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Specification

33 kV AC Indoor Switchgear

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Document information

Owner:	Director Energy Networks and Systems Asset Management Safety Environment and Regulation
Mode:	Heavy rail, Metro
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Document history

Revision	Effective date	Summary of changes
1.0	02/07/2024	First issue with new designation TS 03761 *33 kV AC Indoor Switchgear*. Version recommenced in line with new designation. Change to previous content in EP 01 00 00 01 SP is: • minor amendments and clarification to content, • conversion of the specification to AMB format and style, • updated references to the Australian and TfNSW Standards, • inclusion of requirements for 1500 V dc metro, • inclusion of requirements for market analysis of products with sulphur hexafluoride (gas) (SF_6) alternatives.

Preface

This document is the first issue of TS 03761 *33 kV AC Indoor Switchgear* and supersedes EP 01 00 00 01 SP *33 kV Indoor Switchgear – Non-Withdrawable* version 2.1.

This document specifies the requirements for 33 kV indoor switchgear that are used on the TfNSW heavy rail passenger network and 1500 V dc metro lines within the metropolitan rail area.

The change from previous content includes the following:

- minor amendments and clarification to content
- removal of standard switchboard configurations
- conversion of the specification to AMB format and style
- updated references to the Australian and TfNSW standards
- inclusion of requirements for 1500 V dc metro
- inclusion of requirements for market analysis of products with sulphur hexafluoride (gas) (SF_6) alternatives.

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1 Scope

This document provides the specifications of factory assembled, type tested, metal enclosed, switchgear designed for indoor installation on railway distribution systems operating at a nominal 33 kV ac, three-phase, 50 Hz.

The switchgear panels include equipment that is comprised of a fixed functional unit with an associated off-load disconnector and interlocked earthing facility. These are in combination with the associated SCADA control, measuring, indicating, alarm and protective equipment, including interconnections, accessories, enclosures and supporting structure.

2 Application

The requirements of this document apply to purchase or installation of new 33 kV indoor switchboards in the TfNSW metropolitan heavy rail network and 1500 V dc metro electrical network.

The requirements of this document are not applicable to existing 33 kV indoor switchboards currently in service.

For clarification of any requirements in this document contact the AMB.

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 60051-1 *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 1: Definitions and general requirements common to all parts*

IEC 60051-2 *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 2: Special requirements for ammeters and voltmeters*

IEC 60051-3 *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 3: Special requirements for wattmeters and varmeters*

IEC 60051-8 *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 8: Special requirements for accessories*

IEC 60051-9 *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 9: Recommended test methods*

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

IEC 62271-213 *High-voltage switchgear and controlgear – Part 213: Voltage detecting and indicating system*

Australian standards

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

AS 2629 *Separable insulated connectors for power distribution systems above 1 kV*

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

AS 61869.2 *Instrument transformers – Part 2: Additional requirements for current transformers (IEC 61869-2:2012 (ED. 1.0) MOD)*

AS 61869.3 *Instrument transformers – Part 3: Additional requirements for inductive voltage transformers (IEC 61869-3:2011 (ED.1.0) MOD)*

AS 62271.1 *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear*

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*

AS 62271.100:2019 *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 62271.102 *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

AS 62271.102:2019 *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches (IEC 62271-102:2018, MOD)*

AS 62271.200 *High-voltage switchgear and control gear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

AS 62271.200:2019 *High-voltage switchgear and control gear – 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)*

Transport for NSW standards

TS 00011 *Common Requirements for Electric Power Equipment*

TS 01505 (T MU AM 01001 ST) *Life Cycle Costing*

TS 01517 (T MU AM 01002 MA) *Maintenance Requirements Analysis Manual*

TS 01547.1 (T MU MD 00006 ST) *Engineering Drawings and CAD Requirements*

TS 03736 (T HR EL 19002 ST) *Protection System Requirements for the High Voltage Network*

TS 03742 (T HR EL 00002 PR) *Electrical Power Equipment – Integrated Support Requirements*

TS 03744 (EP 00 00 00 13 SP) *Electrical Power Equipment – Design Ranges of Ambient Conditions*

TS 03756 (T HR EL 20009 ST) *Testing of HV AC and 1500 V DC Cables*

TS 03865 *Electrical SCADA Interface Requirements*

TS 03869 *Lightning Protection and Insulation Coordination*

TS 04978 (T MU HF 00001 ST) *Human Factors Integration – General Requirements*

TS 06178 (T MU MD 00005 GU) *Type Approval of Products*

4 Terms, definitions and abbreviations

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

ac alternating current; an electric current that reverses its direction many times a second at regular intervals

ACCB alternating current circuit breaker

AMB Asset Management Branch (formerly Asset Standards Authority)

BZ bus zone (protection)

CT current transformer

dc direct current

FAT factory acceptance test

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

kWh kilowatt hour

LDiff line differential protection

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

metro an urban railway transportation system that is associated with high capacity and high frequency (typically turn-up-and-go, rather than timetabled) and greater automation

MTM multi trip manual-reset (relay); used for the multi-tripping of ACCBs; This is a manually reset relay with a hand reset flag

RFT request for tender

RTU remote terminal unit

SAT site acceptance test

SCADA supervisory control and data acquisition

SF_6 sulphur hexafluoride (gas)

TAO Technically Assured Organisation

Note: TAO was known previously as AEO (Authorised Engineering Organisation).

TfNSW Transport for New South Wales

VDS voltage detection system

VT voltage transformer

5 TfNSW type approval

All 33 kV indoor switchgear procured in accordance with this document requires type approval by the TfNSW Asset Management Branch (AMB) prior to being connected to the TfNSW metropolitan heavy rail network or 1500 V dc metro electrical networks.

