

## Equipment Technical Specification

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# 11kV vacuum CB truck retrofits for bulk oil CBs

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## EQUIPMENT TECHNICAL SPECIFICATION

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### ETS 0031     11kV vacuum CB truck retrofits for bulk oil CBs

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## 1.0 PURPOSE

This specification sets out in detail the minimum technical requirements for 11kV withdrawable vacuum circuit breaker trucks to replace the following existing 11kV bulk oil circuit breakers used in zone substations in the Endeavour Energy's network:

- Reyrolle LMT/LMT2
- Westinghouse J18/J22
- Hawker Siddeley Brush VIS R4/R8/Q20
- South Wales D4/D6/D8/D20
- G.E.C OLX3

## 2.0 SCOPE

This specification covers the design, manufacture, factory testing, delivery, installation and testing at site of 11kV vacuum CB trucks, with rms current ratings ranging from 400A to 2000A to suit existing Reyrolle (LMT/LMT2), Westinghouse (J18/J22), Hawker Siddeley Brush (VIS R4/R8/Q20), South Wales (D4/D6/D8/D20) and G.E.C (OLX3) switchgear in Endeavour Energy substations.

This specification also details the technical requirement for the optional provision of earthing trucks for Westinghouse J18/J22 and G.E.C OLX3 only.

It is not the intention to specify all aspects of the design and construction details of the equipment in this specification; however the equipment supplied shall 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 shall be manufactured and tested to the standards with the year of publication listed below. Endeavour Energy will consider equipment manufactured to other recognised 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 shall prevail. Any proposed variations from this specification shall be referred to Network Substations Manager for approval in writing prior to acceptance.

## 3.0 REFERENCES

- Company Policy 9.2.5 - Network Asset Design
- Company Policy 9.2.10 - Network Asset Ratings
- Company Policy 9.7.1 - Network Asset Construction
- Company Policy 9.9.1 - Network Asset Maintenance
- Substation Design Instruction SDI 526 – Control panels, cabling and terminations
- Substation Design Instruction SDI 528 – Substations signs and equipment labels
- Substation Design Instruction SDI 535 – Site testing and pre-commissioning
- Branch Procedure PAE 1004 - Product approval process
- Branch form FAE 3214 - 11kV vacuum CB truck retrofits for bulk oil CBs product approval and audit form
- Network Management Plan December 2013 Review
- ENA National Electricity Network Safety Code (Doc 01-2008)
- *NSW Work Health and Safety Act 2011*
- *NSW Work Health and Safety Regulation 2012*
- National Electricity Rules Version 51 - 2012

- AS/NZS 62271.1:2012 - High Voltage Switchgear and Controlgear Part1: 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 60137:2008 - Insulated bushings for alternating voltage above 1kV
- AS1931.1:1996 - High voltage testing techniques
- AS 2981:2008 – High voltage a.c. switchgear and controlgear-vacuum interrupters- High voltage testing- Protection of personnel from X-ray emissions
- AS/NZS 2344:1997: Limits of electromagnetic interference from overhead a.c power lines and high voltage equipment installations
- IEC62271.1:2011 - High voltage switchgear and Controlgear - Part 1 common specifications
- IEC62271.100:2011 - High voltage switchgear and Controlgear - Part 100 High voltage alternating-current circuit breakers
- IEC60529:2013 – Degrees of protection provided by enclosures (IP code)

#### 4.0 DEFINITIONS AND ABBREVIATIONS

<b>CB</b>	circuit breaker
<b>r.m.s</b>	root mean square
<b>rated peak withstand current</b>	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.
<b>rated normal current</b>	The r.m.s value of the current that a switching device is designed to carry continuously under specified conditions.
<b>rated short time withstand current</b>	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.
<b>rated voltage</b>	The highest r.m.s phase to phase voltage of the supply on which the switching device is designed to operate.

#### 5.0 ACTIONS

##### 5.1 General requirements

To manage network failure risk and ongoing costs of repairs, the installation of 11kV withdrawable circuit breaker trucks with vacuum interrupters is required to replace the following 11kV bulk oil circuit breakers used in transmission and zone substations in the Endeavour Energy's network:

- Reyrolle LMT/LMT2
- Westinghouse J18/J22
- Hawker Siddeley Brush VIS R4/R8/Q20
- South Wales D4/D6/D8/D20
- G.E.C OLX3

This specification details the technical requirements for the replacement trucks. This specification also details the technical requirement for the optional provision of earthing trucks for Westinghouse J18/J22 and G.E.C OLX3 only.

