

- 11kV, 22kV and 33kV
- indoor metal-enclosed
- switchgear

ETS 0003

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Revision History

This specification replaces amendment no 0 of ETS 003. All changes are highlighted in this document with grey colouring.

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Contact Information

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For any enquiries relating to the content of this document please contact the Standards Coordinator on 13 10 81.

Document Control

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11kV, 22kV and 33kV indoor metal-enclosed switchgear

1 Purpose

To set out in detail the minimum technical requirements for 11kV, 22kV and 33kV indoor, metal-enclosed switchgear used in transmission and zone substations in the Endeavour Energy's network.

2 Documentation Scope

This Specification covers the design, manufacture, factory testing, delivery and testing at site of 11kV, 22kV and 33kV indoor metal-enclosed switchgear for use in Endeavour Energy's network.

It is not the intention to specify all the design and constructional details of the equipment, however the equipment supplied must meet all the requirements specified in the referenced standards and in this document.

The scope includes all accessories and equipment necessary and normally supplied for the safe operation of the equipment, whether specified or not.

All equipment **must** be manufactured and tested to the standards with the year of publication listed below. Endeavour Energy will consider equipment manufactured to other recognized international standards provided the standards are at least equivalent to Australian and/or IEC standards. In some circumstances based on local network experience, this specification is more stringent than the Australian and International standards it references, in this circumstance the requirements of this specification will prevail. Any proposed variations from this specification **must** be referred to **Substation Assets Manager** for approval in writing prior to acceptance.

3 References

External Regulations

Electricity Supply Act 1995 (NSW)

ENA National Electricity Network Safety Code (Doc 01-2008)

NSW Work Health and Safety Act 2011

National Electricity Rules Version 51 - 2012

External Standards

AS/NZS 3000:2007 - Wiring Rules

AS 2067:2008 - Substations and high voltage installations exceeding 1kV a.c.

AS 62271.1:2012 – high-voltage switchgear and controlgear Part 1: common specifications

AS/NZS 62271.100:2008 - High Voltage Switchgear and Controlgear Part100: High voltage alternating-current circuit breakers

AS 62271.200:2005 - High Voltage Switchgear and Controlgear Part 200: A.C. metal-enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 52kV

AS 62271.102:2005 - High voltage switchgear and controlgear - Alternating current disconnectors and earthing switches

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External Standards

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

AS1000:1998 - The international system of units (SI)

AS 60270:2001 - Recommendations for partial discharge measurements

AS/NZS CISPR16.2-2002 - Electromagnetic interference measuring equipment

AS 4398.1:1996(R2010) - Insulators – Ceramic or glass – Station post for indoor or outdoor use – Voltage greater than 1000V a.c. - Characteristics

AS 4398.2:2005 - Insulators – Ceramic or glass – Station post for indoor or outdoor use – Voltage greater than 1000V a.c. - Tests

AS1627.4:2005 – Metal Finishing - abrasive blast cleaning of steel surfaces

AS/NZS 4680:2006 – Hot-dip Galvanised coatings

AS 60044.1:2007 - Instrument transformers Part 1 Current transformers

AS 60044.1:2007 - Instrument transformers Part 2 Inductive voltage transformers

AS 1734:1997 - Aluminium and aluminium alloy flat sheet, coiled sheet and plate

AS 1824.2:1985 - Insulation Coordination (above 11kV)

AS 1874:2000 - Aluminium and aluminium alloy ingots and castings

AS 1852:1988 - International electrotechnical vocabulary

AS1931.1:1996 - High voltage testing techniques

AS 2067:2008 - Substations and high voltage installations exceeding 1kV a.c.

AS 2532:1982 – Voltage transformers for “measurement and protection

AS 2629:2008 – Separable insulated connectors for power distribution systems above 1kV

AS 2700:2011 – Colour standards for general purposes

AS 2981:2008 - High voltage a.c. switchgear and controlgear-Vacuum Interrupters-High voltage testing- Protection of personnel from X-ray emission

AS/NZS 2344:2016: Limits of electromagnetic interference from overhead a.c powerlines and high voltage equipment installations in the frequency range of 0.15MHz to 3000MHz

AS 3760:2010 – In-service safety inspection and testing of electrical equipment

AS 60269.2.1:2005 Low voltage fuses Part 2.1: Supplementary requirements for fuses for used by authorized persons

IS/IEC62271-1-2007 - High voltage switchgear and controlgear - Part 1 common specifications

IEC62271.1:2012 - High voltage switchgear and controlgear - Part 1 common specifications

IEC60529-2013 - Degrees of protection provided by enclosures (IP Code)

IEC 60376-2005 - Specification of technical grade sulphur hexafluoride (SF6) for use in electrical equipment-Edition 2

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Company Policies and Procedures

Company Policy (Network) 9.2.5 – Network Asset Design

Company Policy 9.2.10 - Network Asset Management

Company Policy 9.6.1 - Network Connections

Company Policy 9.7.1 - Network Asset Construction

Company Policy 9.9.1 - Network Asset Maintenance

Branch Procedure PAE 1004 - Product approval process

Branch form FAE 3135 - 11kV, 22kV and 33kV indoor, metal-enclosed switchgear

Internal Standards

Earthing Design Instruction EDI 516 - Major substation earthing design, construct and commissioning

Equipment Technical Specification ETS 0014 - Protection and control panels

Protection Design Instruction PDI 4002 – Current transformers for protection

Substation Design Instruction SDI 501 – Network Configuration

Substation Design Instruction SDI 526 - Control cabling, panels and termination

Substation Design Instruction SDI 528 - Substation signs and equipment labels

Substation Design Instruction SDI 545 - Acceptable purity limits for SF₆ gas

Substation Design Instruction SDI 547 - Alarm and tripping requirements in SF₆ and dry air equipment

4 Definitions and Abbreviations

Term	Definition
AC	Alternating current
CB	Circuit breaker
CT	Current transformer
VT	Voltage transformer
DC	Direct current
VI	Vacuum interrupter
DAIS	Dry-air-insulated-switchgear
Fixed pattern switchgear	Switchgear in which the circuit breaker is fixed in position and cannot be withdrawn.

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Term	Definition
Functional unit¹	Part of metal-enclosed switchgear and controlgear comprising all the components of the main circuits and auxiliary circuits that contribute to the fulfillment of a single function. Note: Functional units may be distinguished according to the function for which they are intended, for example, feeder circuit breaker unit.
Metal-enclosed switchgear¹ (switchboard)	Switchgear and controlgear assemblies with an external metal enclosure intended to be earthed and completely assembled, except for external connections.
Loss of service continuity category (LSC)¹	Category defining the possibility to keep other compartments/or functional units energised when opening a main circuit compartment.
R.M.S	Root mean square
Rated peak withstand current²	The peak current associated with the first major loop of the short-time withstand current that a mechanical switching device is designed to carry in the closed position under prescribed conditions of use and behavior.
Rated normal current²	The r.m.s value of the current that a switching device is designed to carry continuously under specified conditions.
Rated short time withstand current²	The r.m.s value of current that a switching device is designed to carry in the closed position during a specified short time under prescribed conditions of use.
Rated voltage²	The highest r.m.s phase to phase voltage of the supply on which the switching device is designed to operate.
SCADA	Supervisory Control And Data Acquisition
TBD	Tender Based Design
PCB	Printed Circuit Board

5 Technical Requirements

The metal-enclosed switchgear (switchboard) offered and supplied must be designed and manufactured in conformance with following and other relevant standards referenced except where specifically varied in this document. AS 62271.1:2012 as the common specification.

¹ AS 62271.200:2005 - High Voltage Switchgear and Controlgear Part 200: A.C. metal-enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 52kV

² AS 62271.1:2012 - Common specification for high-voltage switchgear and controlgear

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- AS 62271.200:2005 and IEC 62271.200:2011 for the metal enclosed switchgear components.
- AS 62271.100:2008 & IEC 62271.100:2012 for circuit breakers.
- AS 62271.102:2005 & IEC 62271.102:2013 for disconnectors and earth switches.
- AS 60044.1:2007 (R2016) for current transformers.
- AS 60044.2:2007 (R2016) for voltage transformers.

Metal-enclosed switchgear must be designed so that Endeavour Energy's normal service, inspection and maintenance operations can occur safely. This includes but is not limited to the visual determination of the energised or de-energised state of the main circuit and earth switch position, voltage indication for phasing, earthing of connected cables or other apparatus, locating of cable faults, voltage tests on connected cables or other apparatus and the elimination of dangerous electrostatic charges to allow works to be carried out safely.

The equipment supplied **must** meet the highest industry standards of engineering, design and manufacturing practices.

The **preferred** interrupting medium of the circuit breakers is vacuum (VI). Switchgear requiring oil as the arc interruption or insulation medium is not acceptable.

Endeavour Energy's preference is for the use of switchgear that does not contain SF₆ gas given its associated costs for management and global warming potential (GWP) where alternative cost-effective technologies are available. Cost-efficient offers of equipment containing SF₆ will be considered however weighting will be applied in the evaluation process to preference equipment with no or minimal SF₆. SF₆ management, environmental impact and disposal costs will be considered in the evaluation process. A similar evaluation weighting will be applied to all gas insulated switchgear, regardless of gas used (except dry-air) weighted by its GWP.

Endeavour Energy **historically had** a preference for withdraw-able type switchgear configurations to allow normal maintenance, repair and testing activities to occur with minimal network interruption. Cost-effective fixed pattern switchgear configurations **are preferred** provided appropriate test points, visual proof of de-energisation and earthed state and maintenance regimes are developed in accordance with this specification to allow normal maintenance, operational and testing activities to occur with minimal disruption to the remaining switchgear. Minimal disruption means any works confined to a single functional unit can be safely performed and not require the outage of adjacent sections of the switchgear or busbar.

Notwithstanding any of the above, due to the space restrictions in the substation building, switchboards with minimum space and minimal basement cable termination requirement are given preference in the evaluation.

The switchgear is to be designed, manufactured and tested for indoor service conditions. The supplier **must** provide all accessories necessary for the safe operation of the equipment.

All connections **must** be terminated using crimp lugs and stainless steel or hot dip galvanised bolts as appropriate. Clamps or U-bolt connections are not accepted. Bolts, screws and nuts **must** be ISO metric. All bolts **must** be no longer than necessary. All bolts, nuts and washers used **must** be hot dip galvanised or stainless steel. Cadmium plating will be considered. All nuts used **must** be fitted with approved positive locking devices.

Terminations for secondary systems components and associated wiring is detailed in 5.5.12.

Main metallic enclosures and all equipment enclosures **must** be appropriately earthed to the extent that there is no safety hazard to operating employees, to prevent accidental shorts by human error, and to prevent mechanical damage to the switchgear assembly. Earthing of the switchgear, cables and other

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plant is detailed in 5.5.2. Earthing of items within substations is detailed in EDI 516 - Major substation earthing design, construct and commissioning.

