Technical Note

TN 058: 2014

Issued date 10 July 2014
Effective date 10 July 2014

Subject: Amendment to internal arc classification

This technical note is issued by the Asset Standards Authority to RailCorp engineering standard EP 01 00 00 03 SP 11 kV AC Switchgear – RMU Suitable for Indoor and Kiosk Installation, version 4.1.

This technical note amends the required internal arc classification rating.

This amendment is applicable to new equipment.

1. 11 kV ac switchgear – RMU suitable for indoor and kiosk installation

1.1 Ring main unit ratings

In Section 7.2 Ring Main Units, Table 2 – Switchgear Ratings, replace the internal arc classification rating with the following:

<table>
<thead>
<tr>
<th>Existing paragraph or section</th>
<th>Replacement paragraph or section</th>
<th>Replacement text</th>
</tr>
</thead>
<tbody>
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<td>Internal Arc Classification (As per AS62271-200, Annex A; Defined 3.132)</td>
<td>Internal Arc Classification (As per AS62271-200, Annex A; Defined 3.132)</td>
<td>AFL Internal arc 20 kA, 1s</td>
</tr>
<tr>
<td>Signature</td>
<td>Technical content prepared by</td>
<td>Checked and approved by</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Name</td>
<td>Chris Lilly</td>
<td>Neal Hook</td>
</tr>
<tr>
<td>Position</td>
<td>Principal Engineer</td>
<td>Lead Electrical Engineer</td>
</tr>
<tr>
<td></td>
<td>Substations &amp; HV Network</td>
<td></td>
</tr>
</tbody>
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11KV AC SWITCHGEAR - RMU
SUITABLE FOR INDOOR AND KIOSK INSTALLATION

Version 4.1

Issued May 2013

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## Document control

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<td>September 2006</td>
<td>Last Technical Review</td>
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1 Introduction

This document details the whole of life performance requirements for 11kV Ring Main Unit (RMU) type switchgear for use in the RailCorp distribution system. All information required to ensure that the switchgear is electrically suitable for the RailCorp network is contained in this document or referenced by this document.

The RMUs referred to in this standard consist of various combinations of circuit breaker, switch fuse combinations and switch disconnectors, with or without SCADA indication, combined in units and arranged in linear configurations.

This standard does not apply to 11kV switchboards, fitted with SCADA control.

Switch disconnector functional units, switch fuse combination functional units and circuit breaker functional unit configuration requirements are set out for feeder and transformer applications. For circuit breaker protection, self-powered protection equipment is to be provided and is located with the relevant circuit breaker.

Specific details of the required protection schemes are not included here and are referenced in an associated document.

2 Scope and Application

2.1 General

This document specifies the characteristics of factory assembled, non-withdrawable switchgear designed for indoor or Kiosk installation on railway distribution systems operating at nominal 11kV A.C., three-phase, 50 Hz.

The requirement is for RMU’s of up to four functional units, non-extendable and suitable for use in a linear configuration.

The equipment specified in this document is not for use where a busbar is to be divided into two or more sections.

Switchgear functional units may be circuit breakers, switch fuse combinations or switch disconnectors. Specific panel configuration requirements are set out for the following applications:

- Network switching (feeder)
- distribution transformer

The RMU panels will in general include equipment that comprises a switch disconnector, fixed circuit-breaker or combined switch fuse, with associated earthing facility, in combination with the associated mechanical operation, indicating, alarm, and protective equipment, including interconnections, accessories, enclosures and supporting structure.

A circuit breaker will be used for transformers in the size range 160kVA to 1MVA inclusive in lieu of switch fuse combinations.

Where a circuit breaker is specified, the protection equipment shall be self-powered and shall be located in or immediately above the relevant circuit breaker functional unit. Details of the required protection schemes are specified in RailCorp standard EP 19 00 00 02 SP – Protection System Requirements for the High Voltage Network. The ring main unit shall incorporate the applicable requirements of EP 19 00 00 02 SP.
The switchgear is intended for indoor use or outdoor use in an enclosure (Kiosk) under ambient conditions as specified in Rail Corp standard EP 00 00 00 13 SP. Appropriate derating factors for the installed conditions need to be included in the switchgear design to meet the required specifications.

All equipment shall be supplied complete and operational except as specifically excluded and shall include all necessary accessories and the incorporation of all miscellaneous material, minor parts and other such items, whether or not the items are specified, where it is clearly the intention that they should be supplied or where they are obviously required and necessary for completion, commissioning and future maintenance requirements of the equipment.

2.2 Application

The requirements of this document apply from the date of approval of this standard when a new 11kV indoor/Kiosk RMU is to be installed in the RailCorp 11kV network.

The requirements of this document are not applicable to existing 11kV indoor RMU currently in service in the RailCorp network.

3 Reference Standards

The following documents contain provisions, which, through reference in this text, constitute provisions of this specification.

At the time of publication, the editions indicated were valid.

3.1 International Standards

- **IEC 61958:2000** High-voltage prefabricated switchgear and control gear assemblies - Voltage presence indicating systems
- **IEC 62063:1999** High-voltage switchgear and control gear - The use of electronic and associated technologies in auxiliary equipment of switchgear and control gear
- **IEC 60051-1:1997** Direct acting indicating analogue electrical measuring instruments and their accessories Part 1: Definitions and general requirement common to all parts
- **IEC 60051-2:1984** Direct acting indicating analogue electrical measuring instruments and their accessories Part 2: Special requirements for ammeters and voltmeters
- **IEC 60051-7:1984** Direct acting indicating analogue electrical measuring instruments and their accessories Part 7: Special requirements for multi-function instruments

3.2 Australian Standards

- **AS 62271.100:2005** High Voltage A.C. Switchgear and Controlgear - Part 100 High voltage alternating-current circuit Breakers breakers.
- **AS 62271.102:2005** High voltage A.C. switchgear and controlgear - Part 102 Alternating Current Disconnectors (isolators) and earthing switches.
- **AS 62271.110:2006** High voltage switchgear and control gear - Part 110 Inductive load switching
3.3 RailCorp Standards

Several significant sets of requirements applicable to 11kV AC ring main units are common to other classes of equipment and are set out in the following RailCorp/RIC standards. The equipment shall comply with the relevant requirements set out therein.