#### **5.1.1 General**

The 11kV vacuum CB units shall be designed and manufactured in conformance with:

- AS/NZS 62271.1:2012 as the common specification
- AS/NZS 62271.100:2008 and IEC 62271.100:2012 for alternating current circuit breakers
- AS 62271.200:2005 and IEC 62271.200:2011 for AC metal enclosed switchgear and controlgear rated voltages above 1kV and up to and including 52kV

except where specifically varied in this document.

The unit supplied shall meet the highest standards of engineering, design and manufacturing practices.

The replacement CB truck unit shall be designed to be directly interchangeable with the existing bulk oil CB without the need for modification to the existing fixed part of the switchgear primary equipment including but not limited to spout orifice bushings, shutters and earthing systems. An exception applies to the secondary isolating contacts which shall be converted to a plug and socket arrangement with flexible connection. Additional arc flash control and containment requirements are also specified including the retrofit of arc-proof doors with racking operation behind closed doors.

Endeavour Energy has limited fully dimensioned general arrangement drawings of the various bulk oil circuit breakers detailed in section 5.9. The Contractor shall fully inform themselves of the details of the existing switchgear cubicles and circuit breakers and confirm that the replacement circuit breakers can be installed on site without modifications. There will be limited network outage windows to perform these works.

The specification wiring drawings should be regarded as indicative of the requirements for motor spring charged operating mechanisms. The manufacturer / supplier shall familiarise themselves with the requirements at each site prior to the supply of goods.

Each unit shall comprise of a vacuum CB, plug and socket with flexible connection, arc-proof door with racking operation behind closed doors, CB truck and a spring charge motor operated mechanism.

The tenderer shall specify the guaranteed number of mechanical and fault operations for the circuit breaker and vacuum bottle supplied.

All connections shall 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 shall be ISO metric. All bolts shall be no longer than necessary. All bolts, nuts and washers used shall be hot dip galvanised or stainless steel. Cadmium plating will be considered. All nuts used shall be fitted with approved positive locking devices.

All materials shall be of the type and quality that will give a minimum life expectancy of 45 years.

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

#### **5.1.2 Service conditions**

The unit shall be suitable for use on Endeavour Energy's 11kV 3-phase 50Hz system having the neutral point of the source effectively earthed.

The service conditions are in accordance with the indoor standard requirements of clause 2.1.1 of AS 62271:1:2012. The CB shall be designed to operate in service conditions as 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

### 5.1.3 Safety

The unit shall be designed so that during normal service conditions, inspection and maintenance activities can be carried out safely. The supplier shall provide all accessories necessary for the safe operation of the equipment. Further health, safety and environmental requirements are detailed in 5.2.

## 5.2 Health, safety and environment (HSE) requirements

### 5.2.1 Special environmental requirements - toxicology safety

The supplier shall provide full details, including composition and toxicological information, regarding the health and safety of the materials offered in their products.

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

Material safety data sheets (MSDS) shall be supplied with copies available on site for materials that are supplied and subject to safety considerations in handling and use.

### 5.2.2 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 shall be kept to the minimum levels to comply with all the requirements of AS/NZS 2344:1997.

### 5.2.3 Safety in design

A safety in design report shall be provided by the supplier as part of the evaluation outlining all safety risks associated with the supplied equipment and modifications to the switchboards that form part of the scope of the works.

The supplier shall issue a risk register that will be retained at the substation and operating manual to allow maintenance employees to evaluate the associated risks of the equipment. The risk register shall be provided prior to receipt of goods.

### 5.2.4 Safe working systems

Prior to any site work, a comprehensive risk assessment of all hazards shall be carried out and mitigation measures identified and implemented. The work site hazard and risk assessment shall be provided to Endeavour Energy for approval seven 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 manage the work site hazards.

Works performed on or near Endeavour Energy's network shall 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.