The design and construction of the switchgear **must** be in accordance with the technical requirements stated. All materials **will** be of the type and quality that will give a minimum life expectancy of 45 years.

All values submitted to this specification **must** be guaranteed values and **must** be treated as such in the evaluation and when assessing whether the delivered equipment meets this specification.

5.1 Service conditions

The equipment must be suitable for use on Endeavour Energy's 11kV, 22kV and 33kV 3-phase 50Hz system having the neutral point of the source for 11 kV effectively earthed and non-effectively earthed for 22 kV network. For 33 kV network the neutral point of the source will be effectively earthed mostly with few exceptions of non-effectively earthed.

The service conditions are in accordance with the indoor standard requirements of clause 2.1.1 of AS 62271:2012. The switchgear assemblies must be designed to operate in service conditions detailed in AS62271.1 and as further indicated in the table below.

Service Condition	Criteria
Altitude	<1000 m
Maximum ambient temperature	40 deg. C
Minimum ambient temperature	-5 deg. C
Average index of mean relative humidity: 9:00am	95%
Condensation	Yes
Annual Keraunic days	30

5.1.1 Safety

The complete switchboard **must** be designed to manage the risks associated with the switchboard such that there is no safety hazard to employees in normal service, including when operating and maintenance employees are carrying out inspections and maintenance operations, determining the energised or de-energised state of the main circuit, earthing connected cables and voltage testing of connected cables or other equipment.

Refer 5.3 for additional environmental and safety features.

5.2 Network operating conditions

Endeavour Energy's network is configured and managed in a manner described in SDI 501 – Network Configuration.

5.2.1 Configuration of switchboard

The configuration of indoor switchboard will vary according to the local network requirement of the substation. For this reason, a single line diagram (SLD) will be provided with each order but will be of the configuration detailed in SDI 501 – Network Configuration.

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A circuit breaker unit (a functional unit of the switchboard) requires a circuit breaker, a disconnecter and a fault make earth switch and an integrated protection and control panel for the fixed pattern switchboard. Protection panels for 33kV switchboards however will be separate from the main switchboard as detailed in 5.5.13.

For the withdrawable type switchboard, a circuit breaker unit comprises a withdrawable circuit breaker and a feeder fault make earth switch and integrated control and protection panel. Each switchboard with withdrawable circuit breakers must have a single, separate relocatable earthing truck provided.

For utilisation of asset ratings, Endeavour Energy also utilises double feeder arrangement as an option for 11 kV feeders. In this arrangement two 11 kV feeders are terminated from one single feeder circuit breaker unit. The feeder compartment would require housing two CTs, two relays and provision of two cable terminations along with all the associated secondary wiring.

Switchboards are fitted with a combination of following circuit breaker functional units.

- transformer circuit breaker unit;
- bus section circuit breaker unit;
- feeder circuit breaker unit; and
- feeder circuit breaker unit with double feeder arrangement.

A conceptual single line diagram is provided in Drawing no. 390070 which outlines the components of the above functional units that must be incorporated into the offered switchgear design. Exact CT locations will be provided and confirmed in the evaluation and at order placement. CT requirements are detailed in 5.5.11.1 and Annexure 1.

The ratings of components within the switchboard must be in accordance with the options detailed in 5.4. Endeavour Energy will detail the site-specific requirement for each unit in each circumstance.

5.3 Health, safety and environment (HSE) requirements

5.3.1 Insulating gas global warming potential (GWP)

Endeavour Energy's preference is for the use of switchgear that does not contain SF₆ gas given its management and global warming potential (GWP) where alternative cost-effective technologies are available. Cost-efficient offers of equipment containing SF₆ will be considered however weighting will be applied in the evaluation process to preference equipment with no or minimal SF₆. SF₆ management, environmental impact and disposal costs will be considered in the evaluation process. A similar evaluation weighting will be applied to all gas insulated switchgear, regardless of gas used (except dry-air) weighted by its GWP.

5.3.2 Special environmental requirements - toxicology safety

The supplier will provide with the offer, full details, including composition and toxicological information, regarding the health and safety aspects of all the materials offered in their offer or supplied equipment regardless of content.

Recommended procedures will be provided for the safe handling, safe operation and maintenance of products supplied. The means of disposal of the materials must be clearly stated.

Safety data sheets (SDS) must be provided, with copies available on site, for materials that are supplied and subject to safety considerations in handling and use.

All equipment, packaging and all other accessories provided must be asbestos free.

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The above information is required as part of the offer and will be reviewed as part of the tender process.

5.3.3 Noise levels and radio interference voltage (RIV)

The equipment may be installed in a residential area in close proximity to family residences. Noise and radio interference voltage must be kept to the minimum levels to comply with all the requirements of AS/NZS 2344:2016.

5.3.4 Fall prevention and safe working at heights

The design of the switchgear must be in such a manner that all operational and maintenance work can be performed at ground level. Where any works are required to be performed at heights, the safety at heights requirement must be in accordance with the NSW WorkCover Code of Practice: Managing the risk of falls at workplaces April 2016 and subject to approval by the Substation Assets Manager as part of the evaluation process.

5.3.5 Fire and blast hazards

The switchgear must be designed in a manner to eliminate the risk of rupture and explosive failure and subsequent personnel and fire risk. Where pressurised gas is used, or a rapid pressure increase could cause safety hazards to employees or other equipment, the use of appropriately placed pressure release diaphragms and venting positioning must be provided. Arc fault energy containment, pressure relief and venting are detailed 5.5, the equipment offered must be IAC and categorised as A FLR for the fault ratings detailed in 5.4.

Where SF₆ or other gas which release potentially corrosive and toxic by-products as a result of arcing are used, the supplier will detail appropriate measures to manage the risk to employees and provide measures to eliminate the likelihood of uncontrolled rupture.

5.3.6 Technical safety requirements

The disconnecter and earth switch in the circuit breaker unit or fixed pattern switchgear must be provided between the busbars and the circuit breaker to provide for the safety of employees working on the fixed circuit breaker. Means of visual isolation must be provided. There must be an earthed metal partition separating the circuit breaker compartment and the busbar and feeder compartments at a minimum.

The safety offered by the withdrawable type switchgear must be provided by working on the circuit breaker in the withdrawn state whilst connected to the control system by way of a plug-in socket cable.

Additional safety features including interlocks, indicators and equipment classification are detailed in the technical requirements of 5.4 and 5.5.

5.3.7 Safe working systems

Prior to any site work, a comprehensive risk assessment of all hazards must be carried out and mitigation measures identified and implemented. The work site hazard and risk assessment must be provided to Endeavour Energy for approval 7 days prior to any commencement of work on site. Endeavour Energy reserves the right to specify additional mitigation measures, other than the mitigation methods specified by the supplier to assist in managing the work site hazards.

Works performed on or near Endeavour Energy's network must be performed in accordance with Endeavour Energy's Electrical Safety Rules, Authorisations procedures and all relevant Safe Work Methods Statements (SWMS) and Safe Work Codes of Practice.

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5.4 Technical performance summary

The 11kV, 22kV and 33kV indoor switchboard must meet the following minimum technical requirement summary:

Item	11kV	22kV	33kV
Common requirements for complete switchboard and components			
Applicable standards	AS 62271.1:2012, AS 62271.200: 2005,		
Class	indoor	indoor	indoor
Switchboard configuration	Withdrawable* or fixed pattern	Withdrawable* or fixed pattern	Withdrawable* or Fixed pattern
No. of phases	3	3	3
Rated frequency (fr) (Hz)	50	50	50
Rated voltage (Ur) (kV)	12	24	36
Rated normal current (Ir) (A)	In accordance with CB ratings below	In accordance with CB ratings below	In accordance with CB ratings below
Temperature rise	Meets requirements in clause 4.4.2 of AS62271.1:2011 (table 3)	Meets requirements in clause 4.4.2 of AS62271.1:2011 (table 3)	Meets requirements in clause 4.4.2 of AS62271.1:2011 (table 3)
Switchboard preferred insulation medium	Air preferred / SF6 or other insulating gas will be considered	Air preferred / SF6 or other insulating gas will be considered	Air preferred / SF6 or other insulating gas will be considered
Rated insulation level – lightning impulse (Up) (kV peak) - common value - Across the isolation distance <i>(the distance between the two parts of the main circuit intended to be connected by a withdrawn or removed switching device, if any)</i>	95 95	145 145	170 195
Rated insulation level – 1 min power freq (Ud) (kV rms) - Common value - Across the isolation distance <i>(the distance between the two parts of the main circuit intended to be connected by a withdrawn or removed switching device, if any)</i>	28 32	50 60	70 80
Rated short time withstand current (Ik) (kArms)	20	20	31.5
Rated peak withstand current (Ip) (kAp)	50	50	79

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Item	11kV	22kV	33kV
Rated duration of short circuit current (t_k)(sec)	1	1	1
Nominal supply voltage of closing and opening devices and auxiliary circuits	120V DC	120V DC	120V DC
Minimum number of available normally open spare auxiliary circuits	4	4	4
Minimum number of available normally closed spare auxiliary circuits	4	4	4
Alarms (Where pressurised gas is used)	Motor failure Low gas stage 1 Low gas stage 2	Motor failure Low gas stage 1 Low gas stage 2	Motor failure Low gas stage 1 Low gas stage 2
Lockouts (where pressurised gas is used)	suitable for low gas lock-out in accordance with SDI 547 (as required)	suitable for low gas lock-out in accordance with SDI 547 (as required)	suitable for low gas lock-out in accordance with SDI 547 (as required)
Internal Arc classification type	IAC classified	IAC classified	IAC classified
Accessibility type	A FLR	A FLR	A FLR
Arc test - Current (kArms) - Time (s)	20 1	20 1	31.5 1
Loss of service continuity category – LSC	LSC2B	LSC2B	LSC2A
Shutters and partition type	PM	PM	PM
Maximum partial discharge of complete board at $1.1 U_m/\sqrt{3}$	20pC	20pC	20pC
Busbar			
Rated current (I_r) (A)	2000/2500	2000/2500	2000/2500
Disconnecter and earth switch			
Applicable standards	AS 62271.1:2012, AS 62271.102: 2005		
Insulation medium	Air/SF6	Air/SF6	Air/SF6
Method of operation	Motorised and manual	Motorised and manual	Motorised and manual
Classification of disconnector for mechanical endurance	M1 -2000 operations	M1 -2000 operations	M1 -2000 operations