The type approval process is contained in TS 06178.

6 Functional requirements of 33 kV indoor switchgear

The 33 kV indoor switchgear shall consist of 33 kV busbar, fixed type circuit breakers, disconnectors, earth switches, VTs and associated control and protection equipment.

The 33 kV indoor switchgear shall provide for the following:

- connection of 33 kV feeders, bus tie cables, rectifier transformer, system transformer and harmonic filter circuits to the 33 kV busbar
- isolation and earthing of feeders, bus tie cables, rectifier transformer, system transformer and harmonic filter circuits
- protection and SCADA control for 33 kV feeders, rectifier transformer, system transformer, and harmonic filter circuits and sections on the 33 kV busbar
- means to perform tests on HV cables, without disturbing existing HV cable connections.

7 Switchboard requirements

The switchboard shall be designed and manufactured in accordance with the standards stated in Table 1.

Table 1 – Switchboard standards

Equipment	Standard
Switchgear (common specifications) Circuit breakers Disconnector/Earthing switch Metal enclosed switchgear	AS 62271.1 AS 62271.100 AS 62271.102 AS 62271.200
CT	AS 61869.2
VT	AS 61869.3
Degrees of protection provided by enclosure (IP code)	AS 60529
General	AS 2067
Switchgear status indicators (definite indication of position)	AS 62271.102, Appendix A

Table 2 provides details of general requirements of a switchboard for 33 kV indoor switchgear.

Table 2 – Switchboard general requirements

Parameter	Designation
Switchboard type	Metal enclosed
Class	Indoor
Method of neutral earthing of the system	Effectively earthed and non-effectively earthed
Ambient temperature range	In accordance with TS 03744 (see Note 1)
Maximum altitude	1000 m (see Note 2)
Main device type	Non-withdrawable (see Note 3)
Insulation medium	Solid insulation, air, SF_6 or SF_6 alternative (See Section 8)
Possible extension to switchboard	Both sides

Note 1: Where the switchgear does not meet the temperature requirements of TS 03744, then the applicable derating factors shall be provided.

Note 2: Locations west of Penrith on the Blue Mountains line have a maximum altitude of 1200 m. Derating factors shall be supplied if applicable.

Note 3: Withdrawable switchgear may be considered for switchgear with alternate products to SF_6. The associated whole of life costing shall reflect the additional substation spatial and maintenance requirements. Refer to Section 8 for information regarding the switchgear insulating medium.

Table 3 details switchboard and specific equipment rating requirements.

Table 3 – Switchboard common ratings

Parameter	Rating
Number of phases	3
Nominal system voltage	33 kV
Rated voltage (U_r)	36 kV (minimum)
Rated frequency (f_r)	50 Hz
Busbar Rated normal current (for heavy rail) Rated normal current (for metro)	Single (See Note 1) ≥ 1250 A ≥ 2000 A
Rated lightning impulse withstand voltage (U_p) Common value Across the isolating distance	 170 kV (peak) 195 kV (peak)
Rated short-duration power-frequency withstand voltage (U_d) Common value Across the isolating distance	 70 kV (rms) 80 kV (rms)
Rated short time withstand current (I_k) (for main and earthing circuits)	31.5 kA (rms)
Rated peak withstand current (I_p) (for main and earthing circuits)	80 kA (peak)
Rated duration of short circuit (t_k) (for main and earthing circuits)	3 sec
Internal arc classification (IAC) Arc test current Arc test current duration	AFLR 31.5 kA 3 sec
Rated supply voltage of closing and opening devices and of auxiliary and control circuits (U_a)	125 V dc
Auxiliary supply for switchboard heaters and lights	240 V ac
Partial discharge level including all components	< 50 pC

Note1: Double busbar may be used where required to meet the nominal specified current rating.

Table 4 details the mechanical endurance class for the circuit breaker, disconnector and earth switch.

Table 4 – Switchboard mechanical and electrical class

Designation	Class
Partition class	PI or PM
Disconnector/ Earthing switch	M1, E2
Circuit breaker	M2, E2, C1

7.1 Circuit breaker specific ratings

Table 5 provides details of specific ratings for the circuit breakers applicable to heavy rail.

Table 5 – ACCB common ratings applicable to heavy rail

Parameter (common to all ACCBs)	Rating
Interrupting medium	Vacuum
Rated normal current (I_r) – Bus Tie	≥ 1250 A (see Note 1)
Rated normal current (I_r) – Feeder	≥ 630 A (see Note 1)
Rated normal current (I_r) – System transformer	≥ 630 A (see Note 1)
Rated normal current (I_r) – harmonic filter	≥ 630 A(see Note 1)
Number of trip coils	2 independently operated coils
Number of close coils	1
Rated operating sequence	O – 0.3 s – CO – 3 min – CO
Cables connected	Bottom front or rear and optional top

Note 1: The required busbar rating for a particular location is specified on the approved proposed operating diagram provided at the time of order.

Table 6 provides details of specific ratings for the circuit breakers applicable to metro.

