaker's low voltage panel and remotely at ICON via the SCADA RTU shall be initiated.

6.8.2.3 Level 2 alarm

This level shall indicate that the pressure of the insulating gas has dropped to a level where the circuit breaker is not safe to operate. A second threshold gas pressure low alarm both locally at the respective circuit breaker's low voltage panel and remotely at ICON shall be initiated.

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6.8.3 Pressure relief device

Gas insulated circuit breaker shall be provided with a pressure relief device to limit the pressure of the insulating gas to a safe level in the event of an internal fault or a malfunction of the gas system.

All pressure relief devices shall be designed to vent the excessive pressure away from personnel operating the circuit breaker. Pressure relief devices shall be located away from gauges, meters, gas filling ports and gas density device calibrating points.

6.9 Vacuum circuit breakers

Vacuum circuit breakers utilise vacuum as the interrupting medium. Means shall be provided for testing the units for loss of vacuum without the necessity of removal of the units.

6.10 General equipment arrangement

The circuit breakers covered under this specification are installed in the outdoor switchyard of a substation. This section provides details on the operational arrangement as well as other requirements for the low voltage panel at the circuit breaker and the protection panel located within the substation building.

6.10.1 Operation and control

The outdoor circuit breaker can be operated either locally at the circuit breaker's low voltage panel or remotely via SCADA. Sydney Trains' standard operational practice is to operate the circuit breaker via SCADA.

Local control shall be provided at the circuit breaker primarily for local operation of each circuit breaker for maintenance and emergency switching.

Operation via SCADA shall not be valid when the Local/Remote switch at the circuit breaker is in the Local position.

Local operation shall not be valid when the Local/Remove switch at the circuit breaker is in the Remote position.

Refer to T HR EL 03001 ST for details of the control and protection requirements which are applicable to the rectifier control.

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6.10.2 Common requirements

The requirements in this section shall be common to both the circuit breaker's low voltage panel and the protection panel.

A set of terminals for the marshalling of all auxiliary wiring (such as protection, control, indication) shall be provided. Terminals shall be installed in a way that prevents against direct live contact.

All secondary fuse holders, including those used as links, shall be of the GE 'safeclip' type SC32/20 or similar. Fuse holders containing a fuse link shall be coloured black. Fuse holders containing a solid link shall be coloured white. Access to links and fuses shall be via the panel door. No panel shall require removal for access.

6.10.2.1 LV wiring

LV cabling and wiring shall be in accordance with TS 00011:1.0.

Terminal strips shall be provided for all wires leaving or entering the equipment. They shall be conveniently located so that they are accessible without danger of contact with live sections of the equipment.

All interconnecting wiring shall be suitably protected against mechanical damage, for example, by routing them in protective channels or pipes.

All low voltage wiring in high voltage compartments shall be installed in earthed metallic armouring or conduit and be double insulated.

6.10.3 Low voltage panel

A low voltage panel shall be provided for each circuit breaker. The low voltage panel shall contain all control and monitoring equipment necessary for the operation of the associated circuit breaker.

The low voltage panel shall include the following functions, operating and monitoring facilities:

- a local CLOSE – OPEN switch or push-buttons coloured red and green respectively
- LOCAL – REMOTE selector switch
- a mechanical push-button or similar device for opening the circuit breaker
- Insulating gas monitoring if required
- circuit breaker indications as detailed in Section 6.4.

The low voltage panel shall be a lockable using a padlock, closed, fully shrouded and arc resistant cabinet of at least IP54 protection in accordance with AS 60529. The low voltage panel shall be provided with two earth studs on opposite sides for connection of 70 mm^2 protective earth cable.

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The low voltage panel shall be provided with isolating devices for the supply of all control circuits and equipment located within the respective circuit breaker in accordance with T HR EL 19002 ST.

The low voltage panel shall be provided with a thermostatically controlled heater with cut-off control switch/s to prevent moisture condensation.

A general purpose 240 V ac outlet (GPO) rated at a minimum of 10 A protected by a residual current device (RCD) shall be provided in the low voltage panel. A light shall be provided in the low voltage panel.

The layout within the cabinet shall ensure for the following:

- adequate room is provided for the termination of multi-core control cables, CT secondary cables, dc auxiliary supply cables and other miscellaneous cables that are required for interfacing with equipment within the substation
- cable terminals shall be readily accessible to enable connection of test equipment associated with protection system testing and commissioning
- cable ducting within the cabinet shall be located to allow for the installation of multi-core control cables
- adequate room between duct and cable entry points is provided to allow for the bending radius of cables.