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Item	11kV	22kV	33kV
Classification of earthing switch for electrical endurance	E1 -short circuit making capability	E1 -short circuit making capability	E1 -short circuit making capability
Circuit breaker			
Applicable standards	AS 62271.100:2008, AS 62271.1:2012		
Interrupting medium	Vacuum preferred	Vacuum preferred	Vacuum preferred
Rated normal current (Ir) (A)			
-Transformer	2000/2500	2000/2500	2000/2500
-Bus section	2000/2500	2000/2500	2000/2500
-Feeder	630	630	2000/2500
Temperature rise	Meets requirements in clause 4.4.2 of AS62271.1:2011 (table 3)	Meets requirements in clause 4.4.2 of AS62271.1:2011 (table 3)	Meets requirements in clause 4.4.2 of AS62271.1:2011 (table 3)
First pole to clear factor	1.5	1.5	1.5
Rated Operating sequence (t=0.3sec, t'= 3 min)	O-t-CO-t'-CO	O-t-CO-t'-CO	O-t-CO-t'-CO
Maximum total break time (open + arcing time)	0.06	0.06	0.06
Rated supply voltage of close, trip/open device and auxiliary circuits (Ua)	120 V DC	120 V DC	120 V DC
Number of shunt trip coils	Two (2) independently operated coils	Two (2) independently operated coils	Two (2) independently operated coils
Number of close coils	1	1	1
Mode of operating	Motor charged spring	Motor charged spring	Motor charged spring
Minimum operations with spring fully charged and circuit breaker fully de-energised	Trip – close – trip O-C-O	Trip – close – trip O-C-O	Trip – close – trip O-C-O
Additional requirements for capacitor bank circuit breaker			
Rated cable-charging breaking current (A)	25	31.5	50
Rated single capacitor breaking current (A)	400	400	400
Rated back to back capacitor breaking current (A)	400	400	400
Rated capacitor inrush current (kA)	20	20	31.5
Current transformers			
Applicable standards	AS 60044.1:2007(R2016)		

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Item	11kV	22kV	33kV
Rated insulation level – lightning impulse (Up) (kV peak)	95	145	170
Rated insulation level - 1 min power freq (Ud) (kV rms)	28	50	70
Voltage transformers			
Applicable standards	AS 60044.2:2007(R2016)		
Type	single phase	single phase	single phase
Rated primary voltage – phase to neutral	12kV/ $\sqrt{3}$	24/ $\sqrt{3}$	36kV/ $\sqrt{3}$
Nominal primary voltage – phase to neutral	11kV/ $\sqrt{3}$	22/ $\sqrt{3}$	33kV/ $\sqrt{3}$
Rated secondary voltage – phase to neutral	110/ $\sqrt{3}$	110/ $\sqrt{3}$	110/ $\sqrt{3}$
Rated insulation level – lightning impulse (Up) (kV peak)	95	145	170
Rated insulation level – 1 min power freq (Ud) (kV rms)	28	50	70
Other requirements for CTs and VTs.	As specified in Annexure 1		

Notes:

- Capacitor circuit breakers **must** be restrike free and have been tested to clause 6.111 of IEC 62271.100:2011.
 - The requirements of current transformers and voltage transformers will depend upon the protection scheme to be applied. Therefore, different options for CTs and VTs are included in Annexure 1. However, CT and VT requirement **will** be confirmed at order placement.
 - For selected items only, a measurement error certificate **must** be provided for metering CTs and VTs to confirm the relevant class requirement, including testing uncertainty, and **must** meet the requirements of chapter 7 of the National Electricity Rules. The supplier **is to** tender for both NATA and non-NATA certified VTs and CTs
- * The withdrawable circuit breaker **must** be able to be withdrawn by one person without causing manual handling or physical strain.

5.5 Technical requirements

5.5.1 General

Specific technical details are referenced in the following sections that follow:

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Switchgear component	Reference
Enclosure	5.5.2
Control panel indication (position)	5.5.3
Voltage presence indication	5.5.4
Operational interlocks	5.5.5
Insulating medium and materials (including bushings)	5.5.6
Circuit breaker	5.5.7
Busbar	5.5.8
Earthing switch and disconnectors	5.5.9
Cable terminations	5.5.10
Instrument transformers	5.5.11
Auxiliary and ancillary equipment and control wiring	5.5.12
Protection relays	5.5.13
Labelling	5.5.14
Nameplate	5.5.15

The 11kV, 22kV and 33kV indoor switchboards covered by this Specification **is to** include the following construction features:

- All switchboards **is to** be designed for permanent fixing to the floor.
- Switchboards **is to** comprise of a combination of circuit breaker units as outlined in the single line diagram provided.
- All removable parts, if any, and components of the same type, similar current rating and construction, **is to** be physically and completely interchangeable.
- The switchgear assembly **must** have full segregation between auxiliary and control equipment, cable termination, switching and busbar compartments. Full segregation requires full pressure and arc rated segregation.
- It is preferable that there **is will not be any** electronic printed circuit boards (PCB's) in the switchboard and all its components with the exception of the protection relays in order to provide for the lifetime management of the switchgear. Electronic PCB's can be considered provided approval of the Substation Assets Manager is given which will require any PCB to be readily available for purchase in the market or upgrades to be backward compatible for retrofit into the switchgear for future-proofing. PCB's **is to** be of industry standard design and not proprietary of a single supplier.
- Sharp edges and corners **must** be rounded off to avoid risk of injury.
- The general arrangement and configuration of individual components **must** allow for easy dismantling and removal without the need to dismantle other components.

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- Surfaces to be welded **must** be free of scale, dirt, grease, paint or heavy rust. The welding sequence adopted should reduce distortion as far as reasonably practical.
- All surfaces that will be connected together or which have to be accurate for the purposes of sealing, levelling or setting up during erection **is to** be accurately machined.
- All switchgear **must** operate all three phases simultaneously.
- Clear and reliable mechanical indication (semaphores) **must** be provided to indicate the position of all circuit breakers, disconnectors and earthing switches. The indication **must** be clearly visible from ground level without the need for additional tools and equipment to gain access.
- Switchboards **must** have a clear diagram on the front panel showing the main 11kV, 22kV or 33kV circuit, and indicating the operational position of the earth switches, disconnectors and circuit breakers. A separate control board and mimic panel where applicable is acceptable.
- All operational functions including the withdrawal or isolation of circuit breakers or voltage transformers **will** be carried out from the front of the switchboard with the equipment being operated placed behind closed and rated doors.
- Provision for remote control **is to** be provided for all switching units of the switchboard.
- The parts of the mechanism that require preventative inspection and maintenance **is not be** enclosed in any gas tight compartment.
- It **is to** be possible to conduct timing tests on each circuit breaker without de-energising the other functional units of the switchboard.

5.5.2 Enclosure

All switchgear and controlgear **must** be enclosed within a metal enclosure. The main enclosure **must** provide a degree of the protection of IP4X as a minimum in accordance with IEC60529:2013 and **must** comply with the requirements of clause 5.102 of AS62271.200: 2005. IP5X is preferred and weighting will be applied in the evaluation process to preference this requirement. For gas compartments, IP65 is the minimum requirement to provide protection and minimal leakage rates.

Where SF₆ or pressurised gas is used, the gas and vacuum tightness **must** be guaranteed at a leakage rate not exceeding 0.5% per year for closed pressure systems. Preference will be given to equipment with lower leakage rates than this tested in accordance with AS 62271.1:2012. Sealed pressure systems and chambers **must** be guaranteed at leakage rates not exceeding 0.1% per year.

It **is to** be possible to safely work on any switchgear unit or cable compartment with the remainder of the switchgear energised. There **must** be non-removable metal partitions between adjacent switchgear units/panels to prevent accidental approach to live parts of other units/panels when working on an adjacent panel.

For air insulated switchgear, a pressure relief chamber **must** be provided at the top of the enclosure to discharge any high-pressure build-up in the event of an internal arc fault within the enclosure. Hot gas generated due to internal arcing **must** release at the top of the enclosure and be vented in a controlled direction to improve safety of employees and to avoid damage to other equipment.

All shutters **must** be metallic and in accordance with clause 5.103.3 of AS 62271.200:2005. All metallic shutters **must** be earthed. The shutters **must** not be able to be moved to allow the insertion of fingers or tools once they have been locked.

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All internal and external metal surfaces capable of deteriorating due to corrosion **must** be appropriately cleaned and/or treated against corrosion with primer/paint and/or non-corroding metallic coating. Adequate coating **must** be supplied to protect surfaces from corrosive atmosphere and **must** be capable of maintaining such properties following reasonable physical handling.

Surface preparation and coating details **must** be supplied with the tender. This **must** include all material and application details as well as available colours. Light admiralty grey or light Grey is the preferred colour.

5.5.2.1 Earthing

Earthing of the switchboard, including all equipment, **must** be in accordance with clause 5.3 of AS 62271.200:2005.

A continuous electro-tinned copper earth bar **must** be provided along the total length of the switchboard, having a short circuit current rating at least equal to the rated short-time peak withstand phase to earth current of the main circuit.

Access **must** be provided for the connection of a cable screen earth to the earth bar at each cable compartment at the front of the cable box for easy access. Earth bars **must** have a minimum of four (4) holes in each cable compartment to allow the connection of the power cable screen using M12 bolts.

Each end of the earth bar **must** have holes suitable for the connection of 95mm² compression lugs. The lugs will be connected to the flexible cable from the substation earth grid, using M12 bolts.

The enclosure of each switchgear device **must** be connected to the earth bar. All the metallic parts intended to be earthed and not belonging to main or auxiliary circuits **must** also be connected to the earth bar directly through metallic structural parts.

Interconnections within the functional unit **must** be secured as to provide electrical continuity between the frame, covers, doors, partitions or other structural parts (for example, fastening by bolting or welding).

Earthing of earthing devices **will** be in accordance with clause 5.3.3 of AS 62271.200:2005 and earthing of withdrawable and removable parts **will** be in accordance with clause 5.3.4 of AS 62271.200:2005.

The earthing circuit of the switchboard **must** be capable of carrying the rated short time peak phase to earth currents as applicable.

5.5.2.2 Internal faults

The switchboard covered by this Specification **must** satisfy the requirement in clause 5.101 of AS 62271.200:2005 to prevent the occurrence of internal faults.

5.5.2.3 Compartments

Main components (bus bar, cable termination compartment, all switching units and low voltage and auxiliary circuits) of the switchboard **will** have totally segregated compartments.

Compartments **must** be capable of withstanding the normal and transient pressures to which they are subjected in service.

Auxiliary and control equipment which is installed on the frame of switching devices **must** be suitably protected against disruptive discharge from the main circuit.

5.5.2.4 Inspection windows

Means of visual inspection of the state of disconnectors and earth switches is required. Refer 5.5.9.3.

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5.5.2.5 Anti-condensation heaters

If required by the switchgear design anti-condensation heater(s) **will** be installed.

The heaters **must** be suitable for operation on single phase 230V 50Hz AC supply and **will** be thermostatically controlled. The thermostat **will** be set to 20 deg. Warning labels indicating “**Warning 230V A.C**” in accordance with SDI 528 **must** be fitted to all terminals. The terminals **must** be touch safe and appropriately shrouded (refer 5.5.12).

5.5.3 Control panel indication

The following indication **will** be provided on the control panel of each switching unit:

- A mechanically operated indicator which shows whether the switching device (circuit breaker, disconnecter and earth switch) is open or closed.
- The word OPEN or CLOSED must clearly indicate and be clearly visible in indicating the status of the each switching device. The colour red **must** indicate the closed position and the colour green **must** indicate the open position
- An indicator **must** be provided to show whether the motor driven stored energy device is charged or discharged.
- Each switching **must** be equipped with a non-resettable mechanically operated counter for indicating the number of tripping operations. The counter **must** be readable from the front of the switchgear, from ground level, without the removal of equipment.