EP 00 00 00 12 SP  Electrical Power Equipment – Integrated Support Requirements
EP 00 00 00 13 SP  Electrical Power Equipment – Design Ranges of Ambient Conditions
EP 00 00 00 15 SP  Common Requirements for Electric Power Equipment
EP 19 00 00 02 SP  Protection System Requirements for the High Voltage
EP 20 00 03 01 SP  Requirements for Cable Polymeric terminations and joints
EP 21 00 00 01 SP  Insulation Coordination and Surge Arrester Selection
EP 90 10 00 02 SP  Standard Voltage Tolerances
4 Definitions, Terms and Abbreviated Terms

4.1 Definitions and Terms

For the purpose of this specification, the terms, definitions and abbreviated terms in AS 1852.441 and the following apply:

Circuit-breaker A mechanical switching device that is capable of making, carrying and breaking currents under normal circuit conditions, and also of making, carrying for a specified time and breaking currents under specified abnormal conditions, such as those of a short-circuit.

Circuit-breaker functional unit (panel) A switchgear panel complete with a fixed circuit breaker, switch-disconnector, earthing switch and protection & control equipment.

Disconnector As defined in (AS 1852(441) 441-14-05). A mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements.

Note:

A disconnector is capable of opening and closing a circuit when either negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the poles of the disconnector occurs. It is also capable of carrying currents under normal circuit conditions and carrying for a specified time currents under abnormal conditions such as those of short circuit.

Earthing switch As defined in (AS 1852(441) 441-14-11).

A mechanical switching device for earthing parts of a circuit, capable of withstanding for a specified time currents under abnormal conditions such as those of short circuit, but not required to carry current under normal conditions of the circuit.

Fixed circuit-breaker A circuit breaker which is not a withdrawable part of the panel assembly in which it is mounted.

Switch - fuse combination A mechanical switching device fitted with a fixed fuse, that is capable of making, carrying and breaking currents under normal circuit conditions, and also of making, carrying for a specified time and breaking currents under specified abnormal conditions, such as those of a short-circuit.

Switch-Fuse functional unit (panel) A switchgear panel complete with switch-disconnector, a fixed Fuse, earthing switch.

Metal-clad switchgear Metal-enclosed switchgear in which certain components, for example, circuit-breakers, are arranged in separate compartments that have metal partitions and that are intended to be earthed.

Non-withdrawable switchgear Switchgear that contains circuit breaker and switches, which are not a withdrawable part of the panel assembly in which they are mounted.

Rated insulation level The combination of the rated lightning impulse withstand voltage and the rated short duration power frequency withstand voltage specified in AS 2650.

Rated normal current For main circuits and switching devices, the r.m.s. value of the current that they are designed to carry continuously under the specified conditions of use and behaviour.
**Rated peak withstand current** For main and earthing circuits, 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 behaviour.

**Rated short-time withstand current** For main and earthing circuits, the r.m.s. value of current that the switching device is designed to carry in the closed position during a specified short time under prescribed conditions of use and behaviour.

**Rated closed-loop breaking current (I2a and I2b) (AS 6025.1-2001: 4.102)** The rated closed-loop breaking current is the maximum closed-loop current the switch shall be capable of breaking. Separate ratings for distribution line loop breaking current and parallel power transformer breaking current may be assigned.

**Rated voltage** The highest r.m.s. phase-to-phase voltage of the supply on which the switchgear is designed to operate.

**Switch** A mechanical switching device that is capable of making, carrying and breaking currents under normal circuit conditions, which can include specified operating overload conditions, and also capable of carrying for a specified time, currents under specified abnormal circuit conditions such as those of a short-circuit.

**Switch-disconnector** As defined in (AS 1852(441) 441-14-12). A switch which, in the open position, satisfies the isolating requirements specified for a disconnector.

**Switchgear** A general term that covers switching devices and their combination with associated control, measuring, indicating, alarm, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended, in principle, for use in connection with the generation, transmission, distribution and conversion of electric energy.

**Switchgear functional unit (or functional panel)** Switchgear of modular design that comprises a mechanical switching device, for example, a circuit breaker, a switch-disconnector, a switch-fuse combination or a switch.

**Withdrawable** As defined in (AS 1852(441) 441-13-09).

### 4.2 Abbreviated Terms

- **CT** Current Transformer
- **VT** Voltage transformer
- **RMU** Ring Main Unit
5 Background

RailCorp operates a high voltage AC network in which the nominal voltages used are 11kV, 33kV, 66kV and 132kV. RailCorp also operates a 1500V DC network that supplies power for electric traction.

The RailCorp 11kV network supplies railway stations, signalling locations and other loads along the rail corridor. The RailCorp 11kV system comprises both overhead lines and underground cable with a variety of installations.

6 Functional Characteristics

The 11kV indoor switchgear covered by this standard shall:

- Provide an 11kV busbar.
- Provide for connection of 11kV feeders, and distribution transformer circuits to the 11kV busbar.
- Provide for isolation and earthing of feeders, and distribution transformer circuits.
- Provide protection for distribution transformer circuits.
- Provide the means to perform testing on the HV cables, without disconnecting the HV cables from the RMU.
- Provide for remote indication.