Refer to TS 00011:1.0 for details on low voltage wiring, terminals and labelling requirements.

6.10.4 Protection panel

Protection panel houses essential electrical and protection equipment. Protection panel is located within the substation building and is floor mounted. At new installations or at existing locations where the current protection panel is not suitable, a protection panel shall be provided separately for the circuit breaker/s. A single protection panel can provide for multiple circuit breakers.

The protection panel shall be suitable for cable entries from the top and bottom. The protection panel shall be fitted with labels for the circuits aligned with the substation operating diagram.

The protection panel shall include indications for equipment and protection alarms, as required. The protection panel shall include current ammeter for providing current measurements for circuit breaker/s in accordance with the protection concept design for the location.

The protection panel shall incorporate all applicable requirements of T HR EL 19002 ST, including but not limited to the following:

- protection relays, test blocks and associated labelling
- supply monitoring relays, as required

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- multi-trip and other auxiliary relays, as required
- SCADA requirements
- current, voltage and energy meters, as required
- voltage and current test links or terminals or both to allow measurement by portable instrumentation
- appropriate test links for protection as defined in the protection specification.

Refer to TS 00011:1.0 for details on panel construction, low voltage wiring, terminals and labelling requirements. The protection panel shall have a 240 V ac general purpose outlet (GPO) rated at a minimum of 10 A. Protection panel shall be fitted with light/s within the panel.

6.10.4.1 Instruments, transducers and metering

All instruments, transducers and metering equipment that are required to be installed on the protection panel shall comply with this section and the relevant requirements in TS 00011:1.0.

All indicating instruments shall be flush-mounted industrial type instruments that comply with the requirements of the following IEC standards: IEC 60051-1, IEC 60051-2, IEC 60051-3, IEC 60051-7, IEC 60051-8 and IEC 60051-9. The instruments shall be clearly visible and easily legible from a standing position in front of the protection panel.

Analogue instruments shall have a scale length of at least 90 mm. All instruments on a panel shall be scaled with the same type of characters of the same size. The instruments shall be 96 mm x 96 mm in size, with black scales on a white background.

All current-operated instruments shall be protected against continuous over current up to 150% of nominal value and high current surges up to the fault rating of the circuit breaker.

6.10.4.1.1 Current transducers

B∅ of the metering CT for each circuit breaker shall be connected to a current transducer at the respective protection panel. The output of the current transducer shall be used to drive the ammeter and then be connected to the SCADA RTU for remote analogue indication to allow monitoring of primary circuit current.

Refer to T HR EL 11004 ST for additional information on current transducer requirements.

6.10.4.1.2 Voltage transducers

A voltage transducer shall be connected to each voltage transformer where available and connected to the SCADA RTU for remote indication.

Refer to T HR EL 11004 ST for additional information on voltage transducer requirements.

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6.10.4.1.3 Ammeters

Ammeters shall have two scales that are essentially linear. The main scale shall allow for 150% of the primary current rating of the current transformer. The second scale shall be equivalent to the main scale divided by five, to allow reading of lower currents. A push button fitted to the front of the ammeter shall activate the minor scale. The accuracy of ammeters shall be 3% or better.

The current transformer ratio shall be clearly marked on the face of the ammeter or on the protection panel next to the ammeter.

6.10.4.1.4 Voltmeters

Voltmeters shall have analogue indication with scales that have an indicating range of 80% to 120% of the nominal system voltages. The accuracy of voltmeters shall be 3% or better.

Where voltmeters that have a nominal range from 0% to 120% are required, this will be specified at the time of order.

The nominal voltage shall be marked in red on the scale. A switch shall be provided for selecting voltages between each phase (that is, A–B, B–C, A–C) where 3-phase analogue supply is available.

6.10.4.1.5 Watthour meter

If required, kWh meters shall be three-phase, with pulse output. The pulse output rate shall be 10 per kWh. Where required for revenue metering the kWh meter shall be connected to a metering CT of suitable rating and accuracy class.

6.11 SCADA interface

This section details the various interfaces to the SCADA RTU.

The SCADA alarms from equipment are implemented by a combination of hard wiring and using the serial link (DNP3 secure authentication or Modbus over RS485) on the electronic protection relays and associated transducers. DNP3 is the preferred communication protocol. Refer to T HR EL 11004 ST for further details on the serial connection for intelligent electronic devices.

The serial communication port on all electronic protection relays from the same bus-section shall be connected together and wired to a terminal strip for connection to the SCADA RTU.