### 5.3 Technical performance summary

The 11kV CB shall meet the following minimum technical requirements:

Item	11kV
<b>Circuit breaker</b>	
<b>Applicable standards</b>	IEC 62271.100:2012, IEC 62271.200:2011, AS 62271.1:2012
Interrupting medium	Vacuum
Class	Indoor
Rated normal current ( $I_r$ ) (A) # <ul style="list-style-type: none"> <li>Reyrolle LMT / LMT2</li> <li>Westinghouse J18</li> <li>Westinghouse J22</li> <li>Hawker Siddeley Brush VIS</li> <li>South Wales D-Type</li> <li>G.E.C OLX</li> </ul>	2000 / 1250 / 800 / 630 / 400 1250 / 800 2000 / 1600 2000 / 800 / 630 2000 / 1250 / 800 / 630 / 400 2000 / 1600 / 800 / 630
No. of phases	3
Rated frequency (fr) (Hz)	50
Rated voltage ( $U_r$ ) (kV)	12
Rated insulation level – lightning impulse ( $U_p$ ) (kV peak) <ul style="list-style-type: none"> <li>Common</li> <li>Across the isolating distance</li> </ul>	95 95
Rated insulation level – 1 min power frequency ( $U_d$ ) (kV rms) <ul style="list-style-type: none"> <li>Common</li> <li>Across the isolating distance</li> </ul>	28 32
Rated short time withstand current ( $I_k$ ) (kA r.m.s)	20
Rated peak withstand current ( $I_p$ ) (kA peak)	50
Rated duration of short circuit current ( $t_k$ ) (sec)	1
Temperature rise	Meets requirements in AS 62271.1:2012
First pole to clear factor	1.5
Rated Operating sequence ( $t=0.3\text{sec}, t'=3\text{ min}$ )	O-t-CO-t'-CO
Circuit breaker opening time/sec	0.04
Rated supply voltage of close, trip/open device and auxiliary circuits ( $U_a$ )	120 V DC



Item	11kV
Number of shunt trip coils	Two (2) independently operated coils
Number of close coils	1
Number of available normally open auxiliary contacts	4 min
Number of available normally closed auxiliary contacts	4 min
Mode of operating	Motor charged spring
Minimum operations with spring fully charged and circuit breaker fully de-energised	Trip – close – trip O-C-O
Internal arc classification type	IAC classified
Accessibility type <sup>2</sup>	A-F <sup>2</sup>
Arc test <ul style="list-style-type: none"> <li>• Current (kA)</li> <li>• Time (s)</li> </ul>	20 1
<b>Additional requirements for capacitor bank circuit breaker<sup>1,3</sup></b>	
Rated cable-charging breaking current (A)	25
Rated single capacitor bank breaking current (A)	400
Rated back-to-back capacitor bank breaking current (A)	400
Rated back-to-back capacitor bank inrush current (kA)	20

**Notes:**

1. Capacitor CB shall be restrike free and have been tested to clause 6.111 of IEC 62271.100:2012.
2. \* Separate schedule for IAC A-FL or A-FLR costing from the supplier will also be considered.
3. Endeavour Energy will provide single line diagrams to determine quantity of capacitor CB and all other rating requirements accordingly.

**5.4 Technical requirements**

The design and construction requirements of the CB and truck shall be in accordance with clause 5 of IEC 62271.100:2008.

**5.4.1 Vacuum interrupter**

The interrupting medium shall be vacuum interruption. The interrupting mechanism and contacts shall be designed to achieve low energy dissipation in the vacuum and not cause appreciable degradation of the contacts.

Means shall 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 shall be included as part of the offer.**

The vacuum bottles shall be of a type already or one that shall be approved by the Manager Primary Systems through the Endeavour Energy Product Approval process prior to acceptance of any switchgear.

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

The supplier shall 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 shall be tested in accordance with clause 6.11 of IEC 62271.1:2011.

#### *5.4.2 Primary isolating contacts*

The primary isolating contacts of the CB shall be a self-aligning type, suitable for interfacing with the existing orifice bushing fixed contact and capable of carrying the maximum short circuit current without thermal or mechanical damage. The design shall be such that, after the initial alignment and setting up, the relative alignment of the fixed and movable contacts cannot alter.

The contact fingers shall be suitably located to prevent collapse or incorrect positioning of the fingers within the cluster. If garter type springs are incorporated in the design for contact pressure, a retainer shall be provided so that the spring does not move from its position in the event of breakage.

#### *5.4.3 Operating mechanism*

The CB operating mechanism shall be an integral part of the CB.

The parts of the operating mechanism that require inspection and preventive maintenance shall be easily accessible and not within a non-accessible enclosed compartment.

The operating mechanism shall contain stored energy via a spring charging motor to operate the CB. It shall be possible to perform all operations of the CB either manually or electrically.

The CB in the closed position shall be able to have a TRIP-CLOSE-TRIP operation before the spring needs to be charged.

#### *5.4.4 Operation and control*

The CB closing mechanism shall be electrically operated trip-free.