Note: There is no requirement to provide a facility to earth the busbar.
7 Performance Characteristics

7.1 General

The RMU shall be designed and manufactured in accordance with following standards:


 Except where specifically varied in this standard the RMU shall have the following characteristics:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Phases</td>
<td>3</td>
</tr>
<tr>
<td>Nominal System Voltage</td>
<td>11kV non effectively earthed and solid earth</td>
</tr>
<tr>
<td>Type</td>
<td>Metal Clad, non extensible</td>
</tr>
<tr>
<td>Installed</td>
<td>Indoors &amp; suitable for use outdoors within a kiosk enclosure.</td>
</tr>
<tr>
<td>Insulation system</td>
<td>Sealed switchgear system incorporating a corrosion proof steel tank containing busbar and switching devices enclosed in SF6 gas. Switchgear to be designed as a hermetically sealed pressure system in accordance with AS 2650:2005. Porcelain shall not be used for interface insulation.</td>
</tr>
<tr>
<td>Sealed pressure system life AS 2650:2005 Section 5.15.3</td>
<td>30 years</td>
</tr>
<tr>
<td>Gas pressure guage</td>
<td>To be fitted. Indicating Green (gas pressure OK), Red (gas pressure low).</td>
</tr>
<tr>
<td>Switch Disconnector</td>
<td>Non withdrawable</td>
</tr>
<tr>
<td>Circuit-breakers</td>
<td>Non withdrawable</td>
</tr>
<tr>
<td>Switch Fuse</td>
<td>Non withdrawable</td>
</tr>
<tr>
<td>Busbar</td>
<td>Single</td>
</tr>
</tbody>
</table>

Table 1 - Switchgear characteristics

The switchboard shall be suitable for the environmental conditions as described in RIC standard: EP 00 00 00 13 SP, Electrical Power Equipment - Design Ranges of Ambient Conditions and ambient conditions found within an outdoor kiosk (60º C).
7.2 Ring Main Unit Ratings

The switchgear shall have the following general ratings:

<table>
<thead>
<tr>
<th>Rating Type</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>Not less than 12 kV</td>
</tr>
<tr>
<td>Line to Earth Voltage Rating</td>
<td>Suitable for Resistivity Earthed and Solidly Earthed Systems</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>50Hz</td>
</tr>
<tr>
<td>Busbar - Rated Normal Current for ambients in accordance with AS 2650</td>
<td>630 A</td>
</tr>
<tr>
<td>Fault make, load break switch disconnector (Feeder) AS 60265.1 class E2/M1 - Rated Normal Current</td>
<td>400 A</td>
</tr>
<tr>
<td>Transformer Tee-off Switch Fuse units - Rated Normal Current</td>
<td>200 A</td>
</tr>
<tr>
<td>Transformer Tee-off Circuit Breaker units - Rated Normal Current</td>
<td>200 A</td>
</tr>
<tr>
<td>Rated Insulation Level:</td>
<td></td>
</tr>
<tr>
<td>Minimum Rated peak lightning impulse withstand voltage common value Up</td>
<td>95 kV (Peak)</td>
</tr>
<tr>
<td>Rated short-duration power-frequency withstand voltage (across the isolating distance) Ud</td>
<td>32kV (rms)</td>
</tr>
<tr>
<td>Rated short-duration power-frequency withstand voltage (common value) Ud</td>
<td>28kV (rms)</td>
</tr>
<tr>
<td>Rated short-time withstand current Ik</td>
<td>20 kA (rms)</td>
</tr>
<tr>
<td>Rated short time current, earth circuit</td>
<td>10 kA</td>
</tr>
<tr>
<td>Rated duration of short-time current tk</td>
<td>1 second</td>
</tr>
<tr>
<td>Rated Short Circuit Breaking Capacity</td>
<td>20 kA</td>
</tr>
<tr>
<td>Rated Short Circuit Making Capacity of switch disconnectors and earthing switches</td>
<td>40 kA (peak)</td>
</tr>
<tr>
<td>Network load and closed-loop breaking current (switch disconnectors)</td>
<td>400 A</td>
</tr>
<tr>
<td>Internal Arc Classification</td>
<td>AFLR</td>
</tr>
<tr>
<td>(As per AS 62271-200, Annex A; Defined 3.132)</td>
<td>Internal arc 20 kA, 1 s</td>
</tr>
</tbody>
</table>

Table 2 - Switchgear Ratings
8 Technical Characteristics

8.1 General

The switchgear shall be self powered complete with highest level of arc fault containment to the latest Australian Standards suitable for the application within Railcorp’s 11kV network.

Switchgear shall comply with the requirements of AS 62271-200 and AS 2650.

Specifically, the Switchgear shall meet all Internal Arc Classification (IAC) criteria as proven by test in accordance with Annex A of AS 62271-200.

For the purpose of this standard Isolation devices are: Circuit-Breakers, Switch Disconnector, Switch-Fuse combinations

8.1.1 Ring Main Unit Configurations

The following are requirements for RMU configurations:

- The switchgear functional units shall be assembled into RMU units of switch - disconnectors, combined switch fuses and circuit-breaker functional units.
- Circuit breaker functional units and switch fuse functional units are for use with distribution transformers.
- Switch disconnector functional units are for use with feeders. An optional fault indicator maybe fitted to a feeder switch.
- Circuit breakers with self-powered protection relays shall be used in lieu of switch-fuse combinations for distribution transformers when the transformer is 160kVA or above. The CT’s shall comply with AS 60044.1 and be suitable for prospective fault levels for the Railcorp 11kV system.
- The switch fuse shall be suitably rated for the distribution transformer specified for each order and be able to withstand the inrush current of the transformer. The specific fuse size will be nominated at order.

There is no requirement for the assembled ring main unit to be extendable.