Where the installation is in a new location or the SCADA system is being upgraded at an existing location, then the communication protocol IEC 61850 may be considered if the life cycle costing for the implementation provides a benefit to TfNSW and there are also technical benefits over the use of standard DNP3 protocol.

Refer to T HR EL 19002 ST for further SCADA alarm requirements.

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Refer to T HR EL 11004 ST for details on the SCADA wiring requirements, in particular the requirement for analogue cable to have the screen connected to the location earth at the RTU end only.

6.11.1 Binary indication and ACCB control

Certain information is critical for system operation and shall be independent to the protection relay or communication link to the SCADA RTU.

Refer to T HR EL 19002 ST for details of the SCADA alarms and control that are required to be hard wired to the RTU. Hard wired digital inputs shall be active types where inputs are powered from the equipment.

6.11.2 Analogue indication

Analogue indication shall be provided to SCADA in accordance with Section 6.10.4.1.1 and Section 6.10.4.1.2.

6.11.3 Controls

The SCADA RTU provides voltage free contacts for the following control functions:

- circuit breaker open (trip)
- circuit breaker close.

Refer to T HR EL 11004 ST for details of the RTU voltage free contacts and associated interface requirements. Interposing relays shall be provided for all SCADA initiated control functions.

6.12 Protection

The circuit breaker shall be provided with protection current transformers in accordance with T HR EL 19002 ST. Current transformers shall comply with AS 61869.2.

CT wiring shall be in accordance with T HR EL 19002 ST.

The typical quantity of CTs required at an outdoor substation without a bus zone protection scheme is as follows:

- feeder circuit breaker: three (line differential, overcurrent, metering)
- rectifier circuit breaker: three (overcurrent, overcurrent, metering)
- system transformer circuit breaker: three (transformer differential, overcurrent, metering)
- harmonic filter circuit breaker: three (overcurrent, overcurrent, metering)
- bus-section circuit breaker: two (overcurrent, metering).

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The specific protection schemes and CT requirements for a location are detailed in the approved protection concept for the location which is issued at the time of order. The order and location of the CTs with respect to the circuit breaker is detailed in the approved protection concept schematic.

6.12.1 CTs located within dead tank circuit breakers

Current transformers housed within the bushings of dead tank circuit breakers shall be rated at the same ratings of the associated circuit breaker for the following parameters:

- rated continuous current (I_r)
- rated short time withstand current (I_k).

Connection to the secondary wiring of the CTs shall be made available from the terminals within the low voltage panel of the associated circuit breaker.

6.12.2 Current transformer rating plate

A rating plate shall be fitted to each current transformer.

For dead tank circuit breakers that house CTs within, identical rating plates shall be fixed within the low voltage compartment of the circuit breaker in a position that facilitates ease of access to read the information.

6.13 Nameplates and signs

Nameplates and signs shall comply with AS 62271.100, the relevant part of AS 62271 and TS 00011:1.0 for labelling with the following additions:

- Refer to relevant NSW Statutory Authorities, Acts and Regulations for additional signage requirements. In general, signs will be located on or within the circuit breaker, low voltage panel, cabinets or enclosures containing HV or LV equipment.
- Enclosures containing terminals at voltage greater than ELV shall have a danger label attached to each access door and removable panel.
- Nameplates shall show the TfNSW specification number and version.

6.14 Human factors

The design of the circuit breaker and protection panel shall incorporate the principals of human factor integration as described in T MU HF 00001 ST.

Human factors aspects to be considered relate to controls and displays, information content, alarms and alerts. All equipment shall be designed to minimise safety hazards to operating personnel and prevent accidental short circuits due to human error.

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6.14.1 Controls and displays

Human factors shall be considered in the design of all operational facets of the circuit breaker. This includes aspects such as the following:

- location of the local controls
- position of indications
- accessibility of the protection relays, ammeter and other key items. The location is critical to ensure suitability for use by the operator and maintainer.

6.14.2 Information content

The correct labelling of all controls and indications is critical to reduce the likelihood of operator error while switching.

7 Post type current transformer

This section provides requirements and ratings of post type current transformers for use in TAHE's electrical network.

7.1 Functional requirements

The current transformers covered by this document shall provide the following:

- connection to the primary conductors within the outdoor switchyard
- secondary current for the purposes of protection or metering which is proportional to the primary current.

7.2 Detailed requirements and ratings

The 33 kV, 66 kV and 132 kV outdoor post type current transformers shall be in accordance with T HR EL 19002 ST. They shall be designed and manufactured in accordance with the following standards:

- AS 61869.1:2021
- AS 61869.2:2021.