Table 6 – ACCB common ratings applicable to metro

Parameter (common to all ACCBs)	Rating
Interrupting medium	Vacuum
Rated normal current (I_r) – Bus Tie	≥ 2000 A
Rated normal current (I_r) – Supply point feeder	≥ 2000 A

Parameter (common to all ACCBs)	Rating
Rated normal current (I_r) – Feeder	≥ 1250 A
Rated normal current (I_r) – System transformer	≥ 1250 A
Rated normal current (I_r) – harmonic filter	≥ 1250 A
Number of trip coils	2 independently operated coils
Number of close coils	1
Rated operating sequence	O – 0.3 s – CO – 3 min – CO
Cables connected	Bottom front or rear and optional top

7.2 Busbar earthing facility

If any part of the busbar requires routine maintenance, then busbar earthing facilities shall be provided.

7.3 Switchboard extension

The switchboard and associated functional units shall be designed so that an extension to an existing switchboard is possible at both ends with minimal dismantling to the existing switchboard.

8 Insulating medium

At the time of publication of this specification, there are alternate insulating gases to SF_6 being developed and trialled in industry. The procurement of 33 kV indoor switchgear to this document requires the assessment of commercially available and proven equipment; both switchgear with insulating medium of SF_6 and switchgear 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 TS 01505 for each option. Life cycle costing for the switchgear 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 in place at that time.

Where the insulating medium is SF_6, the supplier of the switchgear shall have a policy whereby they will accept responsibility for disposal of the SF_6 and any remaining SF_6 gas or by-products. The supplier shall also accept responsibility for SF_6 gas, if evacuated during maintenance for

the whole life of the switchgear. SF_6 management, environmental and disposal costs shall be considered in the evaluation process.

9 Earth bars

Each switchgear panel shall include two copper earthing bars, rated for maximum fault levels and not less than 120 mm² cross section area to facilitate earthing.

To assist with stray current mitigation measures from the dc traction system, 33 kV cable screens shall be connected to a separate cable screen earth bar on feeder panels only. This arrangement facilitates the future installation of a transient earth clamp.

The cable screen earth bar shall be connected to the switchboard earth bar via removable links. It shall be isolated from similar bars in adjacent panels.

The cable screen earth bar shall be insulated from the frame of the switchboard by insulated mounts that have been rated for maximum earth potential rise and tested for at least 15 kV for 1 minute.

The cable screen earth bar shall provide for connection of the removable link, three HV cable screens and two cable connections holes for a transient earth clamp.

The switchboard earth bar shall interconnect adjacent switchgear panels and provide all of the following:

- switchgear bonding
- two cable connections to the main substation earth grid
- a removable link per feeder panel for connection to the insulated earth screen earthing bar
- connections for cable screens for panels other than feeders.

9.1 Transient earth clamp

The transient clamp acts as a dc decoupler to provide dc isolation between earthing systems (for example, a local earth system and a remote earth system). Under an ac earth fault, the clamp impedance momentarily changes state to a virtual short circuit, acting to provide a direct connection of HV cable screens to the switchboard earth bar.

The transient earth clamp blocks the path to dc stray current that may otherwise flow via the cable screen.

Transient earth clamps (if required) are associated with feeder panels only.

10 Current transformers

The circuit breaker panels shall be provided with protection and metering CTs in compliance with TS 03736.

CTs shall comply with AS 61869.2.

The typical quantity of CTs is as follows:

- feeder panel: four (BZ, LDiff, OC, metering)
- rectifier transformer panel: four (BZ, OC, OC, metering)
- system transformer panel: four (BZ, Tx diff, OC, metering)
- bus-tie panel: two (BZ, bus-tie cable protection)
- harmonic filter panel: four (BZ, OC, OC, metering).

Specific CT requirements for individual switchboards will be provided in the approved protection concept report for individual switchboards which is issued at the time of order.

Wherever practicable CTs shall be installed in air insulated compartments. If CTs are installed in gas insulated compartments, then facilities shall be provided to enable access to and replacement of the CTs.

10.1 Current transformer rating plate

A rating plate shall be fitted to each CT. A second identical plate shall be fixed within the LV compartment in a position that facilitates ease of access to read the information.

11 Voltage transformers

A three-phase VT or three single phase VTs in compliance with AS 61869.3 and TS 03736 shall be provided for each switchboard and connected to the busbar.

VTs should be installed in air insulated compartments for ease of maintenance and replacement.

Where a switchboard has a feeder connected to a supply authority then an additional VT for tariff metering shall be installed on that feeder panel.

Specific VT requirements for individual switchboards will be provided in the approved protection concept report which is issued at the time of order.

For VTs used in non-effectively earthed systems, the protection equipment and scheme shall be designed to withstand the associated overvoltage that can occur during earth faults.

The VT alarm, protection relay VT supply alarm and phase failure relay shall comply with TS 03736.

12 Circuit breakers

Circuit breaker panels shall comprise of a fixed circuit breaker, switch-disconnector and earthing switch. They shall have specific ratings as specified in Table 5 and Table 6.

12.1 Circuit breaker interrupters

The contacts of the interrupter shall be held open by a positive fail-safe device independent of interrupter vacuum. The closing arrangement shall be designed to give a positive closing action while overcoming the contact hold open device.

12.2 Circuit breaker operating mechanisms

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

The circuit breaker busbar isolator and associated earth switch shall be actuated mechanically. Auxiliary switches shall provide indication of each switch position.

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

All circuit breaker operating mechanisms shall be the stored energy type by means of energy stored in a motor-charged spring with manual and electrical release.

Solenoid based mechanisms shall not be used.

Magnetic actuator type operating mechanisms will be considered, provided that full technical details of the proposed arrangement are supplied. Typical details shall include principle of operation, auxiliary power supply requirements, detail on manual operation and how the requirement for duplicate trip coils is addressed. The suitability of existing dc battery and associated dc circuit wiring shall require assessment in existing locations.