The CB shall close when the close command is applied. The CB shall not attempt to make a second attempt to close if it fails to close on the first attempt.

The CB shall open on an open command when a trip signal is applied to any one trip coil or both trip coils, as appropriate.

The CB shall 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 second.

Mandatory provisions shall be made to prevent the spring charging motor from running continuously in the event that the springs fail to charge.

The CB shall not be able to be tripped electrically while in the feeder earth or bus earth positions.

It is preferable that there shall be no 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 lifetime management of the switchgear. Electronic PCB's can be considered provided approval of the Network Substations 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 shall be of industry standard design and not proprietary of a single supplier.

#### 5.4.5 *Plug box and socket connection*

A plug and socket connection shall be provided to enable connection and disconnection of the secondary circuits should Endeavour Energy elect to move the vacuum CB to a remote location to complete maintenance or other tasks.

Flexible reinforced conduit or heavy duty flexible multi-core cable shall be provided to accommodate the secondary circuits between the fixed portion of the functional unit and the withdrawable CB. Means shall be provided to limit the withdrawal of the CB to such a position that the flexible connection is not subjected to any excessive stress. The flexible connection shall have sufficient length to fully withdraw the CB from the fixed portion of the CB compartment and allow access of operating employees into the fixed portion of the CB compartment with the flexible connection still connected.

The plugs and socket contacts shall be silver plated and self-aligning. The plug portion shall attach securely to the socket portion and the fitting shall be so designed that it is impossible to connect it incorrectly. Connectors that require the manipulation of bolts and nuts for their operation will not be accepted.

The plug boxes shall be connected in a standard manner so that all vacuum CB of the same design and current rating are interchangeable.

#### 5.4.6 *Arc-flash risk management*

Arc fault containment upgrades in accordance with IEC 62271.200:2011 are required for site arc fault risk management. Note however, not all sites have sufficient space at the rear and/or lateral of the switchgear and details of physical constraints to provide the level of arc fault containment offered must be detailed in the tender offer.

##### 5.4.6.1 *Arc-proof doors (mandatory)*

Arc-proof doors retrofitted shall comply with IAC A-F as detailed in IEC 62271.200:2011. Type test certificates shall be provided as proof of compliance.

Racking operation behind closed arc-proof doors shall be provided.

##### 5.4.6.2 *Arc-proof vent flaps and expansion chambers (optional)*

Arc-proof vent flaps and expansion chambers retrofitted to the busbar and CT chambers are optional and shall comply with IAC A-FL as detailed in IEC 62271.200:2011. Type test certificates shall be provided as proof of compliance.

##### 5.4.6.3 *Arc-proof vent flaps, expansion chambers and chutes (optional)*

Arc-proof vent flaps, expansion chambers and chutes retrofitted to the busbar and CT chambers are optional and shall comply with IAC A-FLR as detailed in IEC 62271.200:2011. Type test certificates shall be provided as proof of compliance.

##### 5.4.6.4 *Internal fault detection (optional)*

Details of possible internal arc detection systems (i.e. through the use of light dependant components or expulsion / blow-out micro-switches) associated with a common or multiple tripping relays should be offered in writing with any tender offer. The decision on whether to include the provision for purchase of such a system is subject to approval of the Network Substations Manager on a site-by-site basis based on a risk-cost-benefit-analysis. Details of number of units installed of any internal fault detection system in the market should be provided with the tender offer.

#### 5.4.7 *Earthing*

Earthing of the withdrawable CB, shall be in accordance with clause 5.3 of IEC 62271.200:2011.

The CB shall be provided with an earthing point designed to interface with the existing earthing arrangement of the fixed portion of the CB compartment. The earthing point shall be of sufficient cross sectional area to carry fault currents as detailed in the technical schedule so that panels, framework, undercarriages and the like are not relied upon to carry the earth currents.

#### 5.4.7.1 Earthing trucks (optional)

Westinghouse J18/J22 and G.E.C OLX3 do not have integrated earth switches. This specification requires the optional provision of dedicated earth trucks for sites to improve operator safety when earthing of the switchgear supply is required. The rated technical requirements are as detailed in the minimum requirements of 5.3. A means of visual live line indication of earthing trucks shall be provided.

Where earthing trucks are requested from the supplier, type, routine and site test requirements of AS62271.102-2005 as applicable to earthing trucks will be required and shall be included in any offer.

#### 5.4.8 Bushings

The bushings shall comply with AS 60137-2008. Details of the bushings shall be supplied for evaluation purposes.