General requirements for CTs are detailed in Table 4. Details on the windings within the post type current transformer and their specific ratings including ratio, output and class shall be as per the approved protection concept for the installation. The CT placement shall be as per the protection concept schematic.

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Table 4 – General requirements for current transformers

Parameter	Designation
Current transformer type	Post
Class	Outdoor
Type of system neutral earthing	Effectively earthed and Non-effectively earthed (see Note 1)
Ingress protection (minimum)	IP54
Insulation	Cast resin
Ambient temperature range	In accordance with EP 00 00 00 13 SP
Maximum altitude	1000 m (see Note 2)

Note 1: TAHE's heavy rail network has both effectively earthed and non-effectively earthed systems.

Note 2: Locations west of Penrith on the Blue Mountains line have a maximum altitude of 1200 m. Post type current transformers for these locations shall be rated in accordance with Clause 6.6.2 of AS 61869.1:2021.

Table 5 details specific post type current transformer rating requirements.

Table 5 – Post type current transformer ratings

Parameter	Rating	Rating	Rating
Nominal system voltage	33 kV	66 kV	132 kV
Highest voltage for equipment (U_m)	36 kV	72.5 kV	145 kV
Rated frequency (f_R)	50 Hz	50 Hz	50 Hz
Rated power-frequency withstand voltage (rms)	70 kV	140 kV	275 kV
Rated lightning impulse withstand voltage (peak)	170 kV	325 kV	650 kV
Rated short-time thermal current (I_{th})	≥25 kA or I_k of the corresponding circuit breaker, whichever is higher	≥25 kA or I_k of the corresponding circuit breaker, whichever is higher	≥25 kA or I_k of the corresponding circuit breaker, whichever is higher
Rated continuous thermal current (I_{CTH})	As specified in the protection concept design.	As specified in the protection concept design.	As specified in the protection concept design.

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Parameter	Rating	Rating	Rating
Rated power-frequency withstand voltage for secondary terminals	3 kV (see Note 1)	3 kV (see Note 1)	3 kV (see Note 1)

Note 1: CTs with rated knee point emf (E_k) greater than 2 kV shall comply with Clause 5.3.5 of AS 61869.2:2021.

CTs shall safely withstand the mechanical and thermal stresses subjected during a fault of a minimum magnitude equal to the full short circuit rating of the corresponding circuit breaker.

Oil-filled CTs shall not be used.

Support structures and any special tools required for operation or maintenance of the circuit breaker shall be provided.

CTs shall be provided with rating plates and terminal markings in accordance with Section 6.13 of AS 61869.1:2021 and Section 6.13 of AS 61869.2:2021. The rating plates shall be mounted in such a manner that they are visible. The secondary terminals shall be readily accessible for the CTs.

Where alternate technology to inductive current transformers is proposed, complete technical details and life cycle costing of the alternative shall be provided to TfNSW. Life cycle costing shall include all affected related interface devices, training, operation and maintenance costs.

8 Terminal palms

The material of the palm shall be aluminium alloy or tin-plated copper in accordance with AS 1734 or equivalent.

The busbar connections shall be free of sharp edges to reduce radio interference voltages or corona.

Termination palms shall suit the rating of the equipment in accordance with AS 62271.301 (for example, copper terminal number 6 for 1250 A).

9 Bushings

The bushings shall be made of porcelain, silicon rubber or other proven synthetic material. Silicon rubber is the preferred material for bushings. Bushings shall be grey or light blue in colour. Internal surfaces of porcelain bushings shall not be glazed.

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10 Environment

10.1 General

The circuit breaker and current transformers shall be suitable for locating outdoors in substations which are located adjacent to the track. These locations are subject to vibration and additional dust caused by passing trains.

At locations with high levels of pollution, salt or moisture content in the air due to sea spray, suitable equipment shall be selected with insulators compliant to IEC 60815 and AS 62271.1. Where site pollution severity (SPS) class exceeds medium, required pollution class shall be provided with the RFT in accordance with Appendix E.

Post type current transformers with ceramic insulators susceptible to contamination shall also comply to the creepage distances specified in Section 6.6.1 of AS 61869.1:2021.

Circuit breakers and current transformers shall be rated to ambient temperature ranges as detailed in EP 00 00 00 13 SP.

Circuit breakers shall provide physical protection against entry of spiders, birds or rodents to prevent short circuit of equipment. All equipment associated with the circuit breaker and current transformer assembly shall be designed to eliminate pockets in which water can collect.