For kiosk installation as nominated in Table 3, overall maximum dimensions are 1500 High, 1300 Wide, 820 Deep. Complete switchgear assembly including all accessories must not exceed these dimensions.
A single ring main unit shall comprise the following combinations of each function as described in the Table 3 below:

<table>
<thead>
<tr>
<th>Railcorp Type</th>
<th>Configuration of functional units</th>
<th>Total number of functional units</th>
<th>Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 x switch disconnectors (feeders) 1 x switch fuse (transformer)</td>
<td>3</td>
<td>Kiosk</td>
</tr>
<tr>
<td>2</td>
<td>2 x switch disconnectors (feeders) 1 x circuit breaker (transformer)</td>
<td>3</td>
<td>Kiosk</td>
</tr>
<tr>
<td>3</td>
<td>3 x switch disconnectors (feeders) 1 x switch fuse (transformer)</td>
<td>4</td>
<td>Indoor</td>
</tr>
<tr>
<td>4</td>
<td>3 x switch disconnectors (feeders) 1 x circuit breaker (transformer)</td>
<td>4</td>
<td>Indoor</td>
</tr>
<tr>
<td>5</td>
<td>2 x switch disconnectors (feeders) 2 x switch fuse (transformer)</td>
<td>4</td>
<td>Indoor</td>
</tr>
<tr>
<td>6</td>
<td>2 x switch disconnectors (feeders) 2 x circuit breaker (transformer)</td>
<td>4</td>
<td>Indoor</td>
</tr>
<tr>
<td>7</td>
<td>1 x switch fuse (transformer)</td>
<td>1</td>
<td>Kiosk</td>
</tr>
<tr>
<td>8</td>
<td>1 x circuit breaker (transformer)</td>
<td>1</td>
<td>Kiosk</td>
</tr>
</tbody>
</table>

Table 3 – Ring Main Configurations

8.1.2 Live line Indicators

Live line indicators shall be provided for each of the three phases on each circuit and the busbar. Live line indicators shall comply with the requirements of IEC 61958.

8.1.3 Anti-Condensation Heaters

Anti-condensation heaters may be used for ring main units in kiosk applications where no transformer is installed. If anti-condensation heaters are required an external auxiliary supply will be provided.

8.1.4 Gas Insulation

End of life gas recovery must be provided.

The switchgear shall be factory sealed so as to not require any routine gas replenishment during installation or in normal service.

The design, construction and sealing of gas compartments shall be such that the gas will be maintenance free for 30 years.

A green/red indicator for monitoring the SF6 pressure in each gas compartment while in service shall be provided. This device shall provide indication of the minimum permissible pressure level for safe operation. The pressure level monitoring device shall be clearly visible to the operator from the operating side of the switchgear functional unit. Pressure gauge shall have a green indicator area for gas pressure OK and red indicator area for gas pressure low.
8.1.5 Earthing Bar(s)

To assist with stray current mitigation measures from the dc traction system, it may be necessary to connect 11kV cable screens to a separate cable screen earth bar. This arrangement is to facilitate future installation of a transient earth clamp.

The transient clamp acts as a DC de-coupler, to provide DC isolation between earthing points that are still AC connected. Under an AC earth fault the clamp impedance momentarily changes state to a virtual short circuit, acting to provide a direct connection of HV cable screens to the switchboard earth bar. The transient earth clamp provides a blocking path to dc stray current that could otherwise use the cable screen as a path.

Note some HV panels and HV functional units will require all HV earth screens to be directly connected to the switchboard earth bar.

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

A separate cable screen earth bar shall be provided for each feeder functional unit. This shall be connected to the switchboard earth bar via removable links and shall be isolated from similar bars in adjacent functional units. It shall be insulated from the frame of the switchboard by insulated mounts that have been rated for maximum earth potential rise and tested to 15kV for not less than 1 minute. The cable screen earth bar shall provide for connection of the two removable links, four HV cable screens and mounting holes for a transient earth clamp.

The ring main unit earth bar shall interconnect adjacent switchgear functional units and provide:

- for all switchgear bonding
- for two cable connections to the main substation earth grid
- for two removable links per functional unit for connection to the insulated cable screen earth bar.
- for connection of four HV cable screens
- mounting holes for a transient earth clamp

To provide for mounting of the transient earth clamp to the two earth bars, ie the ring main unit earth bar and the cable screen earth bar, shall be vertically separated as far as possible to provide sufficient space for future insertion of the transient earth clamps.

Earth termination requirements are provided in EP 00 00 00 15 SP, Common Requirements for Electric Power Equipment.

8.1.6 HV Cable Interface

Each circuit-breaker, switch disconnector and switch-fuse combination, functional unit shall be equipped with a HV cable compartment providing a dead-break, separable, fully insulated and shielded system for connection of HV cables. The separable insulated shielded connection system is to be compliant with AS 2629 and relevant ratings specified in Section 7.

The HV cable compartment shall be suitable for connection of single and 3 core XLPE insulated 11kV cables up to a maximum size of 150mm².

Feeder and circuit breaker units are to use Elastimold, bolted, field disconnectable type 400TB (or equivalent to be approved by Railcorp).

Switch fuse units are to use Elastimold type 158LR (or equivalent to be approved by Railcorp).
The cables shall enter the cable compartment from below. Details of the cable connections shall be nominated in the Technical Schedule at Appendix A.

The cable termination shall be capable of withstanding the power frequency test as specified in Table 1 of AS 2650.

8.1.7 Surge Arresters

The switchgear may be installed with short cable feeds from overhead lines.

Sufficient space shall be provided within the cable compartment of each feeder cubicle to install surge diverters if required for the specific feeding configuration.

Surge arrester type and restrictions shall be nominated in the Technical Schedule at Appendix A.

8.1.8 Auxiliary Equipment

Each switchgear functional unit (switch disconnector, switch-fuse, circuit breaker) shall be fitted with:

- Two normally open and two normally closed auxiliary switches. The rating shall be as described in Section 8.10.2. (These auxiliary switches shall be provided in addition to those essential to the circuit-breaker operation).