12.3 Circuit breaker operation and control

The circuit breaker closing mechanism shall be electrically operated, trip-free. The circuit breaker mechanism shall provide lockout that prevents closing, as specified in AS 62271.100.

All circuit breakers in the closed position shall be able to trip-close-trip before the spring needs to be charged again. The circuit breakers shall be arranged for operation by local control and by remote supervisory control. See Section 27.3 for further details.

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.

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.

A mechanical push-button or similar device for tripping the circuit breaker shall be provided. Continuously rated control equipment shall be provided to make the successful closing of the circuit breaker independent of the length of time that the control switch is held in the CLOSE position. This shall ensure that only one closing attempt can be made if the control switch is held in the CLOSE position.

12.4 Circuit breaker auxiliary contacts

A minimum of four normally open and two normally closed spare voltage free auxiliary contacts of Class 2 in accordance with AS 62271.1 shall be provided. These auxiliary switches shall be provided in addition to those essential to the circuit breaker operation.

13 Low voltage cabinet

The secondary equipment including protective relays, controls, transducers, metering and other systems shall be housed in a low voltage cabinet. The location of this low voltage cabinet shall be on the circuit breaker panel; where this is not possible, it may be located separately to the circuit breaker panel with approval from TfNSW, AMB.

The location of the panel shall be suitable to enable the installation of all secondary wiring and accessibility for terminating wiring, programming of protection relays and general testing and commissioning activities.

The low voltage panel shall be a lockable, closed, fully shrouded and arc resistant cabinet suitable for accommodating digital protection relays, test blocks, panel meters and other secondary equipment for control and measurement. Where it is appropriate, equipment may be mounted on a torsion resistant panel door.

The cabinet shall be fitted with a removable gland plate, cable ducting and terminals. The layout within the cabinet shall ensure all of the following:

- adequate room is provided for the termination of multi-core control cables, dc auxiliary supply cables and other miscellaneous cables that are required for interfacing with equipment within the substation
- cable terminals to be readily accessible to enable connection of test equipment associated with protection relay testing and commissioning

- cable ducting within the cabinet to be located to allow for the installation of multi-core control cables. In particular, adequate room between duct and cable entry points to allow for the bending radius of cables
- internal cabinet colour shall be white.

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

14 Switchgear indications

The circuit breaker and switch panel shall have indications clearly visible from the front of the panel (that is, either on the circuit breaker or on the circuit breaker panel).

The circuit breaker / switchgear panel shall have the following definite indications:

- circuit breaker open/close

  This shall be implemented by a mechanically operated indicator, 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, then the colour green shall indicate the open condition. The colour red shall indicate the closed condition.
- switch disconnector open/close/earth (if applicable)

  This shall be implemented by a mechanically operated indicator.
- earth switch position (if applicable)

  This shall be implemented by a mechanically operated indicator.
- stored energy device charged/discharged
- non-resettable operation counter (nominally mechanical).

  However, alternatives shall be accepted if approved by TfNSW AMB.

15 Switchgear auxiliary equipment

Each switchgear panel shall be fitted with a control panel with the following:

- a local CLOSE and OPEN switch or push-buttons coloured red and green respectively
- LOCAL – REMOTE (SUPERVISORY) changeover switch
- electrically operated indicating lights of the LED type

- a set of terminals for the termination of auxiliary wiring.

  All auxiliary wiring for remote closing and tripping circuits, incoming dc control supplies and all spare auxiliary switches shall be connected to these terminals.

This control panel shall have the capability for installing instruments to measure voltage, current and energy. The requirement for which instruments shall be installed will be specified at the time of order.

The requirements of any instrumentation to be fitted are set out in Section 24.

Each bus section's switchboard shall be fitted with a voltmeter and associated phase selection switch to indicate the bus voltage. A voltmeter shall also be provided for monitoring of each 33 kV bulk supply infeed incomer.

Anti-condensation heaters where required shall be provided.

16 Interlocks

Interlocking shall comply with the requirements of AS 62271.200.

All switchgear shall be provided with a comprehensive system of integrated mechanical and electrical interlocks to prevent any dangerous or undesirable operations. The interlocks shall prevent the unsafe operation of the equipment under all service conditions and ensure the correct sequence of operation for all circuit breakers, disconnectors and earthing switches. Actuating levers shall remove or insert in clearly defined positions 'CLOSED' or 'OPEN'.

Facilities provided for operational access to parts of the switchgear panel that contain live components shall be mechanically interlocked. Access to such parts shall not be possible unless all live parts have been rendered safe, either by a visibly applied earth connection or by positively disconnected and screened from the remaining live parts.

Mechanical interlocks shall be provided to ensure positive and substantial protection against malfunction. They shall be designed and constructed to ensure dependable fail-safe operation.

Positive mechanical interlocking shall be provided to prevent inadvertent switching from the ON position to the EARTH position without a definite stop in the OFF position, or from the EARTH position to the ON position without a definite stop in the OFF position.

Access to the test terminals shall only be possible when the associated earth switch is in the EARTH position.

When the circuit test facility is in use, the disconnector shall not be able to close.

If the switchgear panel is designed in a way that the circuit to be earthed is earthed through the main contacts of the circuit breaker, then the circuit breaker shall be interlocked. This is done so that it cannot be tripped by the protection relays or SCADA control while the circuit is earthed.

An analysis shall be provided detailing the integrity of the interlocking system. The analysis shall include all possible failure modes and the controls employed to prevent an unsafe operation.

A truth table shall be provided of all possible and inhibited states the switchgear may occupy.

