# EP 01 00 00 06 SP

# REPLACEMENT OF 11KV CIRCUIT BREAKER (D4XD) TRUCKS IN SOUTH WALES SWITCHGEAR

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|---|---|---|---|
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Engineering Specification

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# 1 Introduction

This document describes the minimum mandatory design requirements and provides guidance for the replacement of 11kV bulk oil circuit breaker (D4XD) trucks in existing South Wales Switchgear at several sites within the RailCorp electrical network.

It is proposed to replace the South Wales Switchgear circuit breaker trucks with new trucks fitted with vacuum circuit breakers. All other existing switch board components such as panels, busbar, cable boxes CT's, protection relay's etc. will be retained in its present form.

The replacement circuit breaker shall be delivered complete with it's support frame and all accessories that may be required to make the installation complete in all respect.

It is therefore a requirement that the new circuit breaker trucks operate identical to the original oil circuit breakers presently in service. It is required that the new circuit breakers trucks shall provide all the operational control, test, safety features as the presently installed circuit breakers.

All information required to ensure that the replacement circuit-breaker trucks are electrically suitable for the RailCorp network and South Wales Switchgear is contained in this document or referenced by this document.

# 2 Applicable standards

The following Standards are either referenced in this document or can provide further information.

## 2.1 International standards

| | |
|---|---|
| *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 62271–100: 2008* | *High-voltage switchgear and control gear - Part 100: Alternating-current circuit-breakers* |
| *IEC 62271–200: 2003* | *High-voltage switchgear and control gear - Part 200: A.C. metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV* |

## 2.2 Australian standards

| | |
|---|---|
| *AS ISO 1000: 1998* | *The international system of units* |
| *AS 60270: 2001* | *High voltage test techniques – Partial discharge measurements* |
| *AS/NZS CISPR 16.1 2004/2006* | *Specification for radio disturbance and immunity measuring apparatus and methods - Radio disturbance and immunity measuring apparatus* |
| *AS 4398.1: 1996* | *Insulators – Ceramic or glass – Station post for indoor and outdoor use – Voltages greater than 1000 V a.c. - Characteristics* |
| *AS/NZS 60137: 2008* | *Insulated bushings for alternating voltages above 1000 V* |
| *AS 1852.441: 1985* | *International electrotechnical vocabulary – Switchgear, control gear and fuses* |

| | |
|---|---|
| *AS 60529:2004* | *Degrees of protection provided by enclosures (IP Code)* |
| *AS 2067: 2008* | *Substations and high voltage installations exceeding 1 kV a.c.* |
| *AS 2650: 2005* | *Common specifications for high-voltage switchgear and control gear standards* |
| *AS 2700S: 2011* | *Colour Standards for general purposes* |
| *AS 6227.301: 2005* | *High voltage switchgear and control gear – Dimensional standardization of terminals* |
| *AS 3760: 2010* | *In-service safety inspection and testing of electrical equipment* |

## 2.3 RailCorp standards

| | |
|---|---|
| *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 00 00 00 13 SP* | *Electrical Power Equipment – Design Ranges of Ambient Conditions* |
| *EP 90 10 00 02 SP* | *Standard Voltage Tolerances* |

# 3 Definitions and abbreviations

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.

**Dead tank circuit-breaker** A circuit-breaker with interrupters in an earthed metal tank.

**Fixed circuit-breaker** A circuit-breaker which is not a withdrawable part of the panel assembly it which it is 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 voltage** The highest r.m.s. phase-to-phase voltage of the supply on which the switchgear is designed to operate.

**Current transformer** An instrument transformer in which the secondary current, in normal conditions of use, is substantially proportional to the primary current and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections

**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** 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.

# 4 Performance characteristics

## 4.1 General

The circuit breaker trucks shall be designed and manufactured tested and delivered in accordance with the latest Australian Standard (AS) and International Standard (IEC) except where specifically varied in this document. Circuit-breakers manufactured in accordance with other internationally recognised standards (such as ANSI/IEEE) may be acceptable to RailCorp provided the circuit-breakers meet the essential performance criteria as specified herein.

The circuit-breakers shall be suitable for the environmental conditions as described in RailCorp document: EP 00 00 00 13 SP, Electrical Power Equipment – Design Ranges of Ambient Conditions.

Similar components of all equipment shall be capable of being interchanged.

## 4.2 Circuit-breaker ratings

The circuit-breaker shall have the following general ratings:

| Item | Description |
|---|---|
| Type | Dead Tank |
| System Parameters:<br>– Nominal system voltage<br>– Highest system voltage ($U_r$)<br>– System frequency ($f_r$)<br>– No. of phases<br>– No. of poles<br>– Class | <br>– 11 kV<br>– 12 kV<br>– 50 Hz<br>– 3<br>– 3<br>– Indoor |
| Interrupting medium | Vacuum |
| Rated insulation level:<br>– Lightning impulse withstand voltage ($U_p$)<br>– Power frequency withstands voltage ($U_d$, kV for 1min.) | <br>– 95 kVp<br>– 28 kV |
| Rated normal current ($I_r$) | – 630A for existing 400A CBs<br>– 1250A for existing 800A CBs |
| Rated short circuit breaking current | 16 kA |
| Rated short circuit making current | 40 kA |
| Total breaking time ($t_b$) | 40 ms |
| Rated operating sequence | O-0.3s-CO-3min-CO |
| Duration of short circuit ($t_k$) | 3 s |
| Mechanical endurance (class)<br>– No. of on/off operations at no load | M2<br>– 10,000 |
| Electrical endurance (class)<br>– Minimum number of break operations:<br>• At rated current<br>• At 16 kA | E2<br><br>• 2000 or better<br>• 20 |
| Operating mechanism:<br>– Method of operation<br>– Operating mechanism type<br>Spring charging motor rating (kW)<br>– Voltage (to be confirmed for each site) | <br>– Manual and Power<br>– Spring<br><br>– 125V DC +10%, -30% |
| No. of independently operating trip coils | 2 |
| No. of independently operating close coils | 1 |
| Supply voltage for trip/close coils (to be confirmed for each site) | 125 V DC +10%, -30% |

**Table 1 - Circuit Breaker Rating**

# 5 Technical requirements

## 5.1 General

The circuit-breaker trucks supplied under this specification shall incorporate ‘dead tank’ circuit-breaker units. The scope of work shall include design, engineering, manufacture, assembly, testing at manufacturer’s works; packaging, shipping and delivery to RailCorp and site works as specified.

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

All circuit breaker trucks of same rating shall be interchangeable.

All equipments shall be designed to minimise safety hazard to operating personnel, prevent accidental “shorts” by human error and prevent access of spiders, birds or rodents.

The design and construction shall be in accordance with the technical requirements stated. All materials shall be of a type and quality that will give normal life expectancy without deterioration.

It is not the intention to specify all minute details of the equipment/accessories used in the specified circuit-breaker assembly. However the equipment shall conform to the highest standards of safety, quality, engineering and workmanship whether specified or not.

## 5.2 Circuit-breaker type

The interrupting medium shall be vacuum.

Each circuit-breaker shall consist of three separate "pole units" mounted on a single piece frame and shall be mechanically interconnected.

## 5.3 Circuit-breaker Operating Mechanism

The circuit-breaker operating mechanism shall be an integral part of the circuit-breaker. The circuit-breakers shall be operated by stored energy motor spring charging mechanism. It shall be possible to perform all operations of the circuit-breaker manually or electrically. Any part of the mechanism that requires routine inspection and maintenance shall not be enclosed in any gas tight compartment.

The circuit-breaker closing mechanism shall be electrically operated, trip-free. The circuit-breaker mechanism shall provide lockout preventing closing, as specified in Clause 441-14-23 of *AS 1852 (441): 1985*.

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

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

A mechanical push-button or similar device for tripping the circuit-breaker shall be provided.

Continuously rated control equipment to make the successful closing of the circuit-breaker independent of the length of time that the control switch is held in the CLOSE position and to ensure that only one closing attempt can be made if the control switch is held in the CLOSE position.

The circuit-breaker shall have one close coil and two trip coils.

All operating coils of the control contactors associated with the closing-tripping device shall be rated for continuous operation.

## 5.4 Circuit Breaker Indication & Auxiliary Contacts

The circuit-breaker shall have the following definite indication:

a) A mechanically operated indicator, indelibly marked, to show whether the circuit-breaker is open or closed. The word OPEN shall be visible only if the circuit-breaker is open 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

b) stored energy device charged/discharged

c) non-resettable mechanical operation counter

The circuit breaker replacement truck shall be identical in electrical and physical functions to the existing breaker trucks.

Each circuit breaker truck shall be supplied with operating handles (one of each type) and any other accessory that may be required for safe operation of the circuit breaker trucks/switchgear.

A minimum of four normally open and four normally closed auxiliary switches or as provided on existing trucks rated at 10 A in a 125 V D.C. inductive circuit or a 240 V A.C. circuit shall be provided.

# 6 Integrated system support requirements

## 6.1 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.

## 6.2 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 00 12 SP Electrical Power Equipment - Integrated Support Requirements.*

# 7 Tests

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

## 7.1 Routine tests

The following routine tests in accordance with *AS 62271.100* Clause 7 shall be conducted on all circuit-breakers and associated equipment.

- dielectric test on main circuit
- dielectric test on auxiliary and control circuits
- measurement of the resistance of the main circuit
- tightness test
- design and visual checks
- mechanical operating tests
- partial discharge measurement test

Results of routine tests shall be compared with those of type test results. Results of routine tests and acceptance will be subject to RailCorp approval.

## 7.2 Type tests

The circuit-breakers shall be of type tested design. It is anticipated that the following type tests in accordance with *AS 62271.100* Clause 6 have been successfully conducted. Results of the type tests shall be submitted. Details of test certificates demonstrating compliance with the specifications including the date, results and name of the testing institution shall be provided.

Type test certificate for each of the specified type tests shall be accepted where it can be demonstrated that the circuit-breaker is of a similar design to the type tested circuit-breaker.

- dielectric tests
- radio interference voltage tests
- measurement of the resistance of the main circuit
- temperature-rise tests
- short-time withstand current and peak withstand current tests
- tightness tests
- EMC tests
- mechanical operation test at ambient temperature
- short-circuit current making and breaking tests
- capacitive current switching tests (as applicable)
- verification of the degree of protection
- low and high temperature tests
- humidity test
- static terminal load tests
- critical current tests
- electrical endurance tests

# 8 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.

## 8.1 Information

The information requirements set out in the following standards apply:

| | |
|---|---|
| *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 03 02 00 01 SP* | *Controls & Protection for Rectification Equipment* |
| *EP 19 00 00 02 SP* | *Protection System Requirements for the High Voltage Network* |

## 8.2 Technical schedule (Appendix A)

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

## 8.3 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

**Replacement of 11kV circuit breaker trucks in existing South Wales Switchgear**

The manufacturer shall supply the following technical information. The information provided shall be guaranteed by the manufacturer and supported by type test certificates.

**General details:**

- Name of the manufacturer .....
- Manufacturer's address .....
- Country of manufacturer .....
- Type/reference no. .....

**Circuit-breaker ratings:**

- Type class .....
- Rated voltage .....
- Rated frequency .....
- No. of phases .....
- No. of poles .....
- Rated normal current .....
- Rated short circuit breaking current .....
- Rated short circuit making current .....
- Duration of short-circuit .....
- Total break time .....
- Rated short time withstand current .....
- First-pole-to-clear factor .....
- Rated operating sequence .....
- Rated insulation level
  - Lightning impulse withstand voltage .....
  - Power frequency withstand voltage .....
- Transient recovery voltage for terminal faults .....
- Characteristics for short line faults .....
- Rated opening time .....
- Rated break-time .....
- Rated closing time .....
- Rated line-charging breaking current .....
- Rated cable-charging breaking current .....
- Rated single capacitor bank breaking current .....

**Circuit-breaker details:**

- No. of breaks per pole .....
- Total length of break .....
- Type of main contact .....
- Type of arcing contact .....
- Type of arc control mechanism .....
- Mass of complete circuit-breaker ..... kg
  - shipping tonnes .....
- General arrangement drawing number(s) .....

**Bushings:** Yes/No

- Material .....
- Type .....
- Make .....
- Country of origin .....
- Applicable standards .....
- Type tested
  - Provide list of type tests conducted with dates and names of test station .....
- External creepage distance .....
- Colour .....
- Maximum partial discharge level .....
- General arrangement drawing number(s) .....

**Operating mechanism:**

- Type .....
- Make .....
- Country of origin .....
- Method of operation .....
- No. of trip coils .....
- No. of close coils .....
- Auxiliary supply voltage for close/trip coils .....
- Variation on auxiliary supply voltage .....
- Power consumed by close coil .....
- Power consumed by trip coil .....
- Spring charging motor rating .....
- Auxiliary supply voltage for spring charging motor .....

- Degree of protection (IP)
  Note: test certificate to be attached .....
- No. of free normally open auxiliary contacts available for RailCorp use .....
- No. of free normally closed auxiliary contacts available for RailCorp use .....
- Auxiliary contacts convertible Yes/No
- Weight of mechanism box .....
- general arrangement drawing number(s) .....

**Control Wiring**

- Wiring colours
  - Active .....
  - Neutral .....
  - DC +ve .....
  - DC –ve .....
- Size of wiring (CSA) used .....
- Does wiring conform to *AS 3000* Yes/No

**Environmental information:**

- Maximum ambient temperature .....
- Maximum height above mean sea level .....
- Maximum wind pressure .....
- Seismic intensity .....
- Maximum noise level during breaker operation at 1 m distance ..... dB
- Maximum radio interference voltage at 1 MHz ..... µV/kV
- Corona extinction voltage ..... kV

**Type test certificate:**

Provide a list of type tests that have been conducted on the circuit-breakers. The following information should be provided:

- Name of test .....
- Test station where test was conducted .....
- Test date .....
- Test certificate number .....
- Detailed test report number .....

**Routine test:**

Provide a list of routine tests that will be conducted on each circuit-breaker before despatch. .....

**Reliability data:**

- Failure modes (for early, normal life & wear out periods) …….....
- Mean time between failures (MTBF) …….....
- Mean time between repairs (MTBR) …….....
- No. of units in Australia …….....

# Appendix B Request For Tender checklist

### Application

Request for Tender should be made in accordance with RFT Checklist in Specification *EP 00 00 00 15 SP*, Common Requirements for Electric Power Equipment.

### Information to be supplied at time of tender

In addition to the general requirements in this standard the following information related to the particular site will need to be supplied:

- Site location
- Access road limits (weight, height and time limit)
- no. of circuit-breakers required for each site
- Delivery address

### Information to be sought from the tenderer

- Tenders to complete and submit Technical Schedule in Appendix A
- Type test certificates/reports as specified
- Tenders to complete and submit Integrated Support information as per RailCorp document *EP 00 00 00 12 SP* Electrical Power Systems – Integrated Support Requirement
- General arrangement drawings for each circuit breaker trucks.

# Appendix C Requirements for Technical Aspects of Tender Evaluation

### Evaluation of tenders

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 only if the person is considered 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, the tender evaluation committee shall advise the Chief Engineer Electrical the RailCorp registered file details containing the tender evaluation for future referencing. This is normally a TRIM reference.

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.