A set of terminals for the termination of auxiliary wiring associated with the auxiliary switches, fault indicators, fuse blown or transformer protection relay outputs shall be provided.

8.2 Circuit-Breaker Functional Unit

8.2.1 General

Circuit-breaker functional units shall comprise a fixed circuit breaker, switch-disconnector and interlocked earthing switch.

Circuit breakers shall comply with the requirements of AS 2650 and AS 62271 – 100.

Circuit breakers shall be used for distribution transformers in the range 160kVA to 1MVA inclusive.

There is no requirement for motorised operation of circuit breakers used in RMU configurations.

8.2.2 Circuit Breaker Type

The interrupting medium shall be either vacuum or SF₆.

Each circuit breaker shall consist of three separate “pole units” mounted on a single piece frame and shall be mechanically interconnected.
8.2.3 Circuit-Breaker Operating Mechanisms

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

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

All circuit breakers shall be equipped with a mechanism which upon closing with a manual operating handle in the one-movement charges the opening mechanism for the circuit breaker. Opening is actuated either by a mechanical push button or by the self powered protection device.

The circuit breaker in the closed position shall be able to trip using its self-powered mechanism before the mechanism needs to be charged again.

8.2.4 Protection Relay and current transformers

The protection equipment shall be located for front access and be logically associated with the relevant circuit breaker functional unit. Circuit breaker protection relays shall be self-powered and shall not require internal or external batteries.

The self powered protection relay is to detect phase and earth faults. The relay shall be powered from current transformers specifically designed for use with the relay.

The protection relay shall have as a minimum the following features:

- Inverse definite minimum time trip curve suitable for overcurrent protection of transformers.
- Definite time trip curve for earth faults
- The trip settings for both the overcurrent and earth faults shall be adjustable in steps. This adjustment to the settings shall be able to be made from the front of the protection relay.
- Indicators on the front of the relay to reflect the protection function that caused the ACCB to trip.
- It is preferred that the relay has selectable trip curves (SI, VI, LT, RI).

The trip output from the self-powered relay shall be matched to the tripping requirement of the circuit breaker.

The circuit-breaker functional units shall be provided with three phase sets of protection current transformers in compliance with EP 19 00 00 02 SP Protection System Requirements for the High Voltage Network.

An AREVA MMLG01 test block shall be located adjacent to or in the near vicinity of the protection relay.
8.3 Switch-Fuse Functional Unit

8.3.1 General

Switch-fuse combinations shall be used for protection of transformers when the transformer is below 160kVA in size.

Switch-fuse combination functional units shall comprise a fixed switch-disconnector, a fuse and interlocked earthing switches. The fuses are to be easily accessible through the front and interlocked with the earth switch.

Switch-fuse combinations shall comply with the requirements of *AS 2650* and *IEC 62271 – 105* and *AS 2024:1991*.

Switch-disconnectors and earthing switches that have long mechanical and electrical endurance (as defined in *AS 62271* parts 100 & 102) are preferred.

The fuses shall comply with *AS1033.2:1988*. The fuse holder and fuse shall be suitable for the prospective fault rating. The fuse holder shall suffer no degradation following rated fault currents with rated duration times.

Fuse blown indication is to be provided. Voltage free auxiliary contacts are to be wired to terminals for remote indication purposes – see Section 8.1.8.

If any one fuse ruptures the switch disconnector shall open all three phases immediately.

Earthing is to be made simultaneously on both sides of the fuselink where applicable.

There is no requirement for motorised operation of switch-fuse disconnectors when used in RMU configurations.

8.3.2 Switch Disconnector Type

The interrupting medium shall be either vacuum or SF6.

The Switch disconnector used in the switch-fuse combination shall comply with Section 8.4 of this document.

8.3.3 Switch-Fuse Combination Operating Mechanisms

Each switch fuse disconnector shall consist of three separate "pole units" mounted on a single piece frame and shall be mechanically interconnected.

Three separately mounted fuses shall be mounted after the switch disconnect unit. An earth switch unit shall be mounted after the fuse between the cable and the fuse. The earth switch shall be mechanically interlocked with the switch disconnector earth position.

Any part of the switch mechanism that requires routine inspection and maintenance shall not be enclosed in any gas tight compartment.
8.4 Switch Disconnector Functional Unit

8.4.1 General
Switch Disconnector functional units shall comprise a switch-disconnector and interlocked earthing switch.

Switch disconnectors shall comply with the requirements of AS 2650 and IEC 62271 – 102.

There is no requirement for motorised operation of switch disconnectors when used in RMU configurations.

8.4.2 Switch Disconnector Type
The interrupting medium shall be either vacuum or SF6.

8.4.2.1 SF6 Switch Disconnector
Each switch disconnector shall consist of three separate "pole units" mounted on a single piece frame and shall be mechanically interconnected.

8.4.3 Switch Disconnector Operating Mechanisms
Any part of the switch disconnector mechanism that requires routine inspection and maintenance shall not be enclosed in any gas tight compartment.

The switch disconnector shall be manually operated for opening and closing.

8.5 Indications

8.5.1 Circuit Breaker Functional Unit
Circuit-breaker functional unit shall have indications clearly visible from the front of the functional unit (ie. either on the circuit breaker or on the circuit-breaker functional unit).

A mechanically operated indicator, indelibly marked, to show whether the circuit breaker or Isolating switch is open or closed. The word OPEN shall be visible only if the circuit breaker is open and the word CLOSED shall be visible only if the circuit breaker is closed. If colours are used in addition, then the colour green shall indicate the open condition and the colour red shall indicate the closed condition.