#### 5.4.9 Indication (visual)

The following indication shall be provided on each CB:

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

#### 5.4.10 Operational interlocks

Each CB truck assembly shall be provided with interlocking and safety devices that operate in conjunction with existing components on the fixed portion of the CB compartment without the need for modification so the following is achieved.

- Prevent the connecting or disconnecting of the CB to or from the busbars unless the CB contacts are in the open position.
- Prevent the operation (open or close) of the CB unless it is in the service, disconnected, or removed position.
- That the CB shall be locked to the side panels before the CB can be closed. The locking shall be of sufficient mechanical strength to prevent the CB moving when operating under fault conditions.
- It shall not be possible to rack the CB onto the busbar unless the secondary plug and socket connection is connected to the CB.
- It shall not be possible to disconnect the secondary plug and socket connection when the CB is in the "racked in" position.

- Spring Closing Interlock to prevent closing of circuit breaker unless spring is fully charged.
- Padlocking facility for CB trucks and earthing trucks for inhibiting the return of earthed equipment to the service position.

#### 5.4.11 Shutters

Each CB truck assembly shall be designed to operate in conjunction with the existing orifice bushing metallic shutters that cover the primary circuit apertures when the removable part is disengaged. The existing shutters are provided with the following features that must be fully operational on insertion and withdrawal of the supplied switching device:

- The busbar and circuit spout shutters each operated independently of one another.
- The shutters open and close automatically by mechanical means of the CB during its raising and lowering.

#### 5.4.12 Racking operation

The required turning force of the manual CB insertion and withdrawal racking system shall be less than 220N during any part of its travel.

#### 5.4.13 Racking Switches

Each CB shall be equipped such that it operates the existing racking switches located in the fixed portion of the CB compartment in the same manner as the existing bulk oil CB. The truck shall be engineered so that there is no possibility of misalignment or for partial connection when racked in.

#### 5.4.14 Auxiliary and ancillary equipment

##### 5.4.14.1 Auxiliary supplies

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

##### 5.4.14.2 Auxiliary switches, contacts and relays

All ancillary switches, contactors and relays shall be of a type proven to be capable of handling the current and voltages involved in the normal operation of the CB. All operating coils shall be continuously rated for the supply voltage used.

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

Should the supplier require auxiliary switches for local control or indication, additional switches are to be provided for this purpose.

##### 5.4.14.3 Auxiliary wiring termination

All auxiliary wiring terminations from the CB truck shall interface with the existing terminal blocks in the fixed portion of the CB compartment in accordance with SDI 526 unless alternative type tested terminations are used as approved by the Manager Secondary Systems.

##### 5.4.14.4 Control switch

Each unit shall 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 CB by an operator standing at the switchgear.

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

#### *5.4.15 Labels*

All labelling of main equipment and control wiring shall be in accordance with Endeavour Energy's substation design instruction SDI 528 and in particular clause 5.22.

#### *5.4.16 Painting*

Surface preparation and coating details shall be supplied to Endeavour Energy. This shall include all material and application details as well as available colours. Light admiralty grey or light Grey is the preferred colour.

### **5.5 Maintenance requirements**

#### *5.5.1 Spare parts*

The supplier shall supply a list of recommended spare parts, special tools and appliances required for the whole of life operation and maintenance of the CB unit. The list, together with prices, shall 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.

Predicted availability and compatibility of ex-stock parts over the life of the CB will be considered. Lists shall 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 shall be provided. The final quantities of spares to be supplied will be decided as part of contract negotiation.

#### *5.5.2 Failure mode analysis and preventative maintenance*

The supplier shall indicate and provide updates to Endeavour Energy the mean time between failures (MTBF) of the CB and its components including the recommended maintenance regime and maintenance tasks and intervals. This regime shall 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 shall be included in the offer.

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

### **5.6 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 shall be agreed prior to contract acceptance. This include the responsibility for the load profile for each transport mode, transport route, the means of transport, any necessary route alteration, statutory approval or licenses, shipping reservations, insurances and documentation or any other requirement concerning the delivery of the switchgear to the nominated site.

#### *5.6.1 Design for transport*

The switchgear shall 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 shall be built into the design. Endeavour Energy requires the installation on the packaging of suitable

shock indicators based on the equipment design to determine no equipment damage has occurred during transport. All equipment damage shall be the responsibility of the supplier.

#### 5.6.2 *Packing*

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

All measures shall be taken to avoid damage during packing, transporting and dismantling.