5.5.4 Voltage presence indication system (VPIS)

A voltage detection system **must** be included with all functional units. It **must** comply with IEC 61243-5:1997.

Endeavour Energy relies on this device to confirm the presence of any voltage on the incoming cables, bus sections and outgoing cables and therefore it is mandatory that the unit is of a fail-safe design. This **must** be achieved by incorporating redundant capacitor elements in parallel with the capacitor across which the voltage is measured. There **must** also be a spark gap across the measuring circuit to indicate failure of the capacitor elements. The VPIS **is to** be maintenance free.

The indication element of a VPIS **is to** provide clear visual indication of the voltage state. The device **to** provide plug-in points to enable use of an external test device, such as a voltmeter or an indication lamp to check voltage presence or absence. Plug points **to** be suitable to receive a standard 4mm ‘banana plug’ for test purposes.

5.5.5 Operational interlocks

The following interlocks **are to** be provided for safe operation of the switchgear. The interlocks **must** be fail-safe mechanical type.

- It **must** not be possible to open the disconnecter when the circuit breaker is carrying load for fixed pattern switchgear
- It **must** not be possible to gain access to the cable termination compartment unless the circuit is isolated, and the corresponding earth switch is closed. Means to be provided to isolate the control power supplies that operates the circuit breaker and disconnecter
- It **must** not be possible to operate the earth switch if the disconnecter or circuit breaker is in the closed position.

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- It **must** not be possible to withdraw a circuit breaker from the busbar whilst it is in the closed position.

5.5.6 Insulation and insulating medium

The insulation of the switchboard and all other components **is to** be of a type and quality that will provide for a normal operating life of the switchgear of 45 years or more.

5.5.6.1 SF6 requirement (as applicable)

Where SF6 switchgear is offered, the following applies:

- The acceptable level of purity of new SF6 gas **must** be 99.7% by weight when measured from the gas bottle and will be confirmed by the supplier and **must** conform to IEC 60376:2005 and SDI 545 - Acceptable purity limits for SF₆ gas.
- SF6 gas purity **must** comply with the requirements of IEC 60376 and SDI 545 - Acceptable purity limits for SF₆ gas, after compartment filling. SDI 545 - Acceptable purity limits for SF₆ gas, requirements include a maximum moisture content of 200ppmv for new supply of SF6.
- The gas leakage rate **must** be guaranteed to be less than 0.1% a year for the lifetime of the equipment. Static filters **will** be provided within the tank to absorb decomposed products due to arcing. The gas tightness **will** be obtained by elimination of any part likely to wear or to age.
- The SF6 gas tank/chamber **must** be suitable for removal of all SF6 gas without tank/chamber crushing. The tank **must** be able to withstand absolute vacuum.
- Each functional unit **must** be provided with a separate point for SF6 charging and discharging using a DILO valve fitting. SF6 piping **is** not be inter-connected between functional units.
- The supplier **must** provide full details of charging (topping up)/discharging (removal) and storing of the gas without loss of gas, including equipment needed and any safety measures necessary.
- A temperature compensated gas density gauge **is to** be provided to indicate gas operating density within the tank.
- The gauge **is to** be mounted on the front of each functional unit and it **is to** provide the range of acceptable density using colour coded scales (Red - low, Yellow - reduced, Green - normal). The gauge **must** be visible without the need to open doors or covers
- Endeavour Energy's preference is for a density switch with three (3) sets of contacts in accordance with SDI 547 - Alarm and tripping requirements in SF₆ and dry air equipment. The first contact **must** open on stage one low gas alarm, when the gas density falls below the manufacturer's recommended operating density. The second set of two (2) contacts **is to** close on stage two, when the gas density falls below the manufacturer's recommended minimum to prevent the operation of the switchgear unit where unsafe. This system **must** be of a failsafe design. Alternatives offers can be submitted for approval as part of the evaluation process.
- Auxiliary contacts **are to** be provided for Endeavour Energy to choose whether these low-density levels are to be connected to SCADA.
- The concept of the tripping and closing scheme is outlined in the tender base design drawings attached with this specification
- The supplier of the SF6 switchgear **is to** have a return policy whereby they will accept responsibility for disposal of the SF6 switchgear and any remaining SF6 gas or by-products. The supplier **to** also accept SF6 gas that is evacuated during maintenance for the whole life of the switchboard.

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- All exposed gas pipe work **is to** be mechanically protected against any accidental damage.
- SF6 volume and mass of each separate switchgear unit **is to** be provided and included in the name plate data.
- A WorkCover Pressure Vessel Certificate **must** be provided with the tender. Failure to provide the certificate may result in disqualification of the tender.

5.5.6.2 Bushings

All bushings **must** comply with AS 60137-2008. Details of the bushings **is to** be supplied for evaluation purposes.

5.5.6.3 Other insulating components

Details of all other insulating components used and their location including epoxy **must** be provided for evaluation purposes.

5.5.7 Circuit breaker

The design and construction requirements of the circuit breaker **must** be in accordance with clause 5 of IEC 62271.100:2008.

All circuit breaker interrupting mediums **is preferred to be** vacuum.

The withdrawable circuit breaker **must** be able to be withdrawn and inserted by a single person without causing manual handling or physical strain.

Test points for fixed pattern switchboards are required in accordance with 5.5.10.3 and as detailed in the drawings of 5.10.

5.5.7.1 Vacuum interrupter

The design of the interrupting mechanism and contacts **must** be of a design so that the energy dissipated in the vacuum is low and does not cause appreciable degradation of the contacts.

Means **is to** be provided for the testing of the units for the existence of a vacuum without the necessity for the removal of the vacuum bottle(s). **Any special test equipment required for this purpose must be included as part of the offer.**

The vacuum bottles **must** be approved by the **Manager Asset Standards & Design** through the Product Approval process (refer 0) prior to acceptance of any switchgear. Details of approved vacuum bottles can be provided.

The contacts of the interrupter **must** be held open by a positive fail-safe device that is independent of the interrupter vacuum. The closing arrangement **must** be designed so as to give a positive closing action whilst overcoming the contact hold open device.

The supplier **is to** outline the relevant precautions to be taken by Endeavour Energy when testing the vacuum interrupter in line with the requirements of AS 2981-2008.

X-ray emission **must** be tested in accordance with clause 6.11 of IEC 62271.1:2011.

5.5.7.2 Operating mechanism

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

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The parts of the mechanism that require preventive inspection and maintenance **is** not be enclosed in any gas tight compartment.

The mechanism **is to** contain stored energy motor spring charging equipment to operate the circuit breaker. Circuit breakers with pneumatic or hydraulic mechanisms are not accepted. It **must** be possible to perform all operations of the circuit breaker either manually or electrically.

The circuit breaker in the closed position **must** be able to have a TRIP-CLOSE-TRIP operation before the spring needs to be charged.

The mechanism **will** be fitted with a non-re-settable operations counter. The counter must be readable from the front without the need to remove equipment or to open panels.

5.5.7.3 Operation and control

The circuit breaker closing mechanism **must** be electrically operated trip-free.

The circuit breaker **must** close when the close command is applied. The circuit breaker **must** not attempt to make a second attempt to close if it fails to close on the first attempt.

The circuit breaker **must** open on an open command when a trip signal is applied to one (1) trip coil or both trip coils, as appropriate.

The circuit breaker **must** be capable of being operated locally at the CB or remotely through a SCADA system. The SCADA system will provide an OPEN or CLOSE command signal of 1.0 Amp D.C maximum for a duration of one (1) second.

A maintenance LOCAL-REMOTE changeover switch **must** also be provided on the control panel to facilitate the changeover of control.

Local CLOSE and OPEN switches or push buttons **must** be provided in the breaker enclosure to operate the breaker locally.

A mechanical push button or similar device **is to** be provided for tripping the circuit breaker manually.

Necessary provisions **must** be made to prevent the spring charging motor from running continuously in the event that the springs fail to charge.

5.5.8 Busbar

The busbar **must** comprise three (3) single phase copper busbars with connections to the other main switchgear units. There could be multiple sections of busbar, according to the configuration requirement of the switchboard. The busbar **must** be of adequate cross section and adequately supported to withstand all thermal and dynamic forces without damage or deterioration.

5.5.9 Earthing switch and disconnectors

5.5.9.1 Earthing switch

A separate earthing switch **must** be provided to earth incoming, outgoing and bus bar circuits as shown in the single line diagram provided with each order. Each earthing switch **must** have an isolating link appropriately insulated for testing purposes. However, an optional earthing arrangement, with the circuit breaker racking into an earth position, may be considered, if the advantages of such an arrangement are provided by the manufacturer.

The earthing switch **must** be interlocked in accordance with clause 5.3.18 – Operational interlocks, and **it is to** be provided with a locking point to lock the switch in either the open or close position.

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5.5.9.2 Disconnectors

A disconnector **is to** be provided for each incoming and bus bar circuits as shown in the single line diagram provided for fixed pattern switchboards.

The disconnector mechanism **will** be motorised, and **it is to** incorporate a manual override with removable handle. The disconnector **is to** be interlocked in accordance with clause 5.3.18 and **to** be provided with a locking point to lock the disconnector in either the open or closed position.

5.5.9.3 Inspection windows

Inspection windows **is to** comply with clause 5.102.4 of AS 62271.200:2005.

Inspection windows **is to** be provided in all switching units for clear visibility of the gap of the disconnector and earth switch contacts. Alternatively, cameras can be offered for the same purpose. The camera system **is to** be approved by the **Substation Assets Manager** prior to acceptance.

5.5.10 Cable terminations

A separate cable termination compartment **is to** be provided for each switchgear unit, and each compartment **must** be segregated from other compartments by means of steel partition walls.

The cable termination compartment **must** be air insulated, suitable for connection of dry cable terminations. The cable compartment **must** be designed in a manner that provides adequate space with unrestricted access for employees to safely perform cable terminations. The supplier **must** provide the procedure to safely provide access to perform such tasks as part of the evaluation process. Approved plug-in or palm type/heat shrink cable terminations are acceptable.

The cable compartment **is to meet the requirement of** minimum clearances in accordance with AS 2067:2008 or **must** be consistent with the type tested values for the switchboard in accordance with AS 62271. The cable termination current rating **must** be not less than the current rating of the feeder, bus section or transformer circuit breaker.

The gland plate **is to be** of non-magnetic material and separate from the sides. Split gland plates **is to** be provided to accommodate the maximum number of cables.

Appropriate arrangement **must** be made to enable high voltage testing of each phase of each cable terminated to the switchboard.