The following definite indications shall be provided:

a) Circuit-breaker open/close;
b) Switch disconnector open/close;
c) Earth switch position;
d) Stored energy device charged/discharged;
e) Non-resettable mechanical operation counter.
8.5.2 Switch Disconnector Functional Unit
Switch Disconnector functional units shall have indication clearly visible from the front of the functional unit. The following definite indications shall be provided:

a) Switch disconnector open/close;

b) Earth switch position;

8.5.3 Switch-Fuse Functional Unit
Switch-fuse combination functional unit shall have indication clearly visible from the front of the functional unit. The following definite indications shall be provided:

a) Switch disconnector open/close;

b) Earth switch position;

c) Fuse blown;

8.6 Interlocks
Facilities provided for operational access to parts of the switchgear functional unit that contain live components shall be mechanically interlocked so that access to such parts is not possible unless all live parts have been rendered safe, either by an applied earth connection or by being positively disconnected and screened from the remaining live parts.

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

Mechanical interlocks shall be provided in compliance with Section 5.11 of AS 62271-200 to prevent unsafe operation, including:

- Automatic opening of a circuit-breaker when it is used to earth a circuit or the bus bar
- Closing of an earthing switch unless the circuit-breaker is in the open position
- Opening or closing a switch disconnector associated with a circuit breaker unless the circuit breaker is open.
- Closing the cable earth switch while the associated switch disconnector is closed.

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

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

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

It is preferred that the making of the disconnector contacts in the EARTH position shall be directly observable by the operator.

If the earthing of a circuit-breaker or switch fuse combination or switch disconnector functional unit is not visible from the operating position, the corresponding indication shall be directly coupled to the earthing mechanism, to ensure fail-safe indication.
An analysis shall be provided detailing the integrity of the interlocking system. The analysis shall include all possible failure modes and the controls employed to prevent an unsafe operation.

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

8.7 Circuit Earthing Facilities

Each functional unit shall be equipped with circuit earthing switches manufactured and tested in accordance with IEC 62271-102.

Ear switches shall be the integral type.

The earthing system shall be designed and tested for making a live circuit with a prospective peak fault current as specified in Table 2 of this standard. Each circuit-earthing switch shall be mechanically interlocked with the corresponding isolation device in accordance with Section 8.6 of this specification.

The earth switches associated with switch disconnectors for feeders shall be fault making.

The earthing switch associated with transformer circuit breakers or switch fuses shall be rated for fault making if there is any identified failure mode, which could result in the earth switch being closed onto a live circuit.

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

If the equipment is configured to allow the position of the disconnector contacts in the EARTH position to be directly observable, then appropriate illumination shall be provided.

8.8 Padlocking

Facilities shall be provided to padlock:

- The circuit breaker in the open position and the closed position while the disconnector is in the earthed position, and the disconnector in the closed, open and earth positions.
- The switch-fuse combination in the open position and the earth position while the cable earth switch is in the earthed position and the closed position while the cable earth switch is not in the earth position.
- The switch disconnector in the closed, opened and earth positions.
- The disconnector in the closed, opened and earth positions.
- The circuit test facility, if applicable (see Section 8.6 and 8.11).

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

8.9 Fault Indicators

All RMU feeder switch units shall be equipped to interface with a Merlin Gerin Flair 22D fault indicator.

This fault indicator is optional and will be specified with placement of order. The wiring (for SCADA indication interface and remote reset) is to be fitted to all units.
8.10 SCADA Indications and Controls

8.10.1 Binary Indication

The following status indications shall be provided to SCADA via terminals if required:

<table>
<thead>
<tr>
<th>I/O Point Description</th>
<th>Hard Wired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit Breaker (Opened &amp; Closed)</td>
<td>☑</td>
</tr>
<tr>
<td>Switch-Fuse Combination (Opened &amp; Closed)</td>
<td>☑</td>
</tr>
<tr>
<td>Isolator Position (Open, Closed)</td>
<td>☑</td>
</tr>
<tr>
<td>Earthing switch Position</td>
<td>☑</td>
</tr>
<tr>
<td>Protection Relay Faulted alarm</td>
<td>☑</td>
</tr>
<tr>
<td>Earth Fault Trip alarm</td>
<td>☑</td>
</tr>
<tr>
<td>Over Current Trip alarm</td>
<td>☑</td>
</tr>
<tr>
<td>Fuse blown alarm</td>
<td>☑</td>
</tr>
<tr>
<td>Fault Indicator alarm</td>
<td>☑</td>
</tr>
</tbody>
</table>

Table 4 – I/O Points

The terminals shall be mounted in a separate non-metallic panel mounted in a low voltage area to allow for voltage segregation.

8.10.2 Contacts

All operational points for control, alarm, and indication shall have one set of voltage free normally open and normally closed contacts rated to switch 1 Amp at 120V dc.

8.10.3 Controls

RMU's will not be remotely controlled. If a remotely controlled system is required then EP01 00 00 02 11kV Switchgear standard shall be used.

8.11 Circuit Test Facilities

Each functional unit shall incorporate an integral type circuit test facility.

All test facilities shall be suitable for the application of 25 kVdc test voltage associated with the after-installation testing of power cables, and shall be rated for the same system voltage as the switchgear. See EP 20 00 03 01 SP Table 1 of this cable standard for details on tests.

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

It shall be possible to connect a hand applied earthing set to the circuit side of each circuit breaker functional unit, switch fuse combination functional unit and switch disconnector functional unit for use in conjunction with test equipment. It shall be possible to apply or remove the earth connection independent of the application or removal of the test equipment connection. It is permissible that external removable accessories be used to achieve this function.
9 Integrated System Support Requirements

9.1 Integrated Support Objectives
The switchgear manufacturer must establish and provide the information required to operate and maintain the equipment throughout its operational life, in a cost effective manner and to a level that is consistent with the planned operational performance and usage of the switchgear.

This includes:

- Specifying Maintenance Requirements,
- Spares Support,
- Operations and Maintenance Manuals,
- Training, and
- Support Equipment and Tooling.

