2018-22
POWERLINK QUEENSLAND REVENUE