17 HV cable compartment

Each circuit breaker and switch panel shall be equipped with an HV cable compartment for connection of the 33 kV cables. The HV cable compartment should be interlocked with the ACCB.

Due to the variety in physical configurations of existing substations there is the requirement for two separate options for access to the high voltage cable terminations.

The two options are as follows:

- access to the high voltage cables from the front
- access to the high voltage cables from the rear.

The cable bushings shall be arranged side by side facing the front of the switchboard. Bushings shall be positioned to suit connection of three core cables with tails of equal length to facilitate phase transposition without re-terminating the cable.

All cable compartments shall be adequately sealed to prevent entry of vermin and dust.

Each circuit breaker and switch panel shall provide the means to perform cable tests on the HV cables, without disturbing existing HV cable connections.

17.1 Fully insulated cable terminations

Where the cable compartment is designed for fully insulated cable terminations, they shall be suitable for dead-break, separable, fully insulated and shielded system for connection of HV cables. The separable, insulated, shielded connection system shall comply with AS 2629 (or equivalent IEC, EN standards) and relevant ratings specified in Section 7.

17.2 Non-fully insulated cable terminations

Where the cable compartment is designed for non-fully insulated cable terminations, they shall be suitable for air insulated termination. The compartment shall have at a minimum the clearances specified in AS 2067.

To provide protection against flashover due to rodents removable and re-installable elastomeric insulating boots (or approved alternative) shall be fitted.

17.3 Cable compartment size

The cable compartment shall be suitable for a minimum of two cables per phase, either single or three core cables, these are typically XLPE insulated cables. The minimum of two cables per phase shall allow for the installation of surge arresters if required.

All cable compartments shall be of dimensions such that full standard cable withstand power frequency tests as specified in AS 62271.1 can be conducted after cable termination is complete.

Where the cable compartment design results in a length of unsupported cable greater than the length recommended by cable manufacturers, then a method of cable support is required within the compartment.

The standard cable compartment requirement is for bottom entry of cables. A limited requirement for top entry of cables applies. Details of the cable connections options shall be nominated in the technical schedule provided in Appendix A.

18 Surge arresters for 33 kV switchboards

The switchboard shall have provisions for installing a surge arrestor in the feeder panels. If a surge arrester is required, it:

- shall comply with the requirements specified in TS 03869
- the surge arrester shall be type approved by AMB.

19 Circuit earthing facilities

All panels shall be equipped with circuit earthing switches manufactured and tested in accordance with the relevant standard specified in Section 7.

Earth switches shall be the integral type. The earthing of the circuit cables shall be effected via a separately designed make-proof earthing switch. The earthing shall be located directly on the circuit cable and designed without interposing further switching devices.

The earthing system shall be designed and tested for making a live circuit with a prospective peak fault current in accordance with the switchboard requirements specified in Table 2. Each circuit-earthing switch shall be mechanically interlocked with the corresponding circuit breaker or switch. See Section 16 for interlocking requirements.

The earthing switch shall be fully rated for fault making to the requirements specified in Section 7.

Each switch shall be provided with a failsafe indicating device to positively indicate whether it is in the OPEN OR EARTH position. The words 'OPEN' and 'EARTH' shall be used for the respective indication of these positions.

It is preferable that the operator can visually observe the earthing contacts. If this is possible then appropriate long life, maintenance free illumination shall be provided. The light source shall be able to be replaced without the need for isolating HV equipment or significant disassembly of the switchgear.

If the earthing of a circuit is not visible, the corresponding indication shall be directly coupled to the earthing mechanism to ensure fail-safe indication. The equipment manufacturer shall provide the design principles and analysis to support the fail-safe determination. The TAO shall provide the engineering assurance on the submitted documentation.

20 Voltage detecting system

A VDS in accordance with IEC 62271-213 with integrated display to detect the following shall be provided for all HV circuits:

- dead state
- operating voltage
- phase balance.

A voltage presence indicating system in accordance with IEC 62271-206 may be used if a VDS is not available.

Suitable capacitive voltage dividers fitted in the cable connection may be used.

Appropriate connections shall be provided to enable phase comparison in normal operating conditions.

An optional feature is for remote indication of 33 kV cable voltage status and interlocking with the earth switch. Interlocking shall inhibit the earthing of live circuit conductors.

21 Circuit test facilities

Each circuit breaker panel shall incorporate an integral type circuit test facility.

All test facilities shall be suitable for the application of test voltages associated with the after-installation testing of power cables. They shall be rated for the same system voltage as the switchgear as a minimum. Test facilities shall be able to withstand test voltages. Cable testing can require voltages higher than the rated voltage of the switchgear and cable, refer to TS 03756 for more details.

The test facility shall facilitate the connection of test equipment with the circuit earthed and then allow the earths to be removed with the test equipment still connected.

A hand applied earthing set shall be connected to the circuit side of each circuit breaker panel for use in conjunction with test equipment. The earth connection shall be applied or removed independent of the application or removal of the test equipment connection. External removable accessories shall be used to achieve this function.

22 Padlocking

Facilities shall be provided to padlock the following:

- disconnector in the closed, open and earth positions
- earth switch in the open and closed positions
- circuit breaker in the open positions and the closed position while the disconnector is in the earthed position
- circuit test facility, if applicable (see Section 15).

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

23 Segregation of LV wiring and HV compartment

Any low voltage wiring within HV compartments shall be segregated, mechanically protected and installed to provide adequate protection from a HV fault damaging the LV circuits. Compliance with this requirement is detailed in the technical schedule provided in Appendix A.