5.5.10.1 11kV and 22kV cable termination

Cable termination palms **must** comply with AS 62271.301:2005. Termination palms **must** be suitable for the rating of the equipment. The standard connections are flat termination palms. The manufacturer **must** provide the full detail of cable termination facilities suitable for the equipment. Plug in type terminations are also acceptable subject to approval of the **Mains Asset Manager**.

Endeavour Energy uses the following types of cables to connect 11kV and 22kV switchgear units:

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Type of cable	Screened XLPE	
Cable voltage rating	6.35kV/11kV and 12.7/22kV	
Cable conductor	Copper	
Cross sectional area	Option 1	2 x Single core 630mm ² per phase for feeder panel
	Option 2	4 x Single core 800mm ² per phase for transformer panel
	Option 3	4 x Single core 1200mm ² per phase for transformer panel
	Option 4	1 x Three core 240mm ² cable` for feeder panel
	Option 5 (only 11kV)	2 x Three core 240mm ² cable` for feeder panel

5.5.10.2 33kV cable terminations

The cable termination **is to** be flat palm heat shrink based terminations and **is to** be suitable for termination of single core XLPE cable. Plug in type terminations are also acceptable subject to approval of the Network Mains Manager.

All termination parts and hardware necessary to make connections between cable conductors and switchgear **is to** be included as part of the offer.

Endeavour Energy uses the following types of cables to connect to 33kV switchgear units:

Type of cable	Screened XLPE	
Cable voltage rating	33kV	
Cable conductor	Copper	
Cross sectional area	Option 1	3 x Single core 630mm ² per phase for feeder panel
	Option 2	2 x Single core 800/1000/1200mm ² per phase for transformer panel
	Option 3	3 x Single core 800/1000/1200mm ² per phase for transformer panel

5.5.10.3 Provision for cable testing

For fixed pattern switchboards, a test point **is to** be provided for testing the cables without having to remove them from the termination or unplugging them.

5.5.11 Instrument transformers

5.5.11.1 Current transformers

Current transformers offered **must** comply with AS 60044.1:2007(R2016).

Each circuit breaker **must** be provided with three phase sets of current transformers typically in a number of possible options. For option 5 of 5.5.10.1, two sets of CT's for each cable will be provided. **These requirements are detailed in Annexure 1 and must be met by the Supplier.**

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However, the required numbers of cores and ratios of current transformers vary according to the protection and metering requirements of the substation. Therefore, requirements for current transformers will be finalised with each purchase order.

The secondary windings of the current transformers **must** be capable of carrying continuously a current not less than two (2) times the rated secondary current unless explicitly stated otherwise in annexure 1.

In the case of PX class CT's, the supplier **is to** specify in the tender offer the actual values of minimum kneepoint voltage (V_k), and maximum secondary resistance (R_{ct}) for each CT option, and these **must** be maintained throughout the term of the contract unless written approval is given by Endeavour Energy to deviate from these values.

Each set of current transformers **must** have all secondary leads brought out to an accessible terminal block inside the auxiliary control enclosure.

The terminals and leads **is to** be clearly marked with current transformer secondary terminal markings to AS 60044.1:2007. Wiring and terminal links **are to** be arranged to enable the easy changing of CT ratios.

A stainless-steel rating plate **is to** be fitted to each current transformer. A second identical plate **is to** be fixed within the LV compartment in such a position that facilitates ease of access to read the information.

The rated continuous thermal current (I_{cth}) **must** be specified on the CT nameplate in the format ' $I_{cth} = 200\%$ '

5.5.11.2 Voltage transformers

Voltage transformers **must** comply with AS 60044.2:2007(R2016). They **have to** be single phase units and **must** be as indicated in Annexure 1 and the single line diagram.

Where withdrawable VTs are used, it **must** be possible to withdraw the VT from the associated equipment without removing the circuit breaker from the fixed position. A lockable cover **is to** be provided over the high voltage contact.

The operation of the VT **is to** be separate from the main arc chamber and its secondary isolation **must** be achievable in the cabinet. Means **is to** be provided such that the VTs can be safely disconnected and reconnected from behind closed doors to provide safety of operation and maintenance employees.

Withdrawal and insertion of the VT and the locking of the VT shutters **is to** be able to be carried out without climbing onto the switchgear and from ground level.

All VT terminals **is to** be wired to the auxiliary control enclosure. The VT's neutral star point **is to** be earthed in the auxiliary control enclosure for 11kV and 22kV switchboards. 33kV neutral will be earthed in the Endeavour Energy control panels. All voltage transformers **must** have secondary isolation through fuses.

A stainless-steel rating plate **is to** be fitted to each voltage transformer. A second identical plate **is to** be fixed within the LV compartment in such a position that facilitates ease of access to read the information.

5.5.12 Auxiliary and ancillary equipment

5.5.12.1 Auxiliary supplies

Endeavour Energy will provide a 120Vdc station battery supply for closing, tripping and spring charging motors. All coils and spring charging motors **must** be capable of operating correctly within the range of maximum voltage of 130V and a minimum of 84V.

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5.5.12.2 Access to control equipment

All control equipment within the cubicle **must** be easily accessible, with the labelling visible from ground level to an operator of average height (175cm).

Components in the control panel **is to** be arranged to be easily accessible for future mounting, wiring, maintenance and replacement. Easy access **must** be possible without risk of electric shock.

An isolation switch **must** be provided to enable all control circuits to be isolated during maintenance.

5.5.12.3 Protection against electric shock

Control panels that are installed with the electrical equipment **must** be suitably protected against disruptive discharge from the main power circuit. Suitable protective insulated plastic shrouds **must** be provided to cover any exposed links or active conductive components (AC or DC).

5.5.12.4 Protection against fire hazard

All the risk of fire in control circuits **must** be reduced by wiring and terminating the control circuits in line with this specification.

Control circuit components and wiring **must** be chosen such there is no risk of fire developing as a result of the under-rating for both normal and fault conditions

Resistors that might heat up during operation **is to be** adequately positioned such that they do not cause a fire hazard or pose a risk to maintenance employees.

Enclosures **must** be constructed and insulated with material having sufficient resistance to ignition from any possible heat sources.

5.5.12.5 Control fuses

All secondary fuse holders, including those used as links, **is to** be GEC *Safeclip* C32/20 or similar, as approved by the Substation Assets Manager, Primary Systems. Fuse holders containing a fuse link **is to** be coloured black and those containing a solid link **is to** be coloured white. All fuses, links and terminals **must** be accessible from the front of the control panel.

5.5.12.6 Auxiliary contacts and relays

All ancillary contactors and relays **are to** be of a type proven to be capable of handling the current and voltages involved in the normal operation of the switchgear. All operating coils **must** be continuously rated for the supply voltage used.

5.5.12.7 Switchgear auxiliary switches

Each unit **must** be fitted with sufficient auxiliary switches to perform all the functions required by the switchgear units. The additional auxiliary switches are as indicated in the schedule of technical requirements above.

Each contact **must** be suitable for making, carrying and breaking five (5) Amps at 120Vdc and three (3) Amps at 250Vac in a typically inductive (magnet coil) circuit.

5.5.12.8 Control panel wiring

All wiring carried out by the supplier **is to** be in accordance with ETS 0014 – Protection and control panels.

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5.5.12.9 Wire termination

All control cables (internal panel wiring and external control cables) is to be terminated in accordance with SDI 526 - Control cabling, panels and termination.

5.5.12.10 Secondary terminal blocks

All secondary terminals is to be Klippon, Entrelec M series, Phoenix UT series or Weidmuller WDU series or equivalent as approved in accordance with 0.

Current transformer terminal blocks and protection circuit terminal blocks is to be tunnel connectors of the spring pressure type, for example, WDU SL.

Control wiring terminal blocks is to be suitable for the size of conductor being used and the type of terminal strip employed.

Suitable insulated plastic shrouds is to be provided for all auxiliary wiring terminal blocks located in the control cubicle. Where the terminal blocks are used for 230V AC termination, the warning labels with red letters of **Warning 230V AC** on a white background are required.

5.5.12.11 Front panel links

The standard links to be used is to be of a type like Eugaquip (refer drawing D46236) or suitable alternative as approved by the Protection Manager. Suitable protective insulated plastic shrouds or covers must be provided to cover any exposed links or active conductive components (AC or DC).

5.5.12.12 Control switch

Each unit is to be fitted with a Kraus and Naimer (or equivalent) C26 (operating handle G1,02) or push-button control switch with spring return to the neutral position following the electrical operation of the circuit breaker by an operator standing at the switchgear.

The escutcheon of the switch is to include a function designation of the circuit breaker operation. The rating of the switch contacts is to be capable of clearing the coil currents in the event of the breaker not functioning correctly.

5.5.12.13 Labels

All equipment within the cubicle(s) is to be clearly labelled by the supplier, to show its function. Labels is to be of laminated plastic having black upper-case letters on a white background. Lettering and numbering on labels is to be as large as practical and not less than 5mm high.

It is preferred that all labels are of the same size or at least the number of different sizes is kept to a minimum. Labels within the control cubicle is to be affixed using double sided very high bond form tape.

External labels is to be affixed using mechanical means. Labels not be directly affixed to items that are readily removable or interchangeable. Labels is to contain the device number and description of its function.

Current transformer and VT labels is to be made of either stainless steel, aluminium or traffolyte and mechanically affixed both to the CT and VT and the switchboard enclosure.

Drawings of the labels is to be submitted for approval by the Substation Assets Manager.

5.5.12.14 Interface terminal block

All external cabling is to be supplied and terminated by Endeavour Energy.

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The supplier **is to** provide all internal wiring including the interface terminal blocks ready for external wiring termination. The interface terminal facilities **is to** be provided on each unit.

The drawings indicated in section 5.8 include a typical interface terminal block and it **is to** be finalised during the approval process of manufacturing drawings.

The supplier **is to** provide for the connection of all external control cable into each switchgear auxiliary supply compartment.

5.5.13 Protection relay requirements

5.5.13.1 11kV and 22kV switchboards

Protection relays required for each circuit breaker unit will be supplied by Endeavour Energy and terminations for these relays will be carried out at the site by Endeavour Energy.

The circuit breaker panel enclosure opening required for these relays are included in the typical tender drawings and will be finalised at the time of ordering the equipment.

All internal wiring up to the protection relay **must** be carried out by the manufacturer and extra wire length of 300mm **will** be provided at the termination to the protection relay.

5.5.13.2 33kV switchboard

All protection relays will be installed at separate protection panels. All external cabling **is to** be supplied and terminated by Endeavour Energy.

5.5.14 Labelling

All labelling of main equipment and control wiring **must** be in accordance with Endeavour Energy's substation design instruction SDI 528 - Substation signs and equipment labels, and in particular clause 5.22.

5.5.15 Nameplate

The nameplate details of each circuit breaker unit and the instrument transformer (voltage and current) details **is to** be stamped on a stainless steel **or aluminium** plate and attached to the respective enclosure. The nameplate **is to** be easily readable, from ground level, in low lighting conditions.