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

- Endeavour Energy.
- Contract number.
- Supplier's name.
- Mass.
- Voltage rating

### 5.7 **Quality assurance**

Quality assurance certification is required to prove the manufacturers ability to design and consistently manufacture switchgear to this specification. The supplier and all its contractors shall 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.

#### 5.7.1 *Quality assurance plan*

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

- The suppliers 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
- A plan detailing the design, ordering of materials, manufacturing and test plans

#### 5.7.2 *Operations and maintenance manual*

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

Two hard copies and one electronic copy of the complete installation, operation and maintenance manual shall be provided for the complete switchgear supplied for each contract. Each manual shall relate specifically to the equipment supplied and must not contain any material that is not applicable. The manual shall be A4 size and all drawings shall be suitably folded or reduced for filing within the manual. Each manual shall 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.
- Design risk assessment

Following this, for each order, one hard copy and one electronic copy of the following shall be provided:

- 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 in the switchboard clearly marking the components used.

#### 5.7.3 *Additional information*

The following information shall also be submitted;

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

### 5.8 **Testing**

#### 5.8.1 *General*

The supplier shall be responsible for carrying out tests to demonstrate the CB supplied, complies with the technical requirements specified in this Specification.

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

Branch Form FAE 3214 (together with a copy of each of the tests) shall be completed and submitted to Endeavour Energy's Network Substations Manager, Primary Systems for review and approval.

All type tests shall 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 Manager Primary Systems.

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



Type tests shall be less than five years old. Type tests beyond this limit may be acceptable at the discretion of Endeavour Energy's Network Substations Manager, Primary 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 Manager, Primary Systems to demonstrate the testing facility's capability to perform the specified tests. As a minimum, the following information shall be provided:

- qualifications/experience of the testing staff;
- 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 Primary Systems 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 shall not be accepted by Endeavour Energy unless the reports are translated into English by a sworn translator.

#### 5.8.2 Type tests

The offered CB shall be subject to type tests in accordance with clause 6 of AS 62271.1:2012, clause 6 IEC 62271.100:2012 and AS 1931.1:1996 and other relevant standards listed below.

Every CB shall be type tested in accordance with the applicable standard and type test reports shall be provided. Each component of the circuit breaker including auxiliary circuits, shall withstand the temperature rise limits without damage.

As a minimum, the following type tests shall be carried out:

Item	Type Tests	Test method Reference	Acceptable value
1	Dielectric tests	AS 62271.1-2012, clause 6.2	No disruptive discharge
2	Measurement of the resistance of the main circuit	IEC 62271.1-2011, clause. 6.4	The measured resistance shall not be > 20% of before test.
3	Temperature-rise tests	AS 62271.1-2012, clause 6.5	in accordance with table 3 of AS62271.1:2012 depending on the requirements that is <30K (accessible parts) and the like
4	Short-time withstand current and peak withstand current tests	IEC 62271.1-2011, clause 6.6	The measured resistance shall not be > 20% of before test. No failure of CB
5	Tightness tests	IEC 62271.1-2011, clause 6.8	Check vacuum integrity

Item	Type Tests	Test method Reference	Acceptable value
6	Mechanical operation test at ambient temperature	IEC 62271.100-2012, clauses 6.101.2.1 to 6.101.2.3	Operating characteristics before test same as after test
7	Short-circuit current making and breaking tests	IEC 62271.100-2012, 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	IEC 62271.100-2012, clauses 6.111.5.2	No re-strike
9	Verification of the degree of protection	IEC 60529-2013, clauses 11 to 15	Meets requirements of IP4X
10	Low and high temperature tests	IEC 62271.100-2012, clause 6.101.3	No failure during and at completion of tests
11	Humidity test	IEC 62271.100-2012, clause 6.101.4	No change in operating characteristics after test.
12	Electrical endurance tests	IEC 62271.100-2012, clause 6.112	No failure at 110% of rated current.
13	Single-phase and double earth fault tests	IEC 62271.100-2012, clause 6.108	No undue failure of breaker
14	X-Radiation test	IEC 62271.1-2011 clause 6.11	Does not exceed 5 $\mu$ Sv per hour at 1m distance at max operating voltage.  Does not exceed 150 $\mu$ Sv per hour at 1m distance at rated power frequency withstand test voltage.
15	Internal arc test	IEC 62271.200-2011 clause 6.106	Satisfies criterion 1 to 5 of clause 6.106.5 of IEC 62271.200;2000

### 5.8.3 Routine factory tests

The following routine factory tests shall be carried out, on each CB supplied, in accordance with AS 62271.1.2012, AS 62271.100:2008 and IEC 62271.100:2012.

Item	Routine test	Test method reference	Acceptable value
1	Dielectric test on main circuit	AS 62271.1:2012, clause 7.1	No disruptive discharge
2	Dielectric test on auxiliary and control circuits	AS 62271.1:2012, clause 7.2	>5 Mega Ohms using 1kV megger
3	Measurement of resistance of main circuit	AS 62271.1:2012, clause 7.3	The measured resistance shall not be > 20% of before test.
4	Mechanical operation test	IEC 62271.100:2012, clause 7.101	Withstands 5 close/open operations

Item	Routine test	Test method reference	Acceptable value
5	Design and visual test	IEC 62271.1:2012, clause 7.5	Meets specification

#### 5.8.4 Site tests after erection on site

The following tests shall be carried out on the circuit breaker after installation 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 1kV 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	Check vacuum integrity
5	Design and visual checks	Clause 7.5 of IEC 62271.1:2011	Compliance to specifications

In addition all circuit breakers shall undergo operational tests as follows:

- Timing tests of the circuit breakers.
  - Five closes
  - Five opens
  - Five close opens
- Operational tests:
  - Check for proper functioning of all interlocks.
  - Carry out five close/open operations for all circuit breakers

If any site test results are non-conforming, they shall be submitted to the Manager Primary Systems for approval before energisation.

Endeavour Energy will perform its own site tests in accordance with SDI 535 - Site testing and pre-commissioning, tests may be witnessed by the manufacturer / supplier. If the manufacturer / supplier intend to attend the testing, the manufacturer / supplier must notify the principal in writing prior to delivery of the equipment. All costs associated with attending the sites tests are to the manufacturers / suppliers account and responsibility.

### 5.8.5 Submission of test results

#### 5.8.5.1 Type test reports

One copy of type tests report shall 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 Network Substations Manager, Primary Systems.

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 shall be conducted at the manufacturer's expense.

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

#### 5.8.5.2 Routine factory testing

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

## 5.9 Tender drawings

The following drawings are included as part of this specification as samples.

Endeavour Energy has limited fully dimensioned general arrangement drawings of the various bulk oil circuit breakers detailed here. The Contractor shall fully inform themselves of the details of the existing switchgear cubicles and circuit breakers and confirm that the replacement circuit breakers can be installed on site without modifications.

The specification wiring drawings should be regarded as indicative of the requirements for motor spring charged operating mechanisms.

The drawings shall be provided by the Network Substations Manager during the tender process.

Type	Drawing No	Description
Reyrolle LMT/LMT2	B302620	11kV Feeder Reyrolle LMT OCB Protection & Indication circuit diagram
	B302621	11kV Feeder Reyrolle LMT OCB Control & Protection circuit diagram
	C01857	11kV Feeder Reyrolle LMT OCB Control Circuit diagram
	C01858	11kV TX Reyrolle LMT OCB Control Circuit diagram
	C01871	11kV TX Reyrolle LMT OCB Protection & Indication circuit diagram
	C01891	11kV Feeder Reyrolle LMT OCB Wiring diagram
	C01880	11kV Bus Section Reyrolle LMT OCB Protection & Indication circuit diagram
	D2049	11kV Bus Section Reyrolle LMT OCB Control Circuit diagram

Type	Drawing No	Description
	C01890	11kV Bus Section Reyrolle LMT OCB Wiring diagram
Westinghouse J18/J22	071770	11kV Feeder Westinghouse J18/J22 OCB Protection & Indication circuit diagram
	071769	11kV Feeder Westinghouse J18/J22 OCB Control & Protection circuit diagram
	008413	11kV Feeder Westinghouse J18/J22 OCB Control Circuit diagram
	071773	11kV TX Westinghouse J18/J22 OCB Control & Protection Circuit diagram
	071774	11kV TX Westinghouse J18/J22 OCB Protection & Indication circuit diagram
	008415	11kV Bus Section Westinghouse J18/J22 OCB Wiring diagram
HSB VSI R4/R8/Q20	051540	11kV Feeder Hawker Sideley Brush VSI OCB Protection & Indication circuit diagram
	51566	11kV Feeder Hawker Sideley Brush VSI OCB Control Circuit diagram
	51538	11kV Feeder Hawker Sideley Brush VSI OCB Control & Protection circuit diagram
	51535	11kV TX Hawker Sideley Brush VSI OCB Control & Protection circuit diagram
	51534	11kV Bus Section Hawker Sideley Brush VSI OCB Control & Protection circuit diagram
	051542	11kV TX Hawker Sideley Brush VSI OCB Protection & Indication circuit diagram
South Wales D4/D6/D8/ D20	061532	11kV TX South Wales D-Type OCB Connection diagram
	061534	11kV Bus Section South Wales D-Type OCB Connection diagram
	061518	11kV Bus Section South Wales D-Type OCB Control Circuit diagram
	061537	11kV Feeder South Wales D-Type OCB Connection diagram
	061513	11kV Feeder South Wales D-Type OCB Control & Protection circuit diagram
	061512	11kV Feeder South Wales D-Type OCB Control & Protection circuit diagram

Type	Drawing No	Description
	061514	11kV TX South Wales D-Type OCB Control & Protection circuit diagram
	061516	11kV TX South Wales D-Type OCB Protection & Indication circuit diagram
G.E.C. OLX3	047219	11kV Feeder G.E.C OLX3 OCB Protection & Indication circuit diagram
	047220	11kV Feeder .E.C OLX3 OCB Control & Protection circuit diagram
	047259	11kV TX G.E.C OLX3 OCB Protection & Indication circuit diagram
	047256	11kV TX .E.C OLX3 OCB Control & Protection circuit diagram
	490824	11kV Feeder .E.C OLX3 OCB Control circuit diagram
	490826	11kV TX .E.C OLX3 OCB Control circuit diagram

### 5.10 Product approval

#### 5.10.1 Product approval and audit form

Complete information on the equipment shall be provided on Branch Form FAE 3214 as part of the tender process.

#### 5.10.2 Product approval process

The equipment shall be evaluated under the product approval process set out in PAE 1004. The Network Substations Manager, Primary Systems will approve the equipment for use on the network. Final product approval will be issued in writing by the Manager, Primary Systems. On approval of the design all primary and secondary components are fixed and no changes are to be made to the design without obtaining prior approval.

### 5.11 Nameplate data

The nameplate details of each circuit breaker unit shall be stamped on a stainless steel plate and attached to the respective enclosure. The nameplate shall be easily readable, from ground level, in low lighting conditions.

The nameplate shall 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.
- Weight, volume and quality of gas used in the circuit breaker, if applicable
- Internal arc classification (for example IAC classified AF 25kA/1sec)

All nameplates shall be stainless steel.

### 5.12 Documentation

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

- Two hard copies and one electronic copy of the complete installation, operation and maintenance manual shall be provided for the circuit breaker supplied for each contract. Each manual shall relate specifically to the equipment supplied and must not contain any material that is not applicable. The manual shall be A4 size and all drawings shall be suitably folded or reduced for filing within the manual. Each manual shall 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.
- For each order, one hard copy and one electronic copy of the following shall be provided.
  - 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 in the switchboard clearly marking the components used.

### 5.13 Additional information

The following information shall also be submitted;

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

## 6.0 AUTHORITIES AND RESPONSIBILITIES

**Chief Engineer** has the authority and responsibility for:

- approving technical Specifications, including any variations;
- making all decisions concerning compliance in respect to this specification;
- approving nominations of Endeavour Energy's representatives; and
- delegating any of these authorities and responsibilities to the Manager Primary Systems.

**Manager Primary Systems** has the authority and responsibility for:

- endorsing this specification and making recommendations to the Chief Engineer;
- making recommendations concerning compliance in respect to this Specification;
- making nominations of Endeavour Energy's representatives for tender evaluations; and
- approving the relevant actions required and outlined in this specification

**Manager Network Development** has the authority and responsibility for:

- determining that the equipment procured complies with the requirements of this specification; and
- checking FAT and site test reports and seek dispensation from Primary Systems as necessary for marginal non-compliances.

**Network Substations Manager, Primary Systems** has the have authority and responsibility for:

- reviewing all type and routine test reports and alternative proposals submitted for evaluation, and making recommendations to the Manager Primary Systems;
- reviewing this specification based on industry best practice and Endeavour Energy's network requirements; and
- clarifying all the technical aspects of this specification to the stakeholders.

**Project Manager** has the have authority and responsibility for:

- checking that all equipment installed complies with the requirements of this specification; and
- Assisting with site arrangements

**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
- 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.



**7.0 DOCUMENT CONTROL**

**Documentation content coordinator:** Network Substations Manager

**Documentation process coordinator:** Standards Process Coordinator