10.2 Noise

The circuit breakers may be installed at substations in close proximity with residential properties. Noise shall be kept to minimum levels.

11 Tests

The testing requirements for post type current transformers and circuit breakers are split into three distinct categories as follows:

- type tests
- factory acceptance tests (FAT)
- site acceptance tests (SAT).

Testing requirements shall be read in conjunction with TS 00011:1.0.

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11.1 Type tests

The type tests as required in the following standards and their relevant parts shall be completed with copies of type test certificates, test results and reports submitted as part of the tender documentation:

- Circuit breaker:
  - AS 62271.1
  - AS 62271.100
  - AS 62271.200 (for 33 kV circuit breaker/s)
  - AS 62271.203 (for 66 kV and 132 kV circuit breaker/s).
- Post type current transformer:
  - AS 61869.1
  - AS 61869.2.

Type test certificates for each of these tests shall be accepted where it can be demonstrated that the equipment supplied is of a similar design to previously type tested circuit breakers or current transformers.

11.2 Factory acceptance tests (FAT)

Factory acceptance tests (FAT) shall be completed at the manufacturers' premises unless agreed by TfNSW.

Where a TAO is witnessing the FAT on behalf of TfNSW, they are responsible for witnessing and providing engineering assurance on the tests and requirements.

TfNSW shall be notified of the FAT schedule and will advise if attending.

11.3 Routine tests

Routine tests shall be completed as part of the FAT at the manufacturers' premises unless agreed by TfNSW.

For each circuit breaker or post type current transformer the following tests shall be carried out. Routine test reports shall be provided to TfNSW, Asset Management Branch.

Circuit breaker routine tests as listed in the following standards shall be carried out:

- AS 62271-1
- AS 62271-100
- AS 62271-200 (for 33 kV circuit breaker/s)

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- AS 62271-203 (for 66 kV and 132 kV circuit breaker/s).

Current transformer routine tests as listed in the following standards shall be carried out:

- AS 61869.1
- AS 61869.2.

Dielectric dissipation factor and partial discharge testing shall be performed.

Certain routine tests shall be completed as part of the SAT. Section 11.4 provides further detail on specific routine tests required.

11.4 Site acceptance tests (SAT)

Certain routine tests required will need to be repeated once the equipment is installed at site.

The TAO is responsible in conjunction with the manufacturer to determine the exact routine tests that shall be repeated based on the hazards and risk analysis of transporting the equipment from the factory to site and the installation activities required.

Section 11.4.1, Section 11.4.2 and Section 11.4.3 detail the minimum required SATs.

11.4.1 Circuit breaker

The circuit breaker shall be tested following installation and before commissioning into service to check the correct operation of the equipment.

On-site tests shall include, but not be limited to, the following to locate any defects or damages during handling, transportation, storage and erection:

- dielectric test on main circuits
- dielectric tests on auxiliary circuits
- measurement of resistance of main circuit
- gas leakage tests
- measurement of moisture content of insulating gas, where recommended by the supplier
- operation of main and auxiliary circuits
- timing of circuit breaker operation.

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11.4.2 Protection panel

SAT pre-commissioning tests shall include, but be not limited to, the following:

- insulation resistance of all wiring
- continuity of all wiring (point to point)
- secondary injection of all protection schemes
- full operation checks of all control and protection schemes.

11.4.3 Post type current transformer

SAT for post type current transformers shall be performed following installation of the current transformers, prior to commissioning, to verify the correct operation and orientation of the CTs. The SAT shall include, but not be limited to, the following:

- verification of markings
- power-frequency voltage withstand tests on primary terminals
- power-frequency voltage withstand tests on secondary terminals
- tests for accuracy
- determination of secondary winding resistance
- tests for rated knee point emf and exciting current at rated knee point emf.

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Appendix A Whole-of-life cost (normative)

This appendix is provided for TAOs to assess the whole-of-life cost as required by T MU AM 01001 ST.

The selection of the most suitable circuit breaker or current transformer shall be made on the basis of minimising the whole-of-life cost. The following factors as a minimum shall be considered in determining the whole-of-life cost:

- cost of producing technical maintenance plans and associated service schedules
- cost of decommissioning and disposal
- cost of installation
- cost of inventory spares
- cost of maintenance
- cost of manuals
- cost of modifications to other parts of the installation
- cost of replacement parts
- cost of special tools
- cost of staff training
- discount rate
- environmental costs (for example, disposal of SF_6 gas)
- initial purchase price
- lifetime of equipment
- reliability and cost of consequential damage after failure.

