Equipment Strategy for Line Insulators

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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 of the equipment performance requirements. It is not a detailed contract specification.

The intent of this strategy is to specify the Powerlink strategy to be used in both regulated and non-regulated applications. This document will direct the development of detailed technical and procurement specifications for transmission line insulators.

The equipment Strategy for Line Insulators has been developed in consultation with the relevant stakeholders within Powerlink.

1.2 Scope

This document defines the strategy for insulators for application on the HV and EHV overhead transmission line network. The purpose of insulators is to provide insulation and mechanically support transmission line conductors. The Powerlink network predominantly utilises porcelain and glass disc insulators in several creepage profiles, and porcelain bridging posts for horizontal bridging applications. The network also consists of a fleet of composite longrods and post insulators.

Insulation for use at different voltages other than the range mentioned can be purchased on an ad-hoc basis but following the same strategic principles in this document.

It is intended that the equipment strategy will be reviewed on a regular basis so that changes can be incorporated at the most opportune time. The Equipment Strategy will have a life of five (5) years, with a significant review in the third (3rd) year reviewing service experience and if there are new alternative technology solutions.

1.3 Defined terms

Terms	Definition
EHV	Extra high voltage, taken as greater than 230kV and up to 500kV
HV	High voltage, taken as nominal line voltage between 35kV and 230kV
IEC	International Electro-technical Commission
LCCA	Life Cycle Cost Analysis
SAP	Software package used for computerised maintenance management system and asset register

1.4 Monitoring and compliance

This equipment strategy will guide development of the technical specification and tender specification. The success of this strategy is measured by monitoring life cycle costs as well as availability and service history associated.

1.5 Risk management

This document has been developed to clarify necessary requirements of the equipment strategy for the procurement of insulators. It sets out the technical requirements to manage the risks associated with insulators in a manner that will achieve the safety, operational, financial, and business development objectives. Risks are mitigated by adhering to this strategy.

2. Strategy

2.1 Projected use of equipment

Transmission line insulators for Powerlink's overhead transmission network operate at system voltages of 66kV up to 500kV. The Powerlink overhead transmission line network consists of ceramic (porcelain and glass) disc insulators and non-ceramic polymer insulation. Insulators are predominately used to insulate the phase conductors from the structures to avoid flashover under continuous power frequency (50Hz) operation as well as from temporary over-voltages from switching surges, earth faults, resonance conditions and fast-front lightning.

The following insulator selection scenarios shall apply:

- New conventional transmission lines shall be designed and constructed using ceramic disc insulation.
- Ceramic insulating materials consisting of (toughened) glass, or (wet process) porcelain shall be treated as electro-mechanically equivalent, and either should be used in accordance with approved requirements.
- The use of toughened glass shall be avoided in vandalism prone areas.
- Specific installation environments or historical experience with insulator performance for assets in specific environments or geographical localities may result in the nomination for use of RTV coated ceramic or composite insulators on new or reinsulated assets.
- Approval for the use of alternative insulator materials other than naked glass or porcelain shall be sought from Powerlink.

It is recognised that alternate non-ceramic insulator designs are most suitable in some environments. For new permanent transmission lines, approval for the use of composite insulators shall be sought for the following typical scenarios:

- Very high to extreme pollution areas
- Short span applications where insulator and hardware weights impacts are exacerbated.
- Use of horizontal or vertically mounted composite post insulators to minimise clearance violations due to swinging assemblies.
- Maintainability considerations where insulator weights and string length are primary considerations.
- Assets with a nominal service life of 25 years or less.
- Non-conventional, compact or aesthetic transmission line design applications.

2.2 Strategic requirements

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. The main features of Powerlink's vision for transmission line insulators are as follows:

General

- Minimum whole of life cost in alignment with LCCA
- Meet a 40-year service life for ceramic insulators.
- Meet a 25-year service life for composite (polymer) insulators
- Compliance with all relevant international & Australian standards

- High availability, reliability, and cost competitiveness on a whole of life basis.
- First class design and workmanship throughout and only the best and most suitable materials shall be used.

Maintenance

Powerlink's preference is to procure equipment which has:

- Provide maximum reliability under all service conditions.
- Minimum routine non-intrusive inspections whilst the transmission line is in operation.
- Simple, reliable and proven technology
- Supports live-line maintenance methods.
- Disc insulators shall employ locking devices.

Safety and environmental

- The safety of personnel shall be basic to the design.
- Working conditions should be safe to the greatest possible extent for personnel working in the area.
- Meeting standard requirements for corona, noise, and radio interference voltage (RIV).

2.3 Additional requirements

Line insulators should include the following main features:

- Spare parts support during the complete life of the equipment
- Suitable strength to withstand the mechanical loads and deflection limits applied through application on the Powerlink network.
- Suitably dimensioned and designed to meet the reliability performance requirements for power frequency, switching surge and lightning surges.
- Meets performance criteria across code compliant network parameters.
- Withstands an ultimate fault level of 50kA for 0.35s
- Disc types fitted with zinc sleeves to provide extended corrosion protection, fitted with stainless steel pin locking devices in strength ratings of 70, 125 and 160kN.
- 70kN discs shall utilise 16mm coupling and 125kN and 160kN shall utilise 20mm.
- Discs shall be normal (standard), anti-fog or alternating shed (open or external ribbed) profile to meet the geographical environment.
- Composite longrods shall utilise 20mm end fittings and supplied in light grey colour.
- For greenfield applications, a minimum specific creepage length of 25mm/kV (Heavy Pollution). Brownfield applications permit the use of specific creepage distances lower than 25mm/kV, where historical performance has proven it acceptable.
- The insulation level shall be co-ordinated with substation assets considering the effects of lightning surges and switching surges from entering the substation via transmission line assets.
- Longrod composite insulators to have a minimum 160kN mechanical rating, fitted with corona rings on the energised end as a minimum, but may extend to an additional ring at the earthed end to meet specified E-field compliance requirements.
- Marked with name or trademark of the manufacturer, year of manufacture, manufacturer’s catalogue number and where applicable the electromechanical failing load and IEC designations.

- All ferrous parts other than stainless steel shall be hot dipped galvanised complying with Australian Standards requirements.
- Self-restoring
- Robust construction and packaging capable of withstanding the forces that occur during transport over rough roads for long distances, during erection and service without damage.

2.4 Technologies available now

Insulator materials currently available include porcelain, toughened glass, epoxy resins and polymer insulators. Epoxy resins have been deemed as not suitable for use by Powerlink as their use is normally limited to medium voltages due to a weakness to electrical stresses. The applications of coatings to traditional ceramic discs, such a room temperature vulcanised (RTV) silicon rubber, is a widely available technology used extensively as a water-repellent to improve performance in very high pollution environments but presents maintenance risks and therefore deemed only viable for specialist brownfield applications where porcelain or polymer insulations have proved unsuitable.

Insulator types currently available that are suitable for HV and EHV overhead transmission network application include post, discs and longrods. Pins, station posts, bushing and non-composite longrod insulators have been deemed unsuitable for use for overhead transmission networks. Porcelain guy wires insulators installed on guy wires to provide electrical isolation are an effective approved technology.

2.5 Concurrent investigations

In view of continuous technological improvement, it is important that close examination of the available technologies be made to ensure that they meet Powerlink's requirements and adopt the most appropriate technology. Prior to the commencement of adopting new technology, either a trial project or a review of fleet performance and maintenance costs within the industry shall be performed.