The nameplate **must** contain the following information:

- Manufacturer;
- Type/model;
- Serial no;
- Year of manufacture;
- Rated voltage;
- Rated frequency;
- Rated lightning impulse withstand voltage;
- Rated power frequency withstand voltage;
- Rated normal current;
- Rated short-time withstand current;
- Rated peak withstand current;
- Rated duration of short circuit;
- Rated voltage of closing and opening devices;
- Gas density/pressure of circuit breaker, if applicable;
- Weight, volume and quality of gas used in the circuit breaker, if applicable;
- Internal arc classification (for example IAC classified AFLR 20kA/1sec); and
- Loss of service continuity type LSC

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Nameplate details for current transformers **is to** comply with clause 10.2 of AS60044.1:2007, and for voltage transformers, **is to** comply with clause 11 of AS 60044.2:2007. All nameplates **is to** be of stainless steel.

6 Maintenance requirements

6.1 Maintenance access

It **is to** be possible to carry out maintenance on one (1) functional unit without totally de-energising the switchboard or section of the switchboard.

Provision **is to** be made for timing tests to be carried out on each circuit breaker without de-energising remaining circuit breaker units in the switchboard.

Provision **is to** be made for the testing of cables in each cable compartment without de-energising the remaining circuit breaker units in the switchboard.

6.2 Spare parts

The supplier **must** supply a list of recommended spare parts, special tools and appliances required for the whole of life operation and maintenance of the switchboard installation. The list, together with prices, **must** be indicated in the appropriate schedule. The supplier must also provide details of the recommended maintenance and the frequency at which it must be carried out. Special tools are to be part of the main contract.

The items nominated must allow most common defects to be repaired and recommended maintenance to be carried out expeditiously over the whole life of the switchboard.

Predicted availability and compatibility of ex-stock parts over the life of the switchboard will be considered. Lists **must** be complete with part numbers and current prices for each item. Where identical items have been supplied to Endeavour Energy as spares on previous contracts, details of the quantity and type supplied **must** be provided. The final quantities of spares to be supplied will be decided as part of contract negotiation.

6.3 Failure mode analysis and preventative maintenance

The supplier **is to** indicate and provide updates to Endeavour Energy the mean time between failures (MTBF) of the switchboard and its components including the recommended maintenance regime and maintenance tasks and intervals. This regime **is to** be based on the mean time between failure (MTFB) and the critical failure modes identified by the failure mode, effects and criticality analysis (FMECA) of the equipment. Details substantiating the FMECA analysis **is to** be included in the offer.

Recommended tests to be carried out throughout the life of the switchboard and its components, including the pass/caution/fail criteria for each test **is to** be included in the offer.

7 Transportation

The supplier to this specification is responsible for the transportation between a manufacturer's works and the site nominated by Endeavour Energy within Endeavour Energy's franchise area.

The costs, risks and responsibilities for transportation are the responsibility of the supplier and **must** be agreed prior to contract acceptance. This include the responsibility for the load profile for each transport

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mode, transport route, the means of transport, any necessary route alteration, statutory approval or licenses, shipping reservations and documentation or any other requirement concerning the delivery of the switchgear to the nominated site.

7.1 Design for transport

The switchgear must be of a robust design and safeguarded for transportation, capable of withstanding any shock to which it may be subjected to during transport taking all planned transport modes into consideration. Necessary mechanical withstand capability must be built into the design. Endeavour Energy requires the installation on the packaging of suitable shock indicators based on the equipment design to review whether equipment damage has occurred during transport. All equipment damage must be the responsibility of the supplier.

7.2 Packing

The supplier must suitably pack each switchgear unit in a wooden crate complete with all other accessories, such as bolts, nuts, operating shafts, links, and enclosure parts.

All measures must be taken to prevent damage from occurring during packing, transporting and dismantling.

The following must be written in BLACK lettering (75mm high) on each wooden crate:

- Endeavour Energy;
- Contract number;
- Supplier's name;
- Mass; and
- Voltage rating (11kV, 22kV or 33kV).

8 Quality assurance

Quality assurance certification is required to review the manufacturer's ability to design and consistently manufacture switchgear to this specification. The supplier and all its contractors must have a quality system which complies with the requirements of AS/NZS ISO 9001 or other comparable Australian or International equivalent.

All nominated drawings and documents that have to be reviewed by Endeavour Energy are to be submitted as complete packages using document controls systems such that all the relevant information to enable the design to be reviewed are available. Design suitability approval will not relieve the supplier of its responsibilities for the correctness and appropriateness of the design or their responsibility to conform to this specification.

8.1 Quality assurance plan

A quality assurance plan is to be provided as part of the tender; it must be a document subject to approval of Endeavour Energy and must contain as a minimum the following information:

- the supplier's organisational structure for the works;
- a planned outline meeting the requirements and all stages of the scope and specification;
- an index showing all existing procedures, inspection and test plans and drawings;
- AS/NZS ISO 9001 certification for itself and subcontractors; and
- A plan detailing the design, ordering of materials, manufacturing and test plans.

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8.2 Operations and maintenance manual

The manufacturer/supplier **must** submit the following documentation prior to delivery of the equipment to Endeavour Energy as follows:

Two (2) hard copies and one (1) electronic copy of the complete installation, operation and maintenance manual **must** be provided for the complete switchgear supplied for each contract. Each manual **is to** relate specifically to the equipment supplied and must not contain any material that is not applicable. The manual **is to** be A4 size and all drawings **is to** be suitably folded or reduced for filing within the manual. Each manual **is to** include:

- a hard cover to withstand normal handling;
- a comprehensive index;
- installation instructions;
- operating instructions;
- instructions for the routine maintenance of the equipment and associated auxiliary equipment;
- recommended maintenance schedules;
- tests after maintenance work;
- type test reports;
- a complete list of parts with serial numbers;
- copies of detailed drawings;
- drawings of auxiliary equipment;
- routine factory tests;
- data sheets for each piece of equipment used clearly marking the components used; and
- design risk assessment.

Following this, for each order, one (1) hard copy and one (1) electronic copy of the following **must** be provided:

- a complete list of parts with serial numbers;
- copies of detailed drawings;
- drawings of auxiliary equipment;
- routine factory tests; and
- data sheets for each piece of equipment used in the switchboard clearly marking the components used.

8.3 Additional information

The following information **must** also be submitted:

- a list of recommended spares and tools, with prices and availability of each item;
- details of technical back-up facilities available; and
- details of equipment operating history, including how many in service, where, and for what period, plus reference contact names and numbers.

9 Testing

9.1 General

The supplier **must** be responsible for carrying out tests to demonstrate the switchgear units and complete switchboard supplied complies with the technical requirements specified in this Specification.

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The type, sample and routine tests **must** be carried out on the switchboard in accordance with this clause, prior to approval being granted for use within Endeavour Energy's network.

Branch Form FAE 3135 – 11kV, 22kV and 33kV indoor metal-enclosed switchgear (together with a copy of each of the tests) is to be completed and submitted to Endeavour Energy's **Substation Assets Manager, Asset Standards & Design** for review and approval.

All type tests **must** be carried out by a testing authority holding accreditation:

- by NATA Australia; or
- by an accreditation authority recognised by NATA Australia.

Tests from other testing authorities may be accepted at the discretion of the **Substation Assets Manager**.

All type test reports **must** be accompanied by copies of the accreditation certificate(s) issued to the testing laboratory. The accreditation certificate(s) **must** be valid for the relevant test(s) and for the duration of the test(s).

Type tests **must** be less than five (5) years old. Type tests beyond this limit may be acceptable at the discretion of Endeavour Energy's **Substation Assets Manager, Asset Standards & Design** Systems if sufficient information can be provided to show that the manufacturing process, raw materials, design and quality control processes have not significantly changed since the original test date.

All sample and routine tests may be conducted at the manufacturing facility's test laboratory on the condition that sufficient evidence is provided to Endeavour Energy's **Substation Assets Manager, Asset Standards & Design** to demonstrate the testing facility's capability to perform the specified tests. As a minimum, the following information **must** be provided:

- qualifications/experience of the testing employees;
- test procedures for all sample/routine tests;
- testing facility quality control procedures; and,
- test instrument calibration certificates/procedures.

As part of the product approval process, the **Manager Asset Standards & Design** will inform in writing if Endeavour Energy accepts sample and routine tests being conducted at the manufacturing facility's test laboratory.

All documentation submitted (including reports, tests, testing procedures/policies, calibration certificates and the like) written in any language other than English **must** not be accepted by Endeavour Energy unless the reports are translated into English by a sworn translator.

9.2 Type tests

The offered switchgear components (circuit breaker, current transformer, voltage transformers disconnecter and earth switch) and a representative switchboard **must** be subject to type tests in accordance with AS62271.1:2011 and **AS IEC 60060-2:2018** and other relevant standards listed below.

Every component of the representative switchboard **must** be type tested in accordance with the applicable standard with the switchboard fully assembled and type test reports **must** be provided. Each component of the switchboard including auxiliary circuits, **must** withstand the temperature rise limits without damage.

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9.2.1 Representative switchboard

All type tests required in clause 6 of AS 62271.200:2005 and AS 62271.1:2012 **must** be carried out and separate type tests reports **must** be provided for circuit breaker units that have different current ratings for the voltage rating of the switchboard.

As a minimum, the following criterion applies on the representative switchboard:

Item	Type test	Test method reference	Acceptable criteria
1	Dielectric tests	Clause 6.2 of AS 62271.200:2005 and IEC 62271.1:2011	No disruptive discharge (power frequency and impulse)
2	The resistance across the complete main circuit (for each joint)	Clause 6.4 of AS 62271.200:2005 and IEC 62271.1:2011	<25mV at rated current (10/12.5/40μΩ @ 2500/2000/630A)
3	Temperature-rise tests	Clause 6.5 of AS 62271.200:2005 and AS 62271.1:2012	in accordance with table 3 of AS62271.1:2012 depending on the required:<65K for copper in SF ₆ <30K (accessible parts)
4	The resistance across the complete main circuit following temperature rise tests, and the like.	Clause 6.4 of AS 62271.200:2005 and IEC 62271.1:2011	<20% increase from item 2
5	Short-time withstand current and peak withstand current	Clause 6.6 of 62271.200:2005 and IEC 62271.1:2011	<20% increase from item 2 no failure and proven suitable for temperature rise test following
6	Verification of making and breaking capacities	Clause 6.101 of AS 62271.200:2005	<20% increase from item 2 No failure of switch
7	Mechanical operation tests	Clause 6.102 of AS 62271.200:2005	No mechanical failure of devices or interlocks (50 times)
8	Protection verification tests	Clause 6.7 of 62271.200:2005 and IEC 62271.1:2011 / IEC60529:2013	Gas compartments: IP65 Switchgear: IP5X (refer 5.5.2 – minimum 4X as approved)
9	EMC test	Clause 7 of IEC AS/NZS 2344:1997	Does not exceed the field strength DBμV/m limits of Table 1 (0.15-30MHz) and appendix B (>30MHz)
10	Test on non-metallic partitions and shutters (where applicable)	Clause 6.104 of AS 62271.200:2005	Leakage current <0.5mA
11	Pressure withstand test for gas-filled compartments (where not covered under individual switchgear)	Clause 6.103 of AS 62271.200:2005	No rupture
12	Tightness tests	Clause 6.8 of AS 62271.200:2005 and IEC 62271.1:2011	0.1% a year – sealed pressure

