# 2023-27
# POWERLINK QUEENSLAND REVENUE PROPOSAL

## Supporting Document – PUBLIC

## Asset Risk Management Framework

# Powerlink – Asset Risk Management – Framework

| | | |
|---|---|---|
| Policy stream | Asset Management | |
| Authored by | Senior Risk and Portfolio Optimisation Engineer | [redacted] |
| Reviewed by | Manager Portfolio Planning and Optimisation | [redacted] |
| | Manager Asset Strategies | [redacted] |
| Endorsed by | General Manager Network Portfolio | [redacted] |
| Approved by | EGM Strategy and Business Development | [redacted] |

## Version History

| Version | Date | Section(s) | Summary of amendment |
|---|---|---|---|
| 1.0 | 31/12/2015 | All | Original version |
| 1.1 | 25/01/2016 | All | Formatting changes |
| 2.0 | 21/12/2020 | All | Includes additional information on PoF, LoC and cost of consequence models |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

## Table of Contents

# 1. Introduction

## 1.1 Purpose

The purpose of the Asset Risk Management Framework (hereafter referred to as the “Framework”) is to provide a high level overview of the quantitative risk techniques that Powerlink uses as part of asset management and regulatory approval activities.

## 1.2 Scope

This document provides an overview of the methodology used to quantify risks for network assets approaching the end of their technical or economic life.

The Framework outlines a process which enables key risks associated with end of life network assets to be quantified in a structured, transparent and consistent manner. The approach is used as inputs into economic cost benefit assessments which compare options to address end of life issues.

These assessments are used within strategic asset planning and regulatory approval activities.

## 1.3 References

| Document code | Document title |
|---|---|
| | ISO 31000:2009 – Risk Management – Principles and Guidelines |
| A1956394 | RSK-F&BP-STD-A1956394 – Powerlink – Risk Management – Standard |
| A1956393 | RSK-F&BP-PRO-A1956393 – Powerlink – Risk Management – Procedure |
| A1165080 | RSK-FBP-CKL-A1165080 – Powerlink Risk Assessment Matrix |

## 1.4 Defined Terms

| Terms | Definition |
|---|---|
| AEC | Annualised Equivalent Cost. The annualised cost of the investment to address end of life issues. |
| PoF | Probability of Asset Failure. Represents the irreparable failure of the network asset or component. Does not incorporate repairable functional failures. |
| LoC | Likelihood of Consequence. Represents the moderating factors used when assessing the consequences of failure. |
| CoC | Cost of Consequence. Represents the financial (or monetised) equivalent of the risk consequence. |
| Risk Cost | The probability weighted cost of consequence. Risk Cost = PoF x LoC x CoC. |
| SFAIRP | So Far As Is Reasonably Practicable. A guiding principle where all people are given the highest level of health and safety protection based on what could reasonably be done at a particular time. |
| RIT-T | Regulatory Investment Test for Transmission. An economic cost benefit test and consultation process developed by the Australian Energy Regulator prescribed under the National Electricity Rules. |
| AER | Australian Energy Regulator. |

## 1.5 Roles and Responsibilities

| Who | What |
|---|---|
| EGM Strategy and Business Development (SBD) | Ensuring that the Asset Risk Management framework is fit for purpose, and supports Powerlink's asset management principles, objectives and practices. |
| GM Network Portfolio | Setting the asset risk management framework used for quantifying network asset risks. |
| Manager Asset Strategies | Applying the asset risk management framework to quantify network asset risk. |
| Manager Portfolio Planning and Optimisation | Applying the asset risk management framework for strategic planning activities. |
| Manager Network and Alternate Solutions | Applying the asset risk management framework for regulatory approval activities including the Regulatory Investment Test for Transmission. |

# 2. Overview of Risk Cost

## 2.1 Introduction

This document outlines the methodology that Powerlink uses for quantifying risk associated with network assets approaching the end of their technical and economic life.

This methodology is used within the quantification of risk cost that Powerlink undertakes as part of the economic assessment within Regulatory Investment Test for Transmission (RIT-T) consultations. Risk cost is one input into the RIT-T economic assessment. There are also other costs and benefits that are incorporated within the financial analysis.

The methodology is based on the “Cumulative Act Model” or “Swiss Cheese Model” shown in Figure 2.1. The model is conceptualised by the presence of layers within a system that need to fail for the risk event to occur. Each layer of the model comprises of vulnerabilities. The vulnerabilities may consist of hidden defects, lapses in preventative controls, and failures in post mitigation measures. The size of the hole within each layer represents the extent of the vulnerability while the number of layers represent the barriers which act to prevent or mitigate the loss.

This building block methodology provides a modular approach to evaluating risk, and allows better understanding of contributing factors that can lead to the risk event. This enables risk to be quantified in a more structured, consistent and transparent manner.

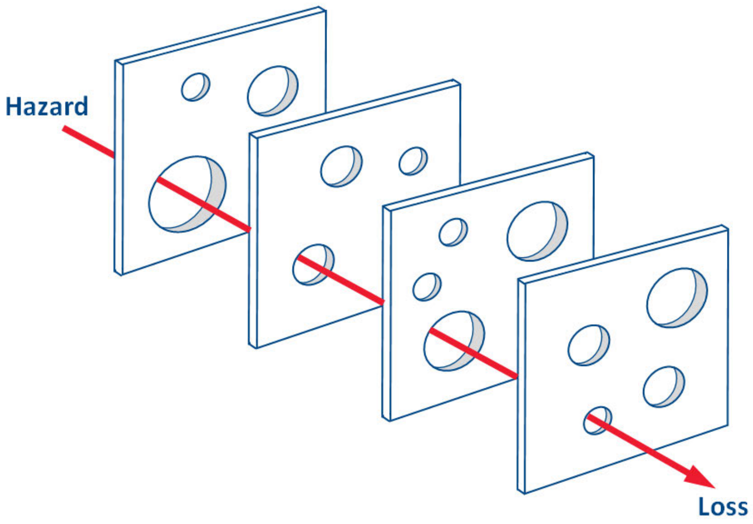


**Figure 2.1 – Cumulative Act Model (“Swiss Cheese Model”)**

## 2.2 Risk Cost Definition

The risk cost provides a measure of the expected financial (or monetised) value of the risk event.

Risk cost is defined as the probability weighted cost of consequence as shown below. The likelihood of consequence factors represent the moderating factors for the consequence occurring.

**Risk Cost** = **Probability of Failure (PoF)** × **Likelihood of Consequence (LoC)** × **Cost of Consequence (CoC)**

Where there are a number of assets with homogenous attributes and characteristics, the risk cost can be calculated across a fleet of assets as follows:

Risk Cost ($) = PoF x Number of Assets x LoC x CoC

The risk cost needs to be defined over a standard period of time. For the purposes of asset planning, risk cost is usually assessed on an annual basis.

<u>Example</u>

An event is expected to occur once every 100 years. The financial equivalent cost of the event is $10 million.

Risk Cost = 0.01 x $10 million = $100,000 per annum.

### 2.3 Risk Cost Calculations

The risk cost for network assets approaching end of life are calculated for each failure type and consequence category. The consequences and moderating factors can vary for different failure modes and risk categories. Hence the risk cost needs to be built up from a series of individual calculations.

Each calculation specifically maps the failure mode to the consequence and corresponding moderating factors.

Powerlink examines risk cost across four broad categories of consequence – safety, network, financial and environmental. Each category of risk may involve a number of consequences and moderating factors.

The calculation of risk cost across the four risk categories for a particular failure type is shown below.

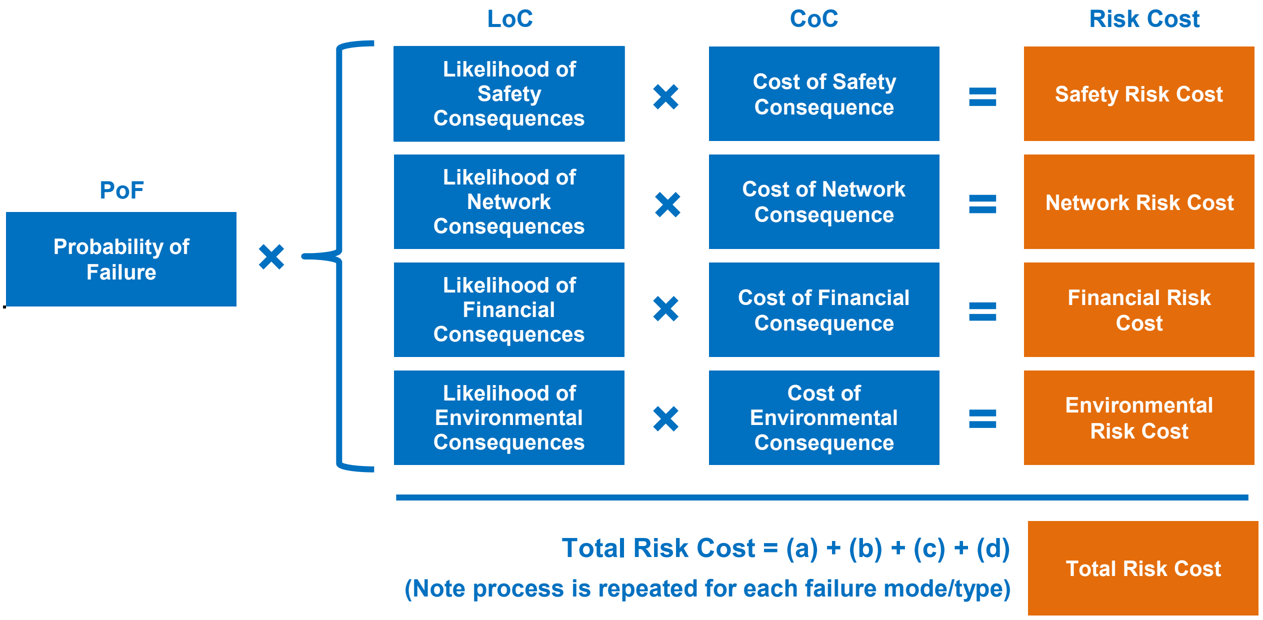


**Figure 2.2 – Risk Cost Calculation Building Blocks**

## 2.4 Cumulative Risk Cost

The risk cost approach can be used to determine cumulative risk levels across a number of network assets.

Consider a system where there are two separate components and the failure of each component occurs in an independent manner. The cumulative risk of the system is defined as:

$$\text{Cumulative Risk} = L1 \times C1 + L2 \times C2 - L1 \times L2 \times C3$$

where: L1 and L2 represent the likelihood of failure for components 1 and 2

C1 and C2 represent the consequences of failure for components 1 and 2

C3 represents the consequence of a concurrent failure of components 1 and 2.

For high impact and low probability events, the third term can often be ignored where the consequence associated with a concurrent failure of both components does not increase in the same proportion to the probability of the concurrent failure. Under these circumstances, the cumulative risk level can be approximated as follows:

$$\text{Cumulative Risk} = L1 \times C1 + L2 \times C2 + \ldots + Ln \times Cn = \sum L \times C$$

The above is valid only where the failures are independent events and the outcomes are comparable.

An example of risk cost calculated for a substation bay is shown in Figure 2.3. The risk cost is the summated risk cost for each individual components of the bay. A similar approach is used for other asset classes.

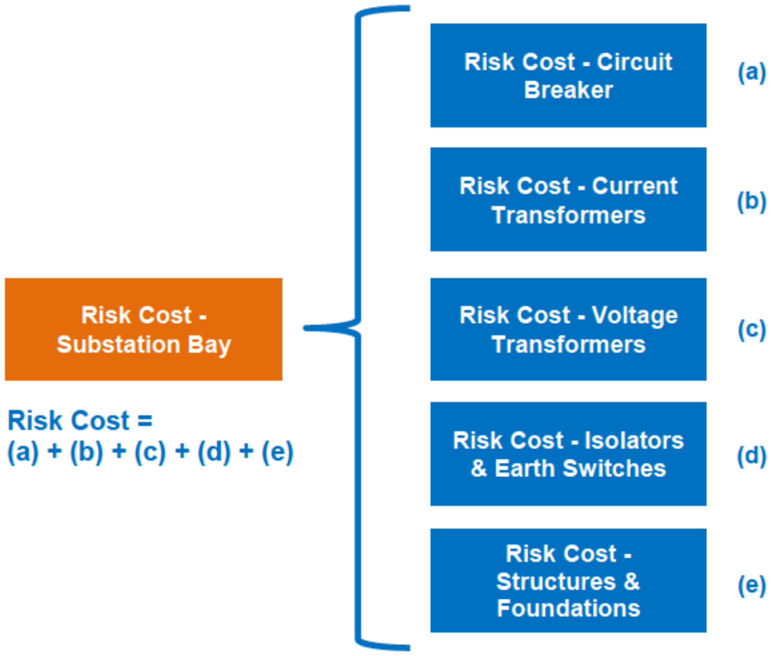


**Figure 2.3 – Cumulative Asset Risk Cost (Substation Bay Example)**

Where the probability of concurrent failures can materially impact risk cost, reliability theory can be used to calculate cumulative risk.

For example, where there are a number of series components reaching end of life within a network element, reliability theory can be used to calculate the cumulative probability of failure. The risk cost is the product of the cumulative probability and network consequence, provided the consequence of failure and moderating factors are similar for each component.

This approach may be especially applicable when calculating the network risk cost for several items of equipment when failure of one or more elements leads to the same network consequence (eg. tower structures making up an overhead transmission line).

# 3. Risk Cost Methodology

## 3.1 Risk Scenario

The first step in assessing risk cost is defining the risk scenario. The risk scenario describes the risk event, and outlines the circumstances and chain of events that need to occur for the adverse impact to eventuate. This in turn provides context for the building block components that are required to quantify risk cost.

## 3.2 Probability of Failure

### 3.2.1 General

It is necessary to quantify the probability of asset failure. For asset planning purposes, asset failure is defined as irreparable failure that requires replacement for continued functionality. The probability of asset failure rates generally excludes repairable faults or non-critical functional failures.

Powerlink endeavours to derive failure curves that are functions of parameters that reflect actual asset condition. Whilst these models are more accurate, they are generally more complex than age based failure models, since the change in condition as a function of time also needs to be derived.

The failure curve needs to consider the particular failure mode of the asset. Where there are several failure modes, the risk cost for each mode of failure needs to be calculated.

### 3.2.2 Failure Patterns

The failure patterns associated with each type of equipment item needs to be determined. The six standard types of failure patterns recognised within asset management are shown in Figure 3.1.

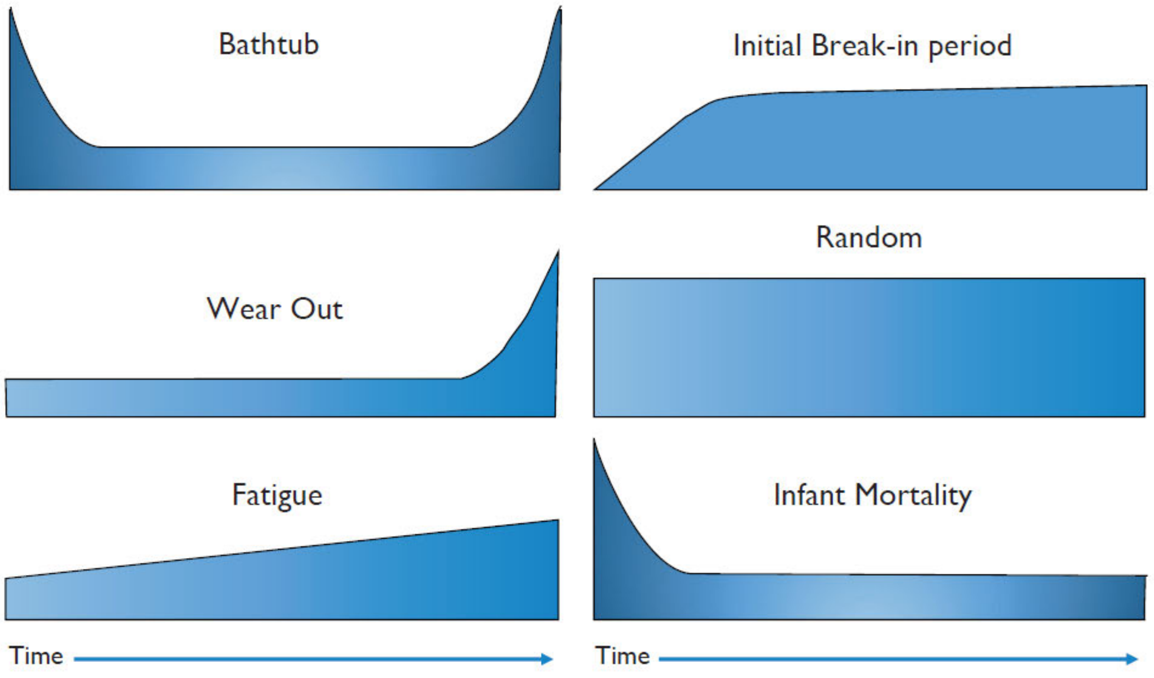


**Figure 3.1 – Categories of Failure Patterns**

Failures of high voltage primary plant (such as large power transformers) generally follow the characteristic bathtub failure pattern.

Overhead transmission line components and hardware generally follow the wear-out failure pattern. This pattern represents an increasing rate of failure towards the end of life as protective galvanising layers are depleted leading to metal loss with corresponding reduction in strength. The structural integrity may also degrade over time due to fatigue resulting from fluctuating stresses (eg. wind induced vibration).

Digital equipment and secondary system protection equipment generally follow a random failure pattern with some element of fatigue.

The ageing portion of the failure pattern is of most interest when quantifying risk cost associated with assets approaching end of life.

### 3.2.3 Hazard Functions

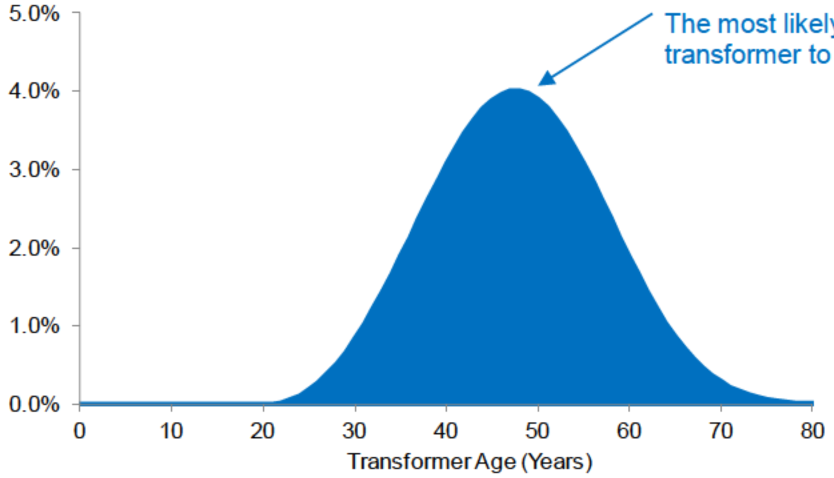
The probability of failure is determined by the hazard function. The hazard function is a conditional probability representing the probability that an asset will fail given that it has survived (not failed) to date. Hence the hazard function represents the “instantaneous” probability of failure for a working system. The conventional bathtub curve generally is a hazard function.

The hazard function differs from the probability of failure distribution (pdf), which defines the probability that an asset will fail in any particular year. The cumulative probability of failure distribution (cdf) is the integral of the probability of failure distribution, and represents the expected likelihood that an item of plant will failure up to a particular point in time.

An example of the three types of probability distributions for the ageing portion of a large power transformer is shown in Figure 3.2. The distribution is based on a Weibull function with the shape parameter (alpha) set to 31 and the scale parameter (beta) equal to 3.2.

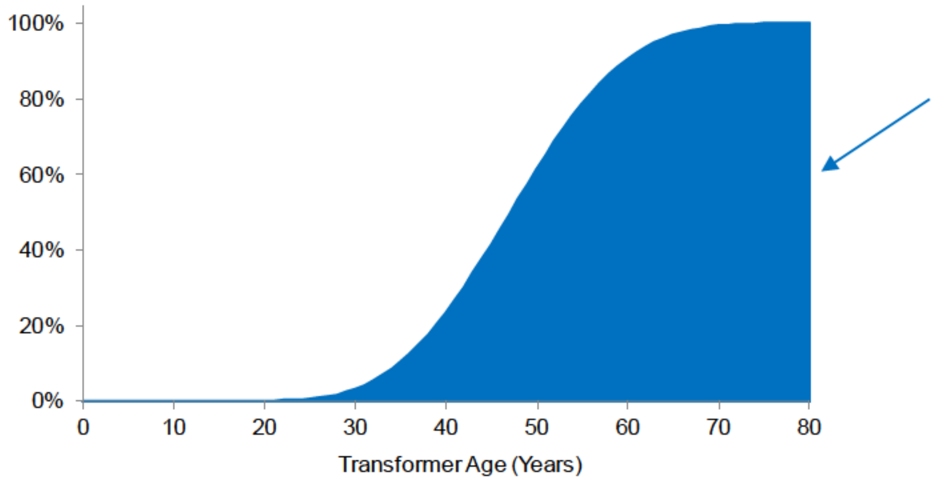
The hazard function is used when calculating risk cost. This is because risk cost for a particular year is based on the consequences associated with irreparable failure of the asset, and assumes that the asset has survived (not failed) to date.

Probability Distribution Function (pdf)



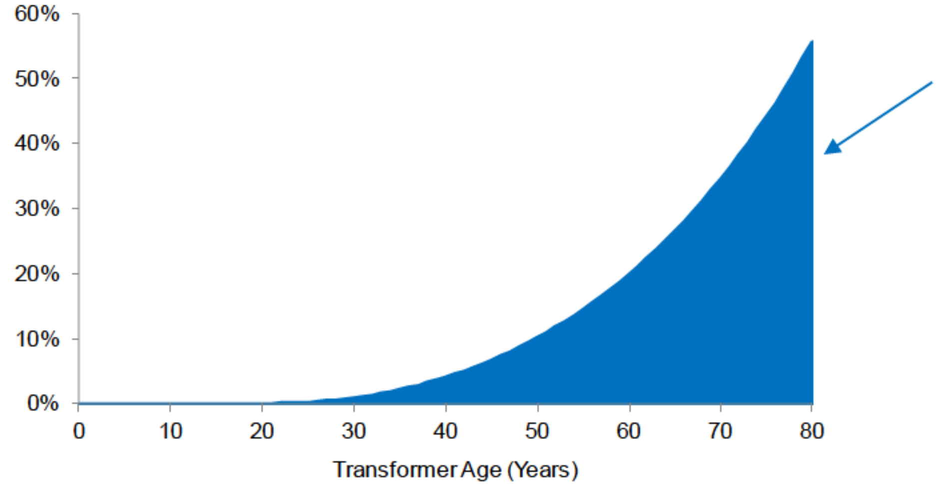
The most likely age for a transformer to fail is 48 years

Cumulative Probability Distribution Function (cdf)



It is almost certain that a transformer will have failed prior to age 80 years

Hazard Function



The probability of a transformer failing at age 80 years given it has not failed prior to this time is around 55%

**Figure 3.2 – Comparison of Probability Distribution Functions**

### 3.2.4 Derivation of Failure Curves

The methodology used for deriving failure curves will depend on a number of factors. Where there is a statistically valid population of equipment components within Powerlink's fleet and there are reliable historical failure records, failure curves can be derived from historical failure events.

Where there are insufficient records, data from reputable and independent external sources (eg EPRI or CIGRE) may be used.

Where failure curves are derived from Powerlink's historical failure events, these are compared against published information to verify the reasonableness of the data.

## 3.3 Likelihood of Consequence (LoC)

The likelihood of consequence represents the moderating factors associated with the consequence. These factors can vary depending on the nature of the failure, the context and location of the asset, and preventative barriers or controls to mitigate the risk. As an example, collapse of an overhead transmission structure will not necessarily result in loss of supply or an injury.

Powerlink bases calculation of the likelihood of consequence from various sources of information including internal records and publically available data. Where data is not available, it may be necessary to estimate the likelihood of consequence using engineering estimates and professional judgement.

The rigour involved with deriving the moderating factors is proportionate to the criticality of the input to the risk cost outcome. Where inputs materially impact the risk cost, additional rigour is generally warranted to validate the input. Conversely, where inputs do not have a material impact on the risk cost, high level estimates may be sufficient.

## 3.4 Cost of Consequence (CoC)

The risk cost approach requires an assessment of the financial equivalent of the risk consequence. For certain types of consequences, the monetised equivalent can be readily determined since this may be a direct financial cost. However, for other types of risk categories, it may be more difficult to place a monetary value on the consequence. For example, it may be difficult to determine the monetised equivalent of safety events since these may involve impacts which are subjective and intangible.

For these types of consequences, it is often useful to base costs using information published by independent and industry reputable sources. Many of these organisations have developed values based on research and surveys for a range of purposes including the formulation of government policy and regulation. In these instances, Powerlink makes use of these valuable references for risk cost calculations.

## 3.5 Assumptions of Controls

Standard controls and mitigation measures that are part of Powerlink's management systems (e.g. asset management systems, health and safety systems, and environment management systems) are taken into account when determining risk cost.

Example of controls include Powerlink's standard operating practices and procedures, protective equipment, and switching operations to transfer loads or reconfigure the network following network faults.

## 3.6 Calculation of Risk Cost

The risk cost is calculated for every material failure mode and category of risk. The risk cost for the asset is determined by adding the individual risk costs for each component across failure modes and risk categories.

Risk cost is generally expressed in real dollars.

### 3.7 Residual Risk

The residual risk is defined as the level of risk following implementation of the credible option or risk mitigation measure.

### 3.8 Risk Cost Benefit

The reduction in risk associated with a credible option is a benefit. This benefit can be quantified using risk cost as follows:

Risk Cost Benefit = Risk Cost Prior to Option – Residual Risk Cost

### 3.9 Financial Analysis

The reduction in risk cost may be used as an input to the financial comparison of credible options within the Regulatory Investment Test for Transmission assessment process.

Other inputs comprise of the cost of the credible options, on-going operation and maintenance costs, and other class of market benefits (where these are not captured under network risk cost evaluation).

### 3.10 Extrapolation of Risk Cost

It may be sufficient to quantify projected risk costs over a ten year modelling horizon, since there are increasing levels of uncertainties in forecasting the deterioration of asset health and other variables beyond this period. However, since the financial analysis comparing options is often carried out across larger modelling periods, extrapolation of risk is required.

The risk cost benefits may be extrapolated beyond the detailed computational period using either linear or non-linear projection techniques.

### 3.11 Materiality of Inputs

It is important to identify the salient inputs that most impact on the calculation of risk cost.

An understanding of the materiality of inputs enables focus to be placed on data that makes the greatest impact on risk cost. This can assist in determining where additional rigour is required in collecting and deriving data, and validating assumptions.

One technique which can be used is based on the concept of participation factors. Participation factors are defined as the ratio of percentage change of output to percentage change in input as follows:

Participation Factor = % Change in Risk Cost / % Change in Input

An assessment of participation factors can assist identifying the salient inputs which contribute to risk cost. This process can help determine where additional rigour is required in validating assumptions and data.

### 3.12 Overlay of Market Benefits

The AER Regulatory Investment Test for Transmission (RIT-T) requires an assessment of market benefits where these may be material in the economic evaluation of credible options.

One class of market benefits relates to the reduction in unserved energy. This category of market benefit comprises of the reduction in involuntary load shedding resulting from implementation of a credible option. However the risk cost benefits associated with implementation of an option may also incorporate a reduction in the likelihood of unserved energy. Hence, the network risk cost benefit associated with an option may also include a component of market benefit.

It is important to ensure that the assessment of credible options do not double count market benefits and network risk cost benefits. For clarity, the market benefits associated with reduction in unserved energy will generally be considered as part of the network risk cost benefits within the financial analysis of options.

There may be other classes of market benefits which are not included as part of the network risk cost benefits. Examples of these include reduction in transmission losses, dispatch cost benefits, and reductions in voluntary load curtailment. These categories of market benefits are quantified separately where they are material to the outcome of an economic assessment.

## 3.13 Event Trees

Event trees may be used to assess different consequence outcomes associated with a particular risk scenario.

The event tree concept provides a structured approach to evaluating the probability weighted cost of consequence, and accounts for the probabilistic nature of risk cost events.

## 3.14 Mapping of Risk Cost to Risk Levels

The mapping of risk cost to risk levels can be carried out by examining the likelihood and consequence used within the Powerlink Risk Assessment Matrix.

The mid-points for each likelihood and consequence square of the corporate risk matrix are shown below. It is possible to calculate the risk cost associated with each square by taking the product of likelihood and consequence as shown in Figure 3.3.

**Table 3.1 – Corporate Risk Matrix Likelihood Scale**

| Likelihood | Description | Frequency | No. Events/Year | Return Period |
|---|---|---|---|---|
| A | Almost Certain | Daily to once every three weeks | 31.25 | 0.032 |
| B | Likely | Every three weeks to every three months | 6.25 | 0.16 |
| C | Possible | Every three months to annually | 1.25 | 0.8 |
| D | Unlikely | Annually to every 7 years | 0.25 | 4 |
| E | Rare | Every 7 to 35 years | 0.05 | 20 |
| F | Very Rare | Every 35 to 175 years | 0.01 | 100 |
| G | Almost Incredible | Every 175 to 800 years | 0.002 | 500 |

**Table 3.2 – Corporate Risk Matrix Consequence Scale**

| Consequence | Description | Range | Cost |
|---|---|---|---|
| 7 | Catastrophic | > $80M | $225M |
| 6 | Extreme | $15M to $80M | $45M |
| 5 | Major | $3M to $15M | $9M |
| 4 | Moderate | $600K to $3M | $1.8M |
| 3 | Minor | $120K to $600M | $360K |
| 2 | Insignificant | $30K to $120K | $72K |
| 1 | Negligible | < $30K | $14.4K |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| A | $450,000 | $2,250,000 | $11,250,000 | $56,250,000 | $281,250,000 | $1,406,250,000 | $7,031,250,000 |
| B | $90,000 | $450,000 | $2,250,000 | $11,250,000 | $56,250,000 | $281,250,000 | $1,406,250,000 |
| C | $18,000 | $90,000 | $450,000 | $2,250,000 | $11,250,000 | $56,250,000 | $281,250,000 |
| D | $3,600 | $18,000 | $90,000 | $450,000 | $2,250,000 | $11,250,000 | $56,250,000 |
| E | $720 | $3,600 | $18,000 | $90,000 | $450,000 | $2,250,000 | $11,250,000 |
| F | $144 | $720 | $3,600 | $18,000 | $90,000 | $450,000 | $2,250,000 |
| G | $29 | $144 | $720 | $3,600 | $18,000 | $90,000 | $450,000 |

**Figure 3.3 – Risk Costs within the Powerlink Corporate Risk Matrix**

It can be seen that there are significant variations in risk cost within the matrix due to the logarithmic nature of the likelihood and consequence scales. Since the risk matrix is based on a base five logarithmic scale, the risk cost for each square is five times that of the horizontal or vertically adjacent square.

The mapping of risk cost to corporate risk levels is derived by taking the leading edge of the transition between risk levels. The mapping of equivalent risk cost thresholds to corporate risk levels is shown in Table 3.3 below.

This mapping of risk cost enables risk levels to be communicated across the organisation using terminology consistent with corporate risk procedures.

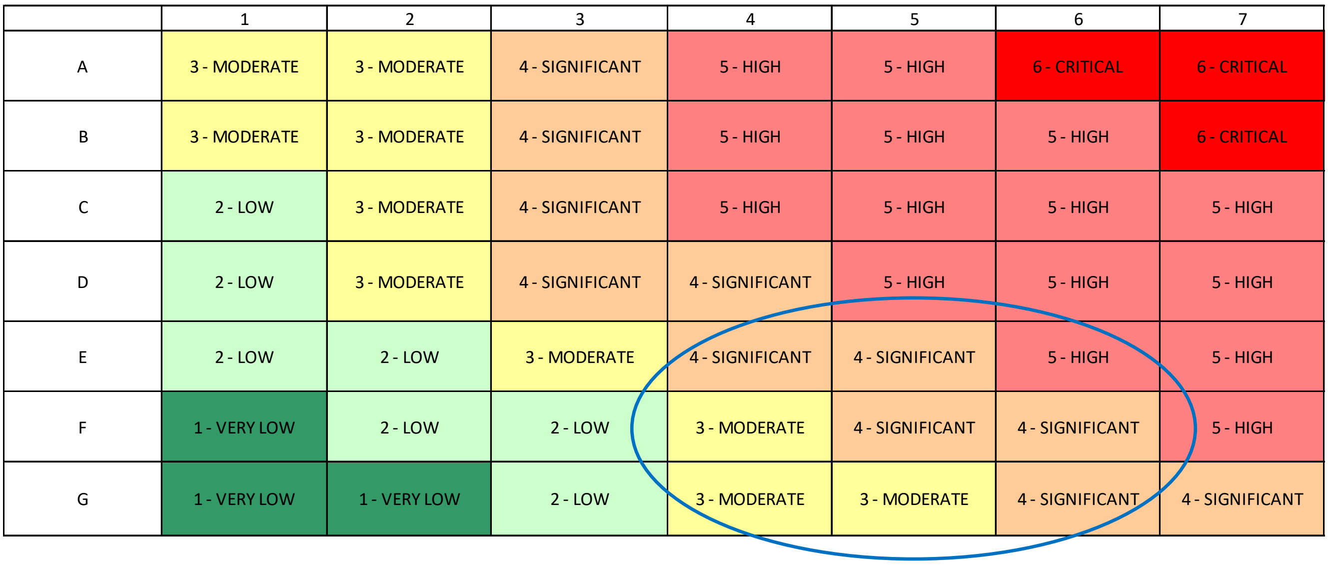
**Table 3.3 – Risk Levels and Equivalent Risk Costs**

| Risk Level | Threshold |
|---|---|
| Critical | ≥ $281 million |
| High | ≥ $11.2 million |
| Significant | ≥ $450,000 |
| Moderate | ≥ $18,000 |
| Low | ≥ $720 |
| Very Low | < $720 |

### 3.15 Nature of Risks within Matrix

The failure of high voltage network assets reaching end of life are generally characterised by events that are very low probability but with potentially high consequences.

The nature of risk associated with end of life network assets are generally located on the bottom right of the corporate risk matrix as shown below. The risk matrix also makes provision for extrapolating additional lower levels of probability where required by using factoring consistent to the logarithmic structure of the risk matrix.



| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| A | 3 - MODERATE | 3 - MODERATE | 4 - SIGNIFICANT | 5 - HIGH | 5 - HIGH | 6 - CRITICAL | 6 - CRITICAL |
| B | 3 - MODERATE | 3 - MODERATE | 4 - SIGNIFICANT | 5 - HIGH | 5 - HIGH | 5 - HIGH | 6 - CRITICAL |
| C | 2 - LOW | 3 - MODERATE | 4 - SIGNIFICANT | 5 - HIGH | 5 - HIGH | 5 - HIGH | 5 - HIGH |
| D | 2 - LOW | 3 - MODERATE | 4 - SIGNIFICANT | 4 - SIGNIFICANT | 5 - HIGH | 5 - HIGH | 5 - HIGH |
| E | 2 - LOW | 2 - LOW | 3 - MODERATE | 4 - SIGNIFICANT | 4 - SIGNIFICANT | 5 - HIGH | 5 - HIGH |
| F | 1 - VERY LOW | 2 - LOW | 2 - LOW | 3 - MODERATE | 4 - SIGNIFICANT | 4 - SIGNIFICANT | 5 - HIGH |
| G | 1 - VERY LOW | 1 - VERY LOW | 2 - LOW | 3 - MODERATE | 3 - MODERATE | 4 - SIGNIFICANT | 4 - SIGNIFICANT |

Nature of risks for network assets approaching end of life

**Figure 3.4 – Nature of Risks for Aged Network Assets**

# 4. Assessment of Consequences

## 4.1 Categories of Consequences

Powerlink classes the consequence of asset failure into four broad categories – safety, network, financial and environmental. The consequences of failure for a particular asset and risk scenario are assessed on a case by case basis taking into account the type of asset, location of the asset, network connectivity, and operating and environmental conditions.

Examples of potential consequences that might arise through the failure of ageing network assets are shown below. These consequences include both internal and external facing impacts (e.g. end user customer impacts). Note this is not intended to be an exhaustive list of consequences that are considered.

Safety

- Potential safety impacts to field personnel working in the vicinity of electrical equipment with potential for explosive failure
- Potential safety impacts to members of the public due to failure of assets in publicly accessible places
- Safety consequences associated with car accidents caused by downed conductors or earthwires that traverse motorways.

Network

- Interruptions to supply as a result of plant failures and outages
- Tripping of adjacent items of plant when equipment fails in an explosive manner
- Extended outages of plant where emergency replacements or spare units are not readily available or take considerable time to install and commission
- De-energisation of a substation in an event of a fire arising from plant failure which may lead to supply interruptions.

Financial

- Replacement of a failed asset in an emergency manner
- Damage to adjacent items of plant in the event of explosive equipment failure or transformer fire
- Clean-up and remediation of oil and other contaminants
- Community engagement costs
- Property damage resulting from structure failures
- Costs associated with supply of diesel generators or other sources of supply during prolonged outages
- Delays to projects, rescheduling of planned works, and other business disruption costs.

Environmental

- Migration of oil outside the substation where containment measures fail
- Release of greenhouse gases (SF6) into the environment arising from equipment failures.

## 4.2 Sources of Data

Powerlink endeavours to base the cost of consequences using data from actual failure events or published by independent and reputable industry sources.

The basis for a selected set of consequences are shown in Table 4.1 below.

**Table 4.1 – Sources for Cost of Consequences**

| Risk Category | Consequence | Source | Input | Value |
|---|---|---|---|---|
| Safety | Safety impacts | Department of Prime Minister and Cabinet Office of Best Practice Regulation (OBPR) | Value of Statistical Life (VSL) | As per the OBPR Guidance Note (1) |
| Network | Loss of supply | Australian Energy Regulator | Value of Customer Reliability (VCR) (2) | Dependent on customer group and mix |
| Financial | Damage to equipment and emergency restoration | Powerlink | Actual financial costs incurred by Powerlink based on historical events | Dependent on asset type and failure |

Notes:

(1) Refer Department of Prime Minister and Cabinet OBPR web-site: https://www.pmc.gov.au/sites/default/files/publications/value-of-statistical-life-guidance-note_0_0.pdf

(2) Refer AER web-site: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/values-of-customer-reliability/final-decision

## 4.3 Health and Safety

At Powerlink, the health and safety of our employees, contractors and the communities in which we operate is essential. Powerlink does not consider that a value can be placed on any human life. Powerlink is committed to the elimination of all work-related injury, illness, and environmental harm.

The National Electricity Amendments Rules on Replacement Expenditure Planning is supported by guidance developed by the Australian Energy Regulator through the Industry Practice Application Note on Asset Replacement Planning[1]. This document refers to the Value of Statistical Life (VSL) as a way of assisting in the calculation of risk cost.

For the purposes of achieving consistency in capital expenditure proposals with other network service providers, Powerlink uses the VSL model recommended by the AER. The use of VSL is for comparison of capital expenditure proposals alone and does not reflect the practice that Powerlink adopts to its risk assessments for the performance of work or detract from its commitment to eliminate all injury from its work.

---

[1] Refer AER web-site: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/industry-practice-application-note-for-asset-replacement-planning/aer-position

## 4.4 SFAIRP

The Workplace Health and Safety Act requires that organisations are responsible for ensuring the health and safety so far as is reasonably practical (SFAIRP). The definition for what is reasonably practical extends to making an assessment whether costs to reduce risks are grossly disproportionate to the risk being mitigated.

There is no definitive point where the level of expenditure may be considered to be grossly disproportionate due to the absence of guidance information and legal precedents. However, standard rules have been generally accepted by regulators internationally for disproportionality which takes into account the nature of the risk and exposure to workers and the public.

Disproportionality factors represent the ratio of the cost of the risk mitigation to the benefits in mitigating the risk. These factors can assist in determining at which point an investment is considered to be grossly disproportionate to the risk being mitigated. This approach is supported by guidance contained within the AER Industry Practice Application Note on Asset Replacement Planning.

Powerlink uses this approach when assessing capital expenditure proposals within RIT-Ts and other asset planning activities. The disproportionality factors used are consistent with those adopted by other Australian and international utilities.

## 5. Risk Cost Considerations

The factors that impact risk cost vary considerably, and depend on the characteristics of the asset, design attributes, physical location, network connectivity, availability of spares, and other considerations. These are reflected collectively within the building block inputs that make up risk cost (ie PoF, LoC and CoC).

Examples of considerations that may impact risk cost are shown below.

**Table 5.1 – Examples of Considerations that may Impact Risk Cost**

| Asset Class | Components | Attributes | Parameters | Impacts on Risk Cost |
|---|---|---|---|---|
| All Primary Plant | Lines, transformers, and substations plant | Health index | PoF | The probability of failure may increase as the asset reaches end of life |
| Overhead Lines | Structures, insulators, earthwires, and other above surface components | Corrosion region | PoF | The condition of assets within high corrosion regions (such as coastal or sub-tropical environments) will deteriorate faster than those in lower corrosion regions |
| | | Proximity to public areas, roads and railways | LoC and CoC | Overhead lines traversing public areas and roads will have higher consequences under structure failure or conductor drop scenarios |
| Substations | Instrument transformers | Equipment casing type and insulating medium | CoC | Older style instrument transformers with porcelain housings and oil insulation will have higher safety, financial and network consequences compared to newer designs |
| | Power transformers and circuit breakers | Availability of spares | CoC | The unavailability of spares can prolong equipment restoration times impacting network reliability and incurring higher financial costs |
| | Transformer bushings | Bushing types | CoC | Older style porcelain bushings can have higher safety, financial and network consequences compared to newer designs |
| Secondary Systems | Protection Relays and Remote Terminal Units | Manufacturers support and availability of spares | CoC | The unavailability of spares and manufacturers support can prolong restoration times impacting network reliability and incurring higher financial costs |
| All Classes | All Components | Network criticality | CoC | The more critical parts of the high voltage system will be impacted more in the event of equipment failures |
| | | Ability for load transfers and embedded generation | CoC | The ability to transfer load across the downstream distribution network or dispatch of embedded generation can help mitigate the network impacts of equipment failures |
| | | Customer type | CoC | Higher value customer loads will be impacted more from loss of supply events (reflected through VCR) |

| Asset Class | Components | Attributes | Parameters | Impacts on Risk Cost |
|---|---|---|---|---|
| | | Location of asset and proximity to transport infrastructure | CoC | Assets located in remote areas will have longer field response and restoration times compared to those located near major roads and regional depots |
| | | Load pattern | LoC | Customer load patterns which are sharper (more peaks) may be impacted less by network outages compared to flatter load shapes |
| | | Condition of adjacent equipment | LoC and CoC | The likelihood of concurrent failures and subsequent loss of load are higher where there are a number of aged plant items within the area |

## 6. Conclusions

This document outlines an approach for quantifying the risk cost of network assets approaching the end of their technical and economic life.

The document outlines a methodology which enables key risks associated with end of life network assets to be quantified in a structured, transparent and consistent manner. The approach is used to provide input into the economic comparison of options within strategic asset planning and regulatory approval activities.

## 7. Distribution list

| Internal | Contact details |
|---|---|
| ☐ Strategy and Business Development | EGM Strategy and Business Development<br>GM Network Portfolio<br>GM Asset Strategies and Planning<br>GM Strategy<br>Manager Portfolio Planning and Optimisation<br>Manager Network and Alternate Solutions<br>Manager Asset Strategies<br>Manager Network Planning<br>Manager Network Strategy |
| ☐ Finance and Governance | GM Regulation<br>Manager Regulation<br>Manager Governance and Risk |