24 Instruments, transducers and metering

All instruments, transducers and metering equipment that are required to be fitted shall comply with this section and the relevant requirements in TS 00011.

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 readable from a standing position in front of the panel.

Analogue instruments shall have a scale length of at least 90 mm. All instruments on a switchboard 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.

24.1 Current transducers

Each feeder, transformer or harmonic filter panel shall have one current transducer connected to B∅ of a metering CT. The output of the current transducer shall be used to drive the ammeter and then be connected to the SCADA RTU for remote indication.

Applicable to metro, each 33 kV bulk supply infeed incomer, 33 kV tie breaker, 33 kV feeder, rectifier transformer, 33 kV transformer and harmonic filtering circuit breaker shall have an ammeter, complete with selector switch to allow each phase to be monitored. The ammeter shall be fitted within the associated switchgear panel.

Digital current measurement devices that have advanced communication capabilities (for example, IEC 61850) may be used in lieu of current transducers. These devices shall be able to drive the ammeter and then be connected to the SCADA RTU for remote indication.

Refer to TS 03865 for additional information on current transducer requirements.

24.2 Voltage transducers

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

Digital voltage measurement devices that have advanced communication capabilities (for example, IEC 61850) may be used in lieu of voltage transducers. These devices shall be connected to each VT and to the SCADA RTU for remote indication.

Refer to TS 03865 for additional information on voltage transducer requirements.

24.3 Ammeters

Ammeters shall have two scales that are essentially linear. The main scale shall allow for 150% of the primary current rating of the CT. The second scale shall be equivalent to the main scale divided by five, to allow reading of lower currents. A pushbutton fitted to the front of the ammeter shall activate the minor scale.

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

The accuracy of ammeters shall be 3% or better. Ammeter accuracy shall be stated in the technical schedule provided in Appendix A.

24.4 Voltmeters

Voltmeter shall have analogue indication with scales that have an indicating range of 80% to 120% of the nominal system voltages.

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.

24.5 Watthour meter

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.

Applicable to metro, the check kWh and kilovolt-ampere reactive hour energy meter(s) shall have accuracy class of not less than Class 0.2 and 0.5 respectively. The meters shall give the pulse input signals to power control system. Digital type kWh energy meter shall be provided for rectifier-transformer circuit and 33/11 kV transformer circuit at the 33 kV primary side. The kWh energy meters shall be of accuracy Class 0.2 with indication of not less than six digits.

All meters shall be of the three-phase, four wire element type.

25 Busbar and circuit protection

Protection schemes shall comply with TS 03736.

The specific protection schemes for a switchboard are specified in the approved protection concept which is issued at time of order.

25.1 High impedance bus zone protection

When a high impedance unit protection scheme is used, the associated components such as protection relay, MTM test block shall be located within one of the end panels that will be nominated in the approved protection concept.

25.2 Internal arc fault detection scheme

An alternative to the traditional high impedance scheme is subject to an approval by the TfNSW AMB. If approved, this system is the preferred scheme. If offered as an alternative to the high impedance scheme the complete system description shall be provided during tender for assessment.

26 Condition monitoring

Condition monitoring allows the real time monitoring of various parameters of the switchgear (for example, temperature, power, and so on). This allows for the data to be monitored, stored and analysed to be able to detect anomalies and predict the overall condition of equipment.

The switchgear manufacturer shall list any condition monitoring equipment that comes installed with the switchgear, as well as any optional condition monitoring equipment that is offered for the switchgear. They shall also include additional relevant information such as datasheets, ratings and the communications protocol or additional equipment that may be required.

During the type approval, the design TAO shall liaise with the operator or maintainer and discuss their requirement for the condition monitoring equipment on the basis that there is benefit to the TfNSW heavy rail network and 1500 V dc metro network.

27 SCADA interface

The SCADA alarms from equipment are implemented by a combination of hard wiring and using the serial link on the electronic protection relays. The serial communication port on all electronic protection relays within a switchboard shall be connected together and wired to a terminal strip for connection to the SCADA RTU.

Refer to TS 03736 for further SCADA alarm requirements and to TS 03865 for SCADA interfacing requirements.

27.1 Binary indication and ACCB control

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

Refer to TS 03736 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 switchgear.

27.2 Analogue indication

The following analogue indications shall be provided to SCADA:

- circuit current (B phase) for each circuit breaker
- bus voltage (measured AØ to CØ) for each section of the switchboard
- feeder voltage (measured AØ to CØ) for feeders fitted with a line side VT.

Current transducers shall be provided to allow monitoring of primary circuit currents by SCADA. Transducers shall be connected to a dedicated metering CT on B phase. See Section 24.1 and Section 24.2.

27.3 Controls

The SCADA RTU provides voltage free contacts which close for a maximum of two seconds for the following control functions:

- circuit breaker Open (trip)
- circuit breaker Close.

The SCADA RTU voltage free contacts have a maximum current rating of 1 A.

Interposing relays shall be provided for the SCADA initiated ACCB close and ACCB trip. See Section 12.3 for additional details.

The disconnector and earthing switch are manually operated and do not require SCADA control.

28 Tests

The switchgear testing requirements are split into three distinct categories as follows:

- type tests
- FAT
- SAT.

Testing requirements shall be read in conjunction with the specification TS 00011.

28.1 Type tests

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

- AS 62271.1
- AS 62271.100
- AS 62271.102
- AS 62271.200.

Type test certificates for each of these tests shall be accepted where it can be demonstrated that the switchgear supplied is of a similar design to previously type tested switchgear.

28.2 Factory acceptance tests

FAT are required to 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.

