Equipment Strategy For High Voltage Circuit Breakers

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1. Introduction

1.1 Purpose

Equipment Strategies document Powerlink's vision for equipment technologies, to provide both Powerlink and suppliers with consistent planning and project management platforms for the life of the strategy. The document expresses Powerlink's vision in terms of the equipment performance requirements. It is not a detailed contract specification.

It is envisaged that the Equipment Strategy for High Voltage Circuit breakers will have a life of ten (10) years. A review of the equipment strategy is required in the fifth (5^{th}) and the eighth (8^{th}) years to enable inclusion of technologies which have matured and show merit to be considered for inclusion in the equipment strategy.

The Equipment Strategy for Circuit Breakers has been developed with input from relevant teams in Powerlink.

1.2 Scope

This document covers High Voltage Circuit Breakers to be used in the networks operated *at* nominal voltages ranging from 72.5 kV to 362 kV for use in new substations and substations requiring partial replacement, refurbishment or augmentation.

1.3 References

Document code	Document title
IEC 61850	International standard used for electrical grid data communication and electrical substation modelling
ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories

1.4 Defined terms

Terms	Definition
NATA	National Association of Testing Authorities, Australia
Circuit Breaker Bushing	An insulated device that allows an electrical conductor to pass safely through a grounded conducting barrier such as is the housing of a transformer or circuit breaker
SAP	Software package used for computerised maintenance management system and asset register
ILAC	International Laboratory Accreditation Cooperation
APLAC	Asia Pacific Laboratory Accreditation Cooperation

1.5 Monitoring and compliance

This equipment strategy will guide development of the technical specification. The success is monitored through regulatory information notice, annual reporting and SAP records review of installed equipment.

The success of this strategy is measured by monitoring life cycle costs associated with this equipment as well as availability and service history.

The minimum records required are:

- Technical specification
- Tender evaluation report

- Period contract
- Purchase orders
- SAP equipment records
- Operation and Manufacturer Manual
- Nameplate details

1.6 Risk management

The risks considered in the development of this strategy are:

- Network Operations Risk – risk related to the increased probability of network outages and their impact on customers and stakeholders
- Safety Risk – risk associated with malfunction of circuit breaker resulting in the prolonged or lack of protection operation exposing personnel and public to fault conditions – can result in serious injuries and fatalities due to electrocution and risk associated with explosive failures of circuit breaker
- Environmental Risk – related to gas leaks
- Financial and Contractual Risk – risk associated with inability to make warranty claims, request access to adequate technical support and spares, increased maintenance costs, additional capital investment costs

2. Strategy

The vision that drives equipment strategy documents is based on historical experience, research and investigations into new products available on the market, reliability centred maintenance analysis and lifecycle cost experience over the expected service life of the equipment (40 years). The main features of the vision for high voltage circuit breakers are as follows:

General:

- Annual Operation and Maintenance cost less than 0.5% of the asset value (assumes routine maintenance requirements as specified below).
- Low stresses, both electrical and mechanical.
- Availability of 99.9%.
- Appropriate monitoring and remote interrogation facilities to allow maintenance staff to optimise site visits.
- Availability of manufacturer's hands-on product support in Australia throughout the life of the product.
- Manufacturer's ability to supervise and/or perform installation, testing and commissioning at Powerlink's nominated sites.
- Manufacturer's ability to supervise and/or perform failure root cause analysis and provide detailed work instructions and or supervise or perform repairs at Powerlink's nominated sites, if requested.
- Provision for extended warranty.
- Minimal variants to cover operational requirements.
- Minimal site assembly and installation time.
- Evaluation and Assessment through Life Cycle Cost Analysis (LCCA)
- Standard connection interfaces to the secondary control systems.

Maintenance:

- Minimal maintenance requirement.
- Minimal routine visual inspections, no more than once a year.
- Circuit breaker non-intrusive service intervals of 12 years or longer and achievable as far as possible while the equipment is in operation.
- Modularity of design to minimise assembly work with as much factory pre-set assemblies as possible.
- Interchangeable spares, preferably factory pre-set, with minimal down time at site.