If the circuit breaker or post type current transformer has not previously been type approved by TfNSW, Asset Management Branch in accordance with T MU MD 00005 GU, then the costs for this process shall be included in the whole-of-life cost.

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Appendix B Data set associated with the equipment (normative)

Section B.1 through to Section B.4 lists the data that shall be supplied by the manufacturer and maintained for the circuit breakers or post type current transformers. This data will remain the property of TfNSW.

B.1 Drawings and information

The following drawings are required as a minimum set:

- Legend and symbols.
- Equipment list.
- Arrangement drawings (for example, circuit breaker, post type current transformer, HV conductor termination, low voltage panels, protection panel). These drawings to include associated weights, dimensions, required safety clearances to meet manufacturers requirements and AS 2067 requirements. Details shall be included to enable the complete installation of the equipment and its connection to HV conductors, LV cables and wiring.
- Schematic diagrams.
- Interconnection diagrams (for example, between the protection panel and low voltage panel of the circuit breaker or protection panel and the secondary terminal box of the post type current transformers).
- Drawings for the rating plate of the equipment will all relevant details populated.
- Diagram showing safety clearances.
- Civil drawings and diagrams as required for the installation.

All drawings shall conform to the requirements of T MU MD 00006 ST.

Note: This list does not include component drawings which are required as part of the integrated support requirements and inclusion in the operations and maintenance manual.

B.2 Technical schedule

The information listed in the technical schedule in Appendix C shall be supplied by the manufacturer and maintained for each circuit breaker and post type current transformer.

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B.3 Life cycle costing

All the data and assumptions pertaining to the determination of the whole-of-life cost calculations shall be recorded. See Appendix A. This is prepared by the TAO.

B.4 Test results

The results of all tests, including type, special, routine, acceptance, periodic and corrective maintenance tests shall be recorded and provided.

Routine and type tests certificates showing the results of each test performed shall be supplied in English.

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Appendix C Technical schedule (normative)

This appendix has the technical schedule which shall be completed at the time of tender. This appendix details the descriptive information that shall be submitted at the time of tender.

C.1 Circuit breaker technical schedule

Circuit breaker general details:	
Manufacturer	
Model	
Service condition	Outdoor
Country of manufacture	
Circuit breaker tank design (dead/live)	
Interrupter type	
Insulation medium	
IP rating (see Note below)	
Design life	
Mechanical endurance class (M1/M2)	
Electrical endurance class (E1/E2)	
Class for restrike performance (C1/C2)	
System class (S1/S2)	
Mass of complete circuit breaker	
Lifting lugs provided?	Yes/No
List of condition monitoring devices integrated within the circuit breaker	
List of additional optional condition monitoring devices recommended for the network	

Note: Test certificate to be provided.

Circuit breaker ratings:	
Rated voltage (U_r)	kV
Rated frequency (f_r)	Hz
Rated continuous current (Ir)	A
Rated short-time withstand current (Ik)	kA
Rated peak withstand current (Ip)	kA
Rated duration of short circuit (tk)	s
Rated insulation level:	

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Circuit breaker ratings:	
Rated short-duration power-frequency withstand voltage (Ud) Common value Across the isolating distance	 kV (rms) kV (rms)
Rated lightning impulse withstand voltage (Up) Common value Across the isolating distance	 kV (peak) kV (peak)
Rated supply voltage of closing and opening devices and of auxiliary and control circuits (Ua)	V
Tolerance for auxiliary supply voltage	%
Rated supply for ACCB spring charge motor	V
Rated supply voltage for circuit breaker heaters and lights.	V
Provide derating factors (if applicable) for ambient conditions to a maximum of 50°C (derating factors should be in a form of table or graph).	

Operating mechanism details:	
Make	
Country of manufacture	
Method of operation	
Type of operating mechanism	
Type of main contact	
Type of arcing contact	
Type of arc control mechanism	
Total length of break	
Number of phases	
Number of poles	
Number of breaks per pole	
Rated operating sequence	
Rated first-pole-to-clear factor (kpp)	
Number of trip coils	
Number of close coils	
Power consumed by trip coil	
Power consumed by closing coil	
Spring charging motor rating	
Maximum break time	ms