28.3 Routine tests

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

Certain routine tests will be required to be completed as part of the SAT.

Section 28.3.1 provides further detail on specific routine tests required.

28.3.1 33 kV Switchboard

For each panel the following tests shall be carried out. Routine test reports shall be provided to TfNSW.

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

- AS 62271.1:2019, Section 8
- AS 62271.100:2019, Section 7
- AS 62271.200:2019, Section 7.

CT and VT routine tests as listed in the following standards shall be carried out:

- AS 61869.2
- AS 61869.3.

Dielectric dissipation factor and partial discharge testing shall be performed.

28.4 Site acceptance tests

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 require to be repeated based on the hazards and risk analysis of transporting the switchgear from the factory to site and the installation activities required.

Sections 28.4.1 and 28.4.2 detail the minimum site acceptance tests required to be completed.

28.4.1 33 kV Switchboard

The switchboard shall be tested following installation and before commissioning into service to check the correct operation of the equipment including the interlocking system and the dielectric strength 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 (if applicable)
- measurement of moisture content of insulating gas (if applicable)
- operation of all devices
- timing of circuit breaker operation.

28.4.2 LV cabinet for secondary equipment

The following site pre-commissioning tests shall be performed on site following installation and before commissioning into service:

- 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.

29 Human Factors

The design of 33 kV indoor switchgear shall incorporate the principals of human factor integration as described in TS 04978.

Human factors aspects to be taken into account relate to controls and displays, information content, alarms and alerts.

29.1 Controls and display

Human factors shall be taken into account in the design of all operational facets of the switchgear. This includes aspects such as:

- location of the local and remote controls for the ACCB, disconnector and earth switches
- position and accessibility of viewing windows
- accessibility of the live line indicators, protection relays, ammeter, voltmeter are other key items that the location is critical to ensure suitability for use by the operator and maintainer.

29.2 Information content

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

Likewise, the design of the labelling and associated diagrams that describes the sequence of operation and position of devices is critical to enable correct operation of the switchgear.

30 Environment

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

The locations are normally naturally ventilated with ambient temperature ranges as specified in TS 03744.

Appendix A Technical schedule (normative)

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

A.1 33 kV switchboard technical schedule

Switchgear general details:	
Manufacturer	
Model	
Country of manufacture	
Busbar insulation medium	
IP rating general of switchboard	
IP rating of low voltage compartment	
Design life	
Partition class	

Switchgear common ratings:		
Number of phases		
Rated system voltage (Ur)		kV
Rated frequency (fr)		Hz
Rated busbar normal current (Ir)		A
Rated short time withstand current (Ik) (for main and earthing circuits)		kA
Rated short circuit making current		kA
Rated peak withstand current (Ip) (for main and earthing circuits)		kA (peak)
Rated duration of short circuit (tk) (for main and earthing circuits)		s
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)

Switchgear common ratings:		
Internal arc classification (IAC) Arc test current Arc test current duration		 kA s
Rated supply voltage of closing and opening devices and of auxiliary and control circuits (U_a)		V dc
Auxiliary supply for switchboard heaters and lights		V ac
Partial discharge level of complete switchboard including all components		
Provide derating factors (if applicable) for ambient conditions to a maximum of 50°C (derating factors shall be in the form of a table or graph)		
Description of all operational and safety interlocking arrangements		
Internal arc fault detection and protection scheme details		

Circuit breaker details:		
Interrupter type		
Rated continuous current (Ir) Bus tie Feeder System Transformer Rectifier Transformer Harmonic filter		 A A A A A
Harmonic filter circuit-breaker class		C1/C2
Number of trip coils		
Number of close coils		
Type of circuit breaker mechanism		
Maximum breaking time		ms
Magnetic actuator duration (if applicable)		ms
Command response time ON OFF		 ms ms
Rated operating sequence		
Cables connected (bottom, top, etc)		

Circuit breaker details:		
Mechanical endurance class		
Electrical endurance class		
Electrical rating of auxiliary contacts Current Voltage		 A V
Number of N/O auxiliary contacts		
Number of N/C auxiliary contacts		
Surge arrester types accommodated		
Surge arrester mounting details/restrictions		

Auxiliary supply requirements:		
ACCB trip coil		
ACCB close coil		
ACCB spring charge motor		
Disconnector/Earth switch motor		
Heater		
Magnetic actuator (if applicable)		

Harmonic filter circuit breaker details:
Has the switchgear been used for un-earthed, straight (no reactors) switching previously?
Has allowance been made for the circuit breakers to be pre-conditioned ready for service with negligible probability of re-strike?
Has the switchgear been tested for 150% dc offset and nominal ac voltage across the open contacts, successfully passing with no discharge in the contact dielectric?
Has allowance been made for energisation currents to be reviewed for use based on the particular site design?