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Item	Type test	Test method reference	Acceptable criteria
			0.5% a year – closed pressure
13	Internal arcing test	Clause 6.106 of AS 62271.200:2005	Satisfies criterion 1 to 5 of Annexure A of AS 62271.200:2005
14	Partial discharge test	Clause 6.2.9 of AS 62271.200:2005	<20pC @ 1.1 Um
15	Dielectric test on cable testing circuit	Clause 6.2.12 of AS 62271.200:2005	No disruptive discharge

9.2.2 Circuit breaker

The testing requirements of clause 6 of AS 62271.100:2008 **must** be met. As a minimum, the following criterion also applies to the circuit breaker:

Item	Type Tests	Test method Reference	Acceptable value
1	Dielectric tests	AS62271.100-2008 Cl6.2	No disruptive discharge
2	The resistance across the complete main circuit (for each joint)	AS62271.100-2008 Cl6.4	<25mV at rated current (10/12.5/40μΩ @ 2500/2000/630A)
3	Temperature-rise tests	AS62271.100-2008 Cl6.5	in accordance with table 3 of AS62271.1:2012 depending on the required that is, <65K for copper in SF ₆ <30K (accessible parts)
4	Short-time withstand current and peak withstand current tests	AS62271.100-2008, clause 6.6	<20% increase from item 2 no failure and proven suitable for temperature rise test following
5	Tightness tests: leakage rate at 45°C	IEC62271.100-2008, clause 6.8	0.1% per annum
6	Mechanical operation test at ambient temperature	AS 62271.100-2008, clauses 6.101.2.1 to 6.101.2.3	Operating characteristics before test same as after test (characteristics recorded) – ops in accordance with technical schedule
7	Short-circuit current making and breaking tests	AS 62271.100-2008, clauses 6.102 to 6.106	No failure to break from 10% to 100% of rated breaking current
8	Capacitive current switching test: Cable charging current breaking test	AS 62271.100-2008, clauses 6.111.5.2	No re-strike
9	Verification of the degree of protection	IEC60529-2009, clauses 11 to 15	Gas compartments: IP65 Switchgear: IP5X (refer 5.5.2 – minimum 4X as approved)
10	Low and high temperature tests	AS62271.100-2008, clause 6.101.3	No failure during and at completion of tests

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Item	Type Tests	Test method Reference	Acceptable value
11	Humidity Test	Clause 6.101.4 of AS 62271.100:2008	No change in operating characteristics after test.
12	Electrical endurance tests	AS62271.100-2008, clause 6.112	No failure at 110% of rated current.
13	Single-phase and double earth fault tests	AS62271.100-2008, clause 6.108	No undue failure of breaker

9.2.3 Disconnectors and earth switches

The testing requirements of clause 6 of AS 62271.102:2005 **must** be met. As a minimum, the following criterion applies to the disconnector and earth switch:

Item	Type test	Test method reference	Acceptable criteria
1	Dielectric tests	Clause 6.2 of AS 60265.1:2001 and IEC 62271.1:2011	No disruptive discharge
2	The resistance across the complete main circuit (for each joint)	Clause 6.4 of AS 60265.1:2001 and IEC 62271.1:2011	<25mV at rated current (10/12.5/40μΩ @ 2500/2000/630A)
3	Temperature-rise tests	Clause 6.5 of AS/NZS 60265.1:2001 and IEC 62271.1:2011	in accordance with table 3 of AS62271.1:2012 depending on the required : <65K for copper in SF ₆ <30K (accessible parts)
4	Short-time withstand current and peak withstand current	Clause 6.6 of AS/NZS 60265.1:2001 and IEC 62271.1:2011	<20% increase from item 2 no failure and proven suitable for temperature rise test following
5	Protection verification tests	Clause 6.7 of AS/NZS 60265.1:2001 and IEC 62271.1:2011	Gas compartments: IP65 Switchgear: IP5X (refer 5.5.2 – minimum 4X)
6	Tightness tests	Clause 6.8 of AS/NZS 60265.1:2001 and IEC 62271.1:2011	0.1% a year – sealed pressure 0.5% a year – closed pressure
7	Making and breaking tests	Clause 6.101 of AS/NZS 60265.1:2001	No failure of switch
8	Mechanical operation tests	Clause 6.102 of AS/NZS 60265.1:2001	Operating characteristics same as before test.

9.2.4 Current transformers

All the relevant type tests in accordance with AS 60044.1:2007 **must** be performed and tests report issued for each type (as specified in Annexure 1). As a minimum, the following type test criteria apply.

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Item	Type test	Test method reference	Acceptable value
1	Short time current test	AS 60044.1:2007, clause 7.1	No damage of CT or wiring Errors do not differ by more than half the accuracy class.
2	Temperature rise test	AS 60044.1:2007, clause 7.2	Compliance with the requirements of Section 4.6 of AS60044.1:2007
3	Lightning impulse test	AS 60044.1:2007, clause 7.3.2	No disruptive discharge.
4	Determination of errors	AS 60044.1:2007, clause 11.4	As per table 11 and 14 in AS60044.1:2007.
5	Radio interference voltage measurement	AS 60044.1:2007, clause 7.5	In accordance with AS/NZS 2344:1997
6	<i>Test for accuracy of measuring CT</i>	<i>AS 60044.1:2007, section 11</i>	<i>Table 11 and 12 of AS 60044.1:2007</i>
7	<i>Test for accuracy of protective CT (P class)</i>	<i>AS 60044.1:2007, section 12</i>	<i>Table 14 of AS60044.1:2007</i>
8	<i>Test for accuracy of protective CT (PX class)</i>	<i>AS 60044.1:2007, section 14</i>	<i>All performance test requirements of section 14.3 / 14.4 are required for PX class CT's with limits as set out in Annexure 1.</i>

9.2.5 Voltage transformers

All the relevant type tests in accordance with AS 60044.2:2007 **must** be performed, and test reports issued for each type (as specified in Annexure 1). As a minimum, the following type test criteria apply.

Item	Type Test	Test method reference	Acceptable value
1	Temperature rise test	AS 60044.2:2007, Clause 8.1	In accordance with 5.4 of AS60044.2:2007
2	Short circuit withstand capability test	AS 60044.2:2007, clause 8.2	No damage to VT; errors do not vary by 1.5P or 0.25M
3	Lightning impulse test	AS 60044.2:2007, clause 8.3.2	No disruptive discharge
4	Radio interference voltage measurement	AS 60044.2:2007, clause 8.5	In accordance with AS/NZS 2344:1997
5	<i>Test for accuracy of measuring VT</i>	<i>AS 60044.2:2007, clause 12</i>	<i>Table 11 of AS 60044.2:2007</i>
6	<i>Test for accuracy of protective VT.</i>	<i>AS 60044.2:2007, clause 13.6.2</i>	<i>Table 12 of AS60044.2:2007</i>

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9.3 Routine factory tests

9.3.1 Switchboard

The routine factory tests detailed in AS 62271.1:2012 clause 7 and AS62271.200:2005 clause 7 **must** be met and be carried out on each complete switchboard supplied. The following minimum criteria also apply:

Item	Routine Test	Test method reference	Acceptable value
1	Dielectric tests on main circuit	Clause 7.1 of AS 62271.200:2005 and IEC 62271.1:2011	No disruptive discharge
2	Tests on auxiliary and control circuits	Clause 7.2 AS 62271.200:2005 and IEC 62271.1:2011	> 5 mega ohms using 1000 Volt megger
3	The resistance across the complete main circuit	Clause 6.4 of AS 62271.200:2005 and IEC 62271.1:2011	< 20% variation from type test value
4	Tightness test	Clause 7.4 of IEC 62271.1:2011	0.1% a year – sealed pressure 0.5% a year – closed pressure
5	Partial discharge measurement	Annexure B of AS 62271.200:2005	<20pC @1.1 Um
6	Design and visual checks	Clause 7.5 of IEC 62271.1:2011	Compliance to specification
7	Mechanical operation test	Clause 7.102 of AS 62271.200:2005	All operations satisfactory after 5 close/open operations
8	Pressure tests of gas-filled compartments	Clause 7.103 of AS 62271.200:2005	No rupture (1.3 times pressure for 60 sec for >50kPA relative)
9	Dielectric dissipation factor	AS62271.100 clause 7.200	value recorded for future use

9.3.2 Circuit breaker

The routine factory tests detailed in AS 62271.1:2012 clause 7 and AS62271.100:2005 clause 7 **must** be met and be carried out on each circuit breaker. The following minimum criteria also apply:

Item	Routine test	Test method reference	Acceptable value
1	Dielectric test on main circuit	IEC62271.1:2007, clause 7.1	No disruptive discharge
2	Dielectric test on auxiliary and control circuits	IEC62271.1:2007, clause 7.2	>5 Mega Ohms using 1000volt megger
3	Measurement of resistance of main circuit	IEC 62271.1:2007, clause 7.3	< 20% variation from type test value
4	Mechanical operation test	AS62271.100:2008, clause 7.101	Withstands 5 close/open operations
5	Design and visual test	IEC 62271.1:2007, clause 7.5	Meets specification

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Item	Routine test	Test method reference	Acceptable value
6	Dielectric dissipation factor	AS62271.100:2008, clause 7.200	value recorded for future use
7	Partial discharge test at 1.1 Um	AS62271.100:2008, clause 7.201	<5pC

9.3.3 Instrument transformers

The routine factory tests detailed in AS 60044.1:2007 clause 8 **must** be carried out on each current transformer supplied. Additionally, the tests of clauses 11, 12, and 14 apply to measuring and protection, P and PX CT's respectively. A test report **must** be provided for each CT with the acceptable criteria as detailed in AS 60044.1:2007.

The routine factory tests of class 9 of AS60044.2:2007 **must** be carried out on each voltage transformer supplied. Additionally, the tests of clause 12.4 and 13.7 of AS60044.2:2007 are required. A test report **must** be provided for each VT with the acceptable criteria as detailed in AS 60044.2:2007.

9.4 Site tests after erection on site

The following tests **must** be carried out on the complete switchboard after erection at the Endeavour Energy site.