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Operating mechanism details:	
Rated closing time	ms
Rated opening time	ms
Rated line-charging breaking current	A
Rated cable-charging breaking current	A
Transient recovery voltage for terminal faults	kV
Characteristics for short-line faults	
Number of N/O auxiliary contacts	
Number of N/C auxiliary contacts	
Electrical rating of auxiliary contacts	
Space heater provided	Yes/No
Space heater voltage rating	V
Space heater power rating	W
Space heater thermostatically controller	Yes/No
Weight of mechanism box	

Circuit breaker low voltage panel details:	
Material	
Colour	
IP Rating	
Lockable?	Yes/No
Opening direction of the door	Horizontal/Vertical
Opening side interchangeable? (For horizontal doors only)	Yes/No
Maximum opening swing angle for the door	
Method of restricting free swing of the door	

Circuit breaker tank details:	
Material	
Thickness	
Welding technology	
Tightness test	
Bursting disc provided	Yes/No
Applicable standards	
Colour	

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Insulating gas details:	
Insulating gas	
Mass of insulating gas	kg
Guaranteed leakage per year	%/year
Gas Pressure	
Gas pressure switch settings:	
Level 1, Alarm pressure	
Level 2, Lockout pressure	

Bushing details:	
Material	
Type	
Make	
Country of manufacture	
External creepage distance	
Maximum partial discharge level	C
Colour	

Control wiring details:	
Wiring colours:	
Active	
Neutral	
DC +ve	
DC -ve	
Size of wiring used (CSA)	mm^2
Conformance to AS/NZS 3000	Yes/No

Current transformers (where mounted within the circuit breaker):
Detail the type of CTs being offered
Where are the CTs located and how are they mounted?

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Current transformers (where mounted within the circuit breaker):
Detail the physical dimensions available for CTs in the bushings

Environmental details:	
Maximum ambient temperature	°C
Maximum height above mean sea level	m
Maximum wind pressure	
Seismic intensity	
Maximum noise level during breaker operation at 1m distance	

Circuit breaker steel structure details:	
Steel structure to support breaker included	Yes/No
Bracket to mount current transformers included (where required)	Yes/No
Galvanised (hot-dip)	
Weight of the structure	Kg
Available height adjustments of CB Steel structure	Yes/No
Details on the height adjustments (if adjustable)	

C.2 Post type current transformer technical schedule

Current transformer general details:	
Manufacturer	
Model	
Country of manufacture	
Insulating material	
IP rating	
Design life	
Mass of the post type CT unit	kg

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Physical dimensions available for CT:	
Radius (inner/outer)	mm
Height	mm

Current transformer ratings:	
Rated frequency (f_r)	kV
Highest voltage for system (U_{sys})	kV
Rated primary current (Ipr)	A
Rated short-time thermal current (Ith)	A
Rated continuous thermal current (ICTH)	A
Rated primary short-circuit current (Ipsc)	A
Rated peak withstand current (Ip)	kA
Rated duration of short circuit (tk)	s
Rated secondary current (Isr)	A
Rated insulation level:	
Rated short-duration power-frequency withstand voltage (Ud)	kV (rms)
Rated lightning impulse withstand voltage (Up)	kV (peak)
Rated power-frequency withstand voltage for secondary terminals	kV

Bushing details:	
Material	
Type	
Make	
Country of manufacture	
External creepage distance	
Maximum partial discharge level	C
Colour	

CT primary connection details:	
Is the connection included?	Yes/No
Material	
Cross sectional area	

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CT steel structure details:	
Steel structure to support CT included	Yes/No
Galvanised (hot-dip)	
Weight of the structure	Kg

C.3 Supply history

The manufacturer shall provide the following supply history:

- period (in years) this model or type has been available for purchase
- estimated period before replacement with new model
- number of units in service worldwide
- number of units in service in Australia.

C.4 Additional descriptive detail and information

The following general descriptive detail shall be provided with the tender:

- Common:
  - copies of all type test certificates and reports
  - details on standards that the equipment complies to
  - any departures from the requirements of this specification If there are departures, include details on a separate sheet
  - description on the HV bushings and HV conductor termination details
  - physical dimensions, weights and required personnel clearances
  - detail on maintenance requirements including frequency, type of maintenance, consumables used, estimated duration and requirement for special tools and personnel
  - operation and maintenance manual.
- Circuit breaker:
  - details on the circuit breaker gas system if required, including type of gas, quantity of gas, gas pressures, gas monitoring system, gas compartment design with associated maintenance and design methodology
  - details on the low gas alarm and tripping scheme, including the tripping arrangement and operational restrictions for each alarm level and critical low gas pressure level

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  - if alternate gas to SF_6 is offered then detailed technical comparison to SF_6, environmental considerations, evidence of proven service history along with details in the above dot-point
  - detail on recommended spares.
- Post type current transformer:
  - details on the physical dimensions available for the current transformers
  - if alternate current measurement products are offered then full technical and operational details are required with required interfacing requirements.