Disconnector switch details:		
Rated normal current (Ir)		A
Mechanical endurance class		
Electrical endurance class		
Electrical rating of auxiliary contacts Current Voltage		 A V
Number of N/O auxiliary contacts		
Number of N/C auxiliary contacts		

Earth switch/earthing facilities details:		
Rated normal current (Ir)		A
Rated make fault current rating		A
Mechanical endurance class		
Electrical endurance class		
Provide details of the circuit earthing facilities offered including the method of indicating the position of the earthing switch and guaranteeing the integrity of that indication		
Provide details of the earthing bars for feeder ACCB panels, and how the requirements of insulated cable screen earth bar is met		
Details on the design principles and analysis of the earthing indication to support the fail-safe determination (see Section 19)		

Low voltage equipment panel details:		
Where are the protection relays, test blocks, meters and low voltage fuses located?		
Describe LV termination and cable access arrangements		
Rating plate attachment method		
Labels attachment method		
Provide details of paint coatings on the switchgear		

Low voltage equipment panel details:		
Provide details of colours of custom paint coatings available		
Maximum height from ground level of protection relays		mm

CT details:
Type of CTs being offered
Where are the CTs located and how are they mounted
Detail the physical space limitations

Voltage transformer details:		
Describe the physical location of the VTs (busbar and incomer) and relevant dimensions		
How are the VTs connected/isolated?		
Are fuses fitted to the primary side of the VTs?		
Details of the VTs offered:		
name of manufacturer		
ratio and class		
burden		VA
voltage factor		
location and type of fuses		
Busbar protection details:		

Is the busbar protection scheme offered a high impedance scheme?	
If the busbar protection scheme offered is not a high impedance scheme please provide details of the alternate scheme including:	
detailed operating documentation	
detailed maintenance documentation	
copies of test certificates	

33 kV cable interface details:
Provide details of how the HV cables are accessed
Maximum size and number of HV cables that can be terminated in each circuit breaker panel. Clearly specify clearances between each cable termination of each phase Provision of a detailed dimensioned drawing of the arrangement is required
Type of cable termination offered. Specify manufacturer, model and full details of separable insulated connector and associated detail on the shielding arrangement (if applicable)
Type of circuit test facility offered

Condition monitoring devices:	
List of condition monitoring devices integrated within the circuit breaker	
List of additional optional condition monitoring devices recommended for the switchgear	
Additional information regarding the listed condition monitoring devices	

A.2 Supply history

The manufacturer shall supply 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.

A.3 Additional description switchgear detail and information

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

- switchgear operation and maintenance manual
- details on standards that switchgear complies
- copies of all type test certificates and reports
- any departures from the requirements of this specification, if there are departures, include details on a separate sheet
- if alternate current and voltage measurement products are offered then full technical and operational details are required with required interfacing requirements
- details on the VDS
- details on interlocking between the ACCB, disconnector and earth switches
- description on the 33 kV cable termination and associated method for testing 33 kV cables
- 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
- description of the panel busbar interconnection arrangements
- details of segregation, mechanical protection of LV wiring in HV compartments.

A.4 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 TS 01517 for details of TfNSW requirements.

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

Appendix B Data set associated with the equipment (normative)

The following data shall be supplied by the manufacturer and maintained for the 33 kV indoor switchgear. This data will remain as a property of TfNSW.

B.1 Drawings and information

All drawings shall conform to the requirements of TS 01547.1.The following drawings are required as a minimum set:

- legend and symbols
- equipment list
- arrangement drawings (for example, complete switchboard, individual bays as required, HV cable compartment, switchboard low voltage panels) These drawings to include associated weights, dimensions, required clearances to meet manufacturers requirements and AS 2067 and NCC requirements. Cross-sections and details shall be included to enable the complete installation of the switchboard and connection of all HV cables, LV cables and wiring
- schematic diagrams
- interconnection diagrams (for example, between the low voltage panels within the switchboard)
- drawings detailing the required floor levels, penetrations and any other civil requirements for the installation of the switchboard shall be provided.

  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 A, supplied by the manufacturer, shall be maintained for each 33 kV indoor switchboard.

B.3 Life cycle costing

All the data and assumptions pertaining to the determination of the whole-of-life cost calculations of the switchgear shall be recorded. See Appendix D for details of whole-of-life cost. 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.

Appendix C Integrated system support requirements (normative)

C.1 Integrated support objectives

The switchgear 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 switchboard.

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.

C.2 Equipment supplier deliverables

The integrated support requirements are a significant deliverable in the procurement of new switchgear. Manuals, training, documentation and other support deliverables shall comply with TS 03742.

Appendix D Whole-of-life cost (normative)

This appendix is provided for TAOs to assess the whole-of-life cost as required by TS 01505.

The selection of the most suitable 33 kV indoor switchgear shall be made on the basis of minimising the whole-of-life cost. The following factors shall be taken into account when determining the whole-of-life cost:

- cost of changes to the technical maintenance plan and service schedules or the creation of new manuals and schedules
- cost of decommissioning and disposal
- cost of installation
- cost of inventory spares
- cost of maintenance
- cost of modifications to other parts of the installation
- cost of replacement parts
- cost of special tools
- cost of staff training
- discount rate
- electrical losses
- environmental costs
- initial purchase price
- lifetime of equipment
- reliability and cost of consequential damage after failure.

If the 33 kV indoor switchgear has not previously been type approved by TfNSW, Asset Management Branch in compliance with TS 06178, then the costs for this process shall be included in the whole-of-life cost.

Appendix E Information for the request for tender (informative)

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

Tenderers should complete and submit the technical schedule provided in Appendix A.

For procurement of 33 kV indoor switchgear, in addition to the requirements in this specification, site specific information and technical information shall be made available to tenderers.

Table 7 provides technical details to be included in the RFT.

Table 7 – 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.
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 should be provided.
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.
CTs	Number, location and details of CTs required if known at the time of tender.
33 kV Cables & surge arresters	The number, size and configuration of 33 KV cables. Whether 33 kV surge arresters are required.
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.

Table 8 provides site-specific information to be considered for including in the RFT.

Table 8 – 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 TS 03744)	Provide any details of any special requirements or conditions required for site such as nonstandard ambient temperature ranges, altitude, moisture, salt or pollution (site pollution severity) class