Item	Routine site test	Test method reference	Acceptable criteria
1	Dielectric tests on main circuit	Clause 7.1 of AS 62271.200:2005 and IEC 62271.1:2011	No disruptive discharge
2	Tests on auxiliary and control circuits	Clause 7.2 AS 62271.200:2005 and IEC 62271.1:2011	>5 mega Ohm using 1000V megger
3	The resistance across the complete main circuit	Clause 6.4 of AS 62271.200:2005 and IEC 62271.1:2011	< 5% variation from routine
4	Tightness test	Clause 7.4 of IEC 62271.1:2011	0.1% a year – sealed pressure 0.5% a year – closed pressure
5	Partial discharge measurement	Annexure B of AS 62271.200:2005	<20pC @ 1.1 Um
6	Design and visual checks	Clause 7.5 of IEC 62271.1:2011	Compliance to specifications

In addition, all switching equipment **must** undergo operational tests as follows:

- Timing tests of the circuit breakers.
 - Five (5) closes
 - Five (5) opens
 - Five (5) close opens
- Insulation resistance test for main circuit of complete board:

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- Close all switchgear in main circuit and test phase to phase and phase to earth insulation resistance: >250 Giga Ohm.
- Operational tests:
 - Check for proper functioning of all interlocks.
 - Carry out five (5) close/open operations for all switching devices (disconnectors, earth switch and circuit breakers).
- SF6 purity analysis for each bottle of gas used during installation.
- SF6 purity analysis for each SF6 compartment to benchmark the initial SF6 in the switchgear.
- SF6 gas purity is to be in accordance with SDI545.

Current transformers and voltage transformers must be tested for ratio and verification of all terminals.

If any site test results are non-conforming, they must be submitted to the Substation Assets Manager for approval in writing prior to acceptance for energisation.

9.5 Submission of test results

9.5.1 Type test reports

One (1) copy of type tests report must be submitted with the tender, clearly indicating pass or fail under all the type test requirements in clause 5.6.2, for approval by the Substation Assets Manager, Asset Standards & Design.

When the offered switchgear has not been successfully type tested, or test results do not meet the technical requirements of this specification, fresh type tests must be conducted at the manufacturer's expense.

Endeavour Energy reserves the right to witness type tests, for which a minimum of four (4) weeks' notice must always be given.

9.5.2 Routine factory testing

The routine factory tests reports must be submitted as part of Factory Acceptance Tests (FAT) for each switchgear unit before delivery of the equipment. Factory Acceptance test reports must be approved by Endeavour Energy prior to the delivery of the switchgear to site.

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10 Tender drawings

The following drawings are included as part of this specification for tendering purposes.

Drawing No	Issue	Description
355760	A	ETS 0003 Indoor CT connection circuit diagram
355758	A	ETS 0003 11kV/22kV switchgear Interface Terminal Block Connection Diagram
355762	A	ETS 0003 Indoor VT connection circuit diagram
386327	A	Tender Base Design 11/22/33kV Indoor Metal Enclosed Switchgear Circuit Breaker Units Single Line Diagrams
390839	A	ETS 0003 11kV/22kV Feeder CB control and protection With Busbar Blocking Scheme Typical Panel Layout
390840	A	ETS 0003 11kV/22kV Transformer CB control and protection Busbar Blocking Scheme typical Panel Layout & material list
390841	A	ETS 0003 11kV/22kV Bus Section CB control and protection Busbar Blocking Scheme Typical Panel Layout and Material list
390842	A	ETS 0003 11kV/22kV Feeder CB control and protection & indication Busbar Blocking Scheme Typical Circuit Diagram
390843	A	ETS 0003 11kV/22kV Transformer CB Control, Protection & Indication Busbar Blocking Scheme Typical Circuit Diagram
390844	A	ETS 0003 11kV/22kV Bus Section CB control, protection & indication Busbar Blocking Scheme Typical Circuit Diagram
390845	A	ETS 0003 11kV/22kV Feeder CB control and protection High Impedance Busbar Protection Typical Panel Layout & Material list
390846	A	ETS 0003 11kV/22kV Transformer CB Control and Protection High Impedance Busbar Protection Scheme Typical Panel Layout and Material list.
390847	A	ETS 0003 11kV/22kV Bus Section CB Control and Protection High Impedance BBP Scheme Typical Panel Layout and Material list.
390848	A	ETS 0003 11kV/22kV Feeder CB Control and Protection & Indication High Impedance Busbar Protection Scheme Typical Circuit Diagram
390849	A	ETS 0003 11kV/22kV Transformer CB Control, Protection & Indication BBP High Impedance Protection Scheme Typical Circuit Diagram
390850	A	ETS 0003 11kV/22kV Bus Section CB Control and Protection & Indication High Impedance Busbar Protection Scheme Typical Circuit Diagram
390070	A	ETS 0003 11kV, 22kV and 33kV single line diagram

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11 Product approval

11.1 Product approval and audit form

Complete information on the equipment must be provided on Branch Form FAE 3135 – 11kV, 22kV and 33kV indoor metal-enclosed switchgear.

11.2 Product approval process

The equipment must be evaluated under the product approval process set out in PAE 1004 – Product Approval Process. The Substation Assets Manager, Asset Standards & Design will approve the equipment for use on the network. Final product approval will be issued in writing by the Manager, Asset Standards & Design.

12 Authorities and Responsibilities

General Manager Asset Management has the authority and the responsibility for:

- approving this technical specification including any variations;
- making all decisions concerning compliance in respect to this specification; and
- delegating any of these authorities and responsibilities to the Manager Asset Standards & Design.

Manager Asset Standards & Design has the authority and responsibility for:

- endorsing this technical specification for suitability in Endeavour Energy's network;
- making recommendations to the General Manager Asset Management; and
- making nominations of Endeavour Energy's representatives for tender evaluations; and
- making recommendations concerning compliance in respect to this Specification.

Substations Assets Manager has the authority and responsibility for:

- reviewing this technical specification for suitability in Endeavour Energy's network;
- determining the equipment procured complies with the requirements of this specification; and
- checking FAT and site test reports and seek dispensation from Manager AS & D as necessary for marginal non-compliances.
- making recommendations to the Manager Asset Standards & Design based on industry best practice.

The **Manager Secondary Systems** has the authority and responsibility for:

- endorsing the instrument transformer and secondary systems components of this specification; and
- approving the relevant actions required and outlined in this specification in regard to secondary systems components and instrument transformers.

Commercial Manager has the authority and responsibility to check that the switchgear purchased through the tender process complies with the requirements of this specification.

Manufacturers/suppliers have the authority and responsibility for:

- maintaining awareness of their responsibilities and conformance requirements under this specification;
- checking all products supplied to Endeavour Energy comply with this specification;
- checking that the contractor/s under their control have provided suitable training for their staff and for work on Endeavour Energy's network;
- checking that an effective safety, environmental and quality auditing system is in place; and

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- **11kV, 22kV and 33kV indoor metal-enclosed switchgear**
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- Implementing this specification and keeping Endeavour Energy or other responsible equivalent officers informed of any factors that may prevent them from accepting responsibility for its full implementation

13 Document Control

Documentation content coordinator: Substation Assets Manager

Documentation process coordinator: Standards Process Coordinator

11kV, 22kV and 33kV indoor metal-enclosed switchgear

Annexure 1: Instrument Transformers

A1.1 Current transformers

11kV and 22kV feeder panel (refer all notes, including 3)		
Protection cores per phase	3	
Cores	1 & 2 (closest to busbar)	3 (away from busbar)
Rated Transformation Ratio	600/1	2000/1
Class	2.5VA 5P20	0.15PX 50(R _{ct} +1)
Rated continuous thermal current	200%	100%
Rated Short Time Withstand Current	20kA/1sec	
Secondary Resistance at 75°C	Supplier to specify in the tender offer (PX only)	

11kV feeder panel for double cable		
Protection cores per phase	4	
Cores	Cores 1(closest to busbar), 2& 3 on each leg	4 (away from busbar)
Rated Transformation Ratio	600/1	2000/1
Class	2.5VA 5P20	0.15PX50(R _{ct} +1)
Rated continuous thermal current	200%	100%
Rated Short Time Withstand Current	20kA/1sec	
Secondary Resistance at 75°C	Supplier to specify in the tender offer (PX only)	

11 and 22kV transformer and bus section panel (refer all notes, particularly 3)		
Protection cores per phase	3 (transformer incomer), 2 (bus section)	
Rated Transformation Ratio	2000/1	
Class	0.15PX 50 (R _{ct} +1) transformer section	0.15PX50(R _{ct} +1) bus section
Rated continuous thermal current	200% (11kV), 100% (22kV, All CB sizes)	
Rated Short Time Withstand Current	20kA/1sec	
Secondary Resistance at 75°C	Supplier to specify in the tender offer (PX only)	

11kV, 22kV and 33kV indoor metal-enclosed switchgear

33kV feeder, transformer and bus section (refer all notes, particularly 3)		
Option:	Option 1	Option 2
Protection cores per phase	4 (TS – all positions) 3 (ZS – feeder and transformer) 2 (ZS – bus section)	3 (ZS – feeder and transformer) 2 (ZS – bus section)
Rated Transformation Ratio	2000/1000/500/300/1	1000/800/300/1
Class	0.05PX200(R _{ct} +2) @ 2000/1	0.05PX100(R _{ct} +2) @ 1000/1
Rated continuous thermal current	200%	200%
Rated Short Time Withstand Current	31.5kA/1sec	25kA/1sec
Secondary Resistance at 75°C	Supplier to specify in the tender offer (PX only)	

Note-1: All options are to be available

Note-2: All current transformers must be tested for compliance to class as set out in AS 60044.1-2007.

Note-3: A metering core is to be provided on the transformer panel of 5VA class 0.5S statistical measurement & indication. FS10. As an option, this metering CT should also be offered for each feeder panel to be determined on a case by case basis.

Note-4: The CT class/designation format provided in the table to give the manufacturer some flexibility in how they build the CT. But actual values for knee point voltage (V_k) and secondary winding resistance at 75 °C (R_{ct}) must be specified in the tender offer and these need to be maintained consistently throughout the periodic contract term. Actual knee point voltage (V_k) and secondary winding resistance at 75 °C (R_{ct}) must be provided on the nameplate of the CT.

Note-5: CT insulation levels in accordance with section 5.4

11kV, 22kV and 33kV indoor metal-enclosed switchgear

A1.2 Voltage transformers

Voltage	11kV	22kV	33kV
Applicable standards	AS 60044.2:2007		
Type	3XSingle phase, Electromagnetic, naturally cooled		
Rated primary voltage – phase to neutral	12kV/ $\sqrt{3}$	24kV/ $\sqrt{3}$	36kV/ $\sqrt{3}$
Rated secondary voltage – phase to neutral	110/ $\sqrt{3}$	110/ $\sqrt{3}$	110/ $\sqrt{3}$
Rated insulation level – lightning impulse (Up) (kV peak)	95	145	170
Rated insulation level – 1 min power freq (Ud) (kV rms)	28	50	70
Rated burden	50VA		
Rated Frequency	50Hz		
Accuracy Class	0.5M/3.0P		
Category of Performance	B		
Rated Voltage Factor (Duration)	1.9 (30 sec)		
Primary Fuse	Preferred		
Secondary fuse	Accessible		
Connection	YNyn		
Duty	General measurement & protection		

Produced by Asset Standards and Design Branch

W Endeavourenergy.com.au
T 131 081



ABN 11 247 365 823