C.5 Reliability data

Reliability data shall be submitted including, but not limited to, design life, failure modes, mean time between failures (MTBF) and mean time between repairs (MTBR). Refer to T MU AM 01002 MA *Maintenance Requirements Analysis Manual* for details of TfNSW requirements.

This manual supports the TfNSW Asset Management Policy with detailed processes for undertaking a maintenance requirement analysis.

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Appendix D Integrated system support requirements (normative)

D.1 Integrated support objectives

The circuit breaker or post type current transformer manufacturer shall establish and provide the information required to operate and maintain the equipment throughout its operational life. This shall be done in a cost-effective manner and to a level that is consistent with the planned operational performance and usage of the equipment.

This includes the following:

- specifying maintenance requirements
- spares support (availability of spares - timeframe, where they are held)
- operations and maintenance manuals
- training
- support equipment and tooling.

The Integrated support requirements are a significant deliverable in the procurement of a new equipment. Manuals, training, documentation and other support deliverables shall be in accordance with T HR EL 00002 PR *Electrical power equipment – integrated support requirements.*

D.2 Operation and maintenance manual

An operation and maintenance manual shall be provided for the equipment in accordance with T HR EL 00002 PR. The requirements for the scope of the operation and maintenance manual are as detailed in T HR EL 00002 PR. Photographs showing the following details are also required:

- Circuit breaker:
  - a. installed circuit breaker and low voltage panel
  - b. photos that would assist in clarifying the operation and maintenance of the circuit breaker.
- Post type current transformer:
  - c. rating plate showing CT details
  - d. terminal box of post type current transformers showing secondary terminals and polarity markings
  - e. primary terminals showing polarity markings.

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The manufacturer's standard operation and maintenance manual will be accepted providing it is applicable to the product that is installed. It is acceptable that variations of the circuit breaker or current transformers that are not installed are blanked out. The additional photos listed can be provided as an appendix to the standard manufacturer's manual.

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Appendix E Information requirements for RFT (normative)

This appendix contains information requirements to be provided with the RFT at the time of tender and by the tenderer with the submission.

See Appendix C for the requirements for tenderers to complete and submit the technical schedule.

For procurement of outdoor circuit breakers and outdoor post type CTs, in addition to the requirements stated in this specification, relevant site-specific information and technical information shall be made available to tenderers.

Table 6 provides a list of technical details to be considered for including in the RFT.

Table 6 – List of technical details to include in the in the RFT

Item	Technical details to include in the RFT
Voltage for auxiliary and control supply (For circuit breaker)	At existing locations, where the available voltage for auxiliary supply is different from 125 V dc, provide details of available supply.
AC supply for heater and lighting (For circuit breaker)	At existing locations, where the available voltage differs from 240 V ac, provide details of available supply.
Ratings	Existing or proposed ratings, including short time withstand current, rated duration of short circuit and rated continuous current rating of equipment being connected to shall be provided.
Type of system neutral earthing	Effectively earthed or non-effectively earthed.
Current transformers	Number, location and details of CTs required if known at the time of tender.
Diagrams	Proposed operating diagrams or single line diagrams for the site showing the location and orientation (if known) of the circuit breaker/s.
Drawings	Relevant drawings including general arrangement drawings, where available for existing locations.
Special requirements for specific applications (Circuit breakers for Harmonic filters, etc)	Required class for restrike performance (C1 or C2), Required performance parameters of the circuit breaker whilst interrupting capacitive current or any other parameters required for specific applications.

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Table 7 provides a list of site-specific information to be considered for including in the RFT.

Table 7 – Site-specific information to include in the RFT

Item	Information to include in the RFT
Site location	Details of the location and address for the site.
Delivery address	Delivery address and any special instructions if required.
Site specific limitations on size or arrangement	Indicate whether there are size or other limitations imposed by surrounding environment or infrastructure.
Access and transportation limits	Access road weight limit Maximum road width Maximum standard height above road
Access road alongside operating railway	Provide details of whether the access road to the site is within the rail corridor and adjacent to an operating railway track.
Special service or environmental conditions (where varied from conditions listed in this specification or EP 00 00 00 13 SP)	Provide any details of any special requirements or conditions required for site such as nonstandard ambient temperature ranges, altitude, moisture, salt or pollution (SPS) class.

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