9.2 Equipment Supplier Deliverable
The Integrated support requirements are a significant deliverable in the procurement of new Switchgear. Manuals, training, documentation and other support deliverable's shall be in accordance with EP 00 00 0012 SP, Electrical Power Equipment - Integrated Support Requirements.

9.3 Maintenance Concept
In the event of major failure it is anticipated that the entire ring main unit would be replaced.

10 Tests
Testing requirements are to be read in conjunction with the specification EP 00 00 00 15 SP, Common Requirements for Electric Power Equipment.

10.1 Routine tests
Routine tests as listed in:

AS 2650, Section 7
IEC 62271-100, Section 7
IEC 62271-200, Section 7

Shall be carried out on each panel.

10.2 Type tests
The results of type tests as required in:

AS 2650
IEC 62271-100
IEC 62271-200

Shall be made available by the supplier upon request.

Test certificate details, demonstrating compliance with the above standards, including the date, results and name of the testing body shall be supplied in the Technical Schedule at Appendix A.
Type test certificates for each of these tests will be accepted where it can be demonstrated that the switchgear supplied is of a similar design to previously type tested switchgear.

11 Data Set associated with the Equipment

The following data shall be supplied by the manufacturer and maintained for the switchgear. This data will remain the property of RailCorp.

11.1 Information

Information requirements are to be read in conjunction with the specification:

- EP 00 00 00 12 SP, Electrical Power Equipment – Integrated Support Requirements.
- EP 00 00 00 15 SP, Common Requirements for Electric Power Equipment.
- EP 19 00 00 02 SP, Protection System Requirements for High Voltage Network.

11.2 Technical Schedule at Appendix A

The information listed in the technical schedule at Appendix A, supplied by the manufacturer, shall be provided for each switchboard.

11.3 Life Cycle Costing

All the data and assumptions pertaining to the determination of the whole-of-life cost calculations shall be recorded.
### Appendix A  Technical Schedule

The manufacturer shall supply the information listed in this technical schedule.

#### Switchgear information:
- manufacturer
- country of origin
- catalogue/type designation
- total switchgear mass, kg

<table>
<thead>
<tr>
<th>Circuit breaker type</th>
<th>SF6 / Vacuum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch disconnector type</td>
<td>SF6 / Vacuum</td>
</tr>
<tr>
<td>Switch Fuse combination switch disconnector type</td>
<td>SF6 / Vacuum</td>
</tr>
</tbody>
</table>

#### Switchgear Ratings:
- Voltage, kV
- Busbar Normal Current
- Insulation Level:
- Peak lightning impulse withstand voltage
- Short duration power frequency withstand voltage
- Short time withstand current Ik
- Peak withstand current Ip
- Duration of short time current Tk

#### Switch-fuse combination Ratings:
- Rated Current A
- Fuse rating
- Off-load making capacity A
- Duration of short time current Tk
- Short circuit breaking capacity current
- Short circuit making current

#### Fuse Ratings:
- Fuse rating
- Fuse brand
- Fuse type
- Fuse length
- Fuse diameter
- Fuse blown indication
- Supply fuse curve
Circuit-Breaker Ratings:
- Circuit Breaker(s) rating
- Duration of short time current Tk
- Short circuit breaking current kA
- Short circuit making current peak kA

Circuit Breaker Protection Relay Self-Powered:
- manufacturer
- country of origin
- catalogue/type designation
- minimum load current for correct operation of relay
- Number of CT required for protection relay
- How earth protection operates
- Phase protection operating current Is
- Type of self powered trip coil system

Switch-disconnector Ratings:
- Rated Current A
- Breaking capacity:
- Charging current
- Earth leakage fault
- No-load cable
- Duration of short time current Tk
- Short circuit breaking capacity current
- Short circuit making current peak A
- Short circuit making current peak for earth switches kA
- Class of disconnector to IEC 60265

Ring main unit - General arrangement drawing showing overall dimensions (h, w, d in mm), cable termination locations and required space around unit for access and arc venting requirements for:
- Single circuit-breaker functional unit
- Switch Disconnector functional unit
- Switch fuse functional unit
- Total length of Ring Main unit with arc duct (if applicable)
- Required clearances at sides and rear of ring main unit.
- Required clearance at front of ring main unit for installation and removal
- Required clearances on top of ring main unit
− Cable trench width
− Depth of protrusions into cable trench (if applicable)
− Total mass of Ring Main Unit

Ambient conditions assumed for stated current ratings above and applicable derating values for ambient of 50°C

Current ratings of switchgear at worst case ambient conditions given in RailCorp specification: EP 00 00 00 13 SP Electrical Power Equipment – Design Ranges of Ambient Conditions

Surge arrester types accommodated

Surge arrester mounting details/restrictions.

Switchgear IEC Classifications:
− Internal arc classification
− Internal arc test current, kA Internal arc test duration
− Circuit breaker mechanical durability class
− Circuit breaker electrical durability class
− Switch disconnector mechanical durability class
− Switch disconnector electrical durability class
− Switch-fuse combination mechanical durability class
− Switch-fuse combination electrical durability class
− Earth switch mechanical durability class
− Earth switch electrical durability class

Reliability Data:
− Failure Modes (for early, Normal life & wear out periods)
− Mean Operating Hours between failure modes
− Mean Time To Repair. Provide details of any special requirements, test and support equipment etc
− Number of units in service in Australia
− Period (years) this model/type has been available for purchase
− Number of units in service worldwide

Details of lifting and slinging for individual functional units

Description of the panel busbar interconnection arrangements

Description of all operational and safety interlocking arrangements.

Table of all possible and inhibited states that the circuit breakers, switch-fuse combinations and switches in the switchgear may occupy.

Analysis demonstrating the integrity of all interlocking arrangements which includes an analysis of all possible failure modes and the controls designed in to manage them
Clearance hole or stud size of earthing bar offered

Gas used for insulation of Bus Bar

In which compartments are the gas used?

Detail of gas pressure monitoring device.

Quantity of the SF6 to be used in each separately filled compartment?

Specify the degree of SF6 gas tightness for the switchgear.

If the circuit-breaker or switch disconnectors or switch-fuse disconnector is a vacuum type state the method of indicating vacuum loss (if any)

Does the circuit-breaker functional unit include in-line off-load disconnectors?

Is the switch disconnector offered 2-way or 3-way? 2 or 3

Details of the circuit earthing facilities offered including the method of indicating the position of the earthing switch and guaranteeing the integrity of that indication.

Diameter of the earth clamping screw

Number of circuit breaker spare auxiliary contacts

Number of switch-fuse combination unit spare auxiliary contacts

Number of switch disconnector spare auxiliary contacts

Type of circuit test facility offered

Describe the test plugs

Type of switch-disconnector offered

Maximum size and number of HV cables that can be terminated in each circuit breaker functional unit. Clearly specify clearances between each cable termination of each phase. Provision of a detailed dimensioned drawing of the arrangement is required.

Type of cable termination offered. Specify manufacturer, model and full details of separable insulated connector. Detail shielding arrangement to be included

Type and ratings of live line indicators

CT space limitations and mounting arrangements (for CTs provide details for both bus and circuit sides of the circuit breaker).

Number and Details of the Current Transformers offered for each function:
  - type
  - encapsulation material
  - class
  - burden, VA
  - tap ratios
- tap points
- knee-point voltage
- secondary resistance
- excitation current at knee-point voltage

Details of terminal block/rail mounted terminals offered for current transformers

Type of test block offered

Location of fuses, MCCBs or links

Details of points, test burden and current for routine accuracy tests on current transformers

Details of instruments offered

Details of indicators offered

**Details of Fault indicators offered**

- manufacturer
- catalogue/type designation
- Trip current ranges
- Number and type of contacts
- local Indicator details
- Reset details
- Test arrangements

The four (4) current threshold of the Fault indicators offered.

1) ........................................
2) ........................................
3) ........................................
4) ........................................

Details of switchgear internal wiring identification

Describe LV termination and cable access arrangements

Details of terminal blocks offered

Rating plate attachment method

Labels attachment method

Details of coatings provided

Colours of custom coatings available

Number of I/O for each device

Gas recovery details

Can the switchgear be motorised for remote operation after installation
Appendix B  RFT Checklist

Application

The following material is for guidance in the preparation of a Request for Tender for this type of equipment. This checklist itself is not intended to directly form part of any contract.

This section to be read in conjunction with the RFT Checklist in specification EP 00 00 00 15 SP, Common Requirements for Electric Power Equipment.

Information to be supplied to the Tenderer

Where this document is used as the basis for procurement of equipment for a particular location, in addition to the general requirements in this standard the following information related to the particular site will need to be supplied:

Requirement for specific deliverable’s including:

- Installation and on-site operational testing, if to be carried out by the supplier
- Recovery and replenishment of SF6 gas after its service life (must be rendered by the supplier of SF6 switchgear).
- Spare sets of fuses for switch-fuse combination.

Number and type of switchboard configuration required including:

- The number, type and sequence of functional units required in each switchboard.
- Fault level.
- The continuous current rating of feeder, transformer circuit breaker functional unit selected.
- The continuous current rating of feeder, transformer and switch-fuse combination functional unit selected.

HV cable connection ratings.

The required cable size.

The requirement for fault indicators.

Any required restrictions on the dimensions or placement of the switchgear.

Location specific surge arrester requirements.

Notice that the contractor will be required to provide appropriate seals for 11kV receptacles to prevent contamination during storage and transport.

Notice that the provisionally selected tenderer will be required to provide access to a sample ring main unit and full set of wiring diagrams for evaluation of the interlocking of the isolate/earth switch by RailCorp’s interlocking experts (signals discipline).

Information to be Sought From the Tenderer

Integrated Support information as per RailCorp Standard

Alternate offers for extensible switchgear.

Tenders to complete and submit Technical Schedule at Appendix A.
Appendix C  Requirements for Technical Aspects of Tender Evaluation

Evaluation of tenders

Tender submissions will be evaluated based on a number of criteria. One constant criterion is compliance with this specification. The Chief Engineer Electrical requires that persons evaluating the technical aspects of this tender have sufficient technical competence for the task.

Tender evaluation committees shall forward details of persons evaluating the technical aspects of the tender to the Chief Engineer Electrical for concurrence. This will normally be in the form of an email and is to include sufficient detail of the tender and the person to enable the Chief Engineer Electrical to satisfy themself of the merits of the evaluating person. A minimum of 4 weeks notice is required prior to the evaluation of the Tenders.

The Chief Engineer Electrical will advise within 5 working days only if the person is considered technically unsuitable for the technical evaluation.

Acceptance of product

A number of the specifications require acceptance of product at both the factory and at site. The purchaser is to advise the Chief Engineer Electrical the details of the person carrying out the acceptance testing for the concurrence of the Chief Engineer Electrical. A minimum of 4 weeks notice is required prior to the evaluation of the acceptance testing.

The Chief Engineer Electrical will advise only if the person is considered unsuitable for the acceptance testing.

The Chief Engineer Electrical reserves the right to nominate a representative to review and/or attend such acceptance.

Record Keeping

Where product is purchased against this specification, the Chief Engineer Electrical requires that relevant detail be provided so that it can be logged against this specification.

For RailCorp purchases, all records are recorded in Ariba.

Where this specification is utilised by parties external to RailCorp (Alliance parties, etc) then copies of all relevant technical information and evaluation shall be forwarded to the Chief Engineer Electrical for filing against the specification. In addition copies of selected commercial information pertaining to the ongoing support of the product as follows is also required.

- Warranty details
- Spare parts and associated availability
- Product support information.