Safety and Environmental:

- The risk of explosive failure is to be kept as low as reasonably practicable.
- Failure modes should be non-life threatening and as safe as reasonably practicable for personnel working in the yard.
- Main insulation medium is not oil and bushings are not made of porcelain or similar material.
- Gas used in the Circuit Breaker should be recyclable and/or recoverable. Use of suitably trialled and tested circuit breakers that use a non-greenhouse gas will be looked at favourably.
- Minimal leakage rates of gas with the aim of being less than 0.1% per annum, with a maximum guaranteed of less than 0.5% per annum
- Noise and Radio Interference Voltage (RIV) are equal or lesser than those of the circuit breakers presently in service in Powerlink network.

2.1 Equipment strategy elements:

Based on the above vision the main equipment strategy elements are listed below.

a. The future Circuit Breaker specification shall include the following main features:
   - Designed for an operating life of 40 Years.
   - Live tank or dead tank technology with strong preference to utilise dead tank technology.
   - Non-ceramic insulators and gas insulation medium.
   - Safe Operation, availability and reliability to meet network requirements.
   - Inclusion of overpressure devices (for example, rupture disks).
   - Analog on-line gas density monitoring to be connected into the substation automation system.
   - Rapid auto-reclose capability including single pole auto reclose.
   - Point on wave switching capability readily available to work with Powerlink specified point of wave relay (Mechanically staggered mechanisms as a means of controlling switching over-voltages are not acceptable).
   - Service and spare parts Australian based support during the complete life of the equipment.
   - Powerlink prefers suppliers who are able to describe the lifecycle stages of their product and hence clarify the availability of spares and support.
   - Minimal leak rate of gas (preference given to improved seal systems, including appropriate flange direction to reduce seal exposure to weather elements).
   - Preference will be given to design which actively minimises the chances of corrosion in all aspects. Anti-corrosion measures applied especially in areas of known corrosion e.g. unprotected flanges, rupture disks, gas ports, gas pipes, etc. and/or external weather sealant on all flange joints will be well regarded.
   - Designed to have minimal routine inspection/maintenance.
   - Simplified operating mechanism free from compressed air or hydraulics.
   - An independent means of isolating the circuit breaker gas volume from the filling point.
   - Ground access to the filling point.
   - Ground access to circuit breaker number of operations counter and circuit breaker position indicator.
   - Calibration of measuring / testing equipment used by the manufacturer to be NATA certified or equivalent local national standards.

b. Bushing current transformers have to be tested by NATA certified laboratory or by facilities accredited to ISO/IEC 17025 and have mutual recognition through ILAC or APLAC.

c. The manufacturer's ability to be able to provide support for the whole of life of the breaker including the ability to install, commission and service the breaker, perform circuit breaker failure root cause analysis, provide detailed work instructions, supervise or perform repairs as well as holding the spares required to support the breaker across the 40 year life will be well regarded.

2.2 Projected use of equipment

All circuit breakers to be purchased will be used for switching transmission lines, transformers, generators, capacitors/reactors/SVCs or for bus-coupling.

2.3 Technologies available now:

Of prime importance to Powerlink is the proper mix of various sub-systems to achieve the Strategy and Planning group goals. A careful selection of such sub-systems is essential so that minimal life cycle cost is achieved while attaining benefits such as high reliability ease of commissioning, simple operation and low cost maintenance.

2.4 Concurrent investigations:

The market position for circuit breakers with Fibre Optic Current Sensors and electronic current and voltage transformers with merging units integrating with IEC 61850 secondary systems will continue to be monitored. The possibility of using such merging units with protection systems which are non-compliant with IEC 61850 by the use of analogue outputs from merging units may be assessed in the future.

2.5 Summary

The equipment strategy detailed in this document will be adopted for all future requirements of high voltage circuit breakers, unless otherwise identified during project scoping due to the identified specific and explicit reasons.

It is foreseen that the adoption of the equipment strategy detailed in this document will achieve the minimum life cycle cost as well as ensuring the benefits of high reliability, ease of commissioning, simple operation, reduced environmental footprint and increased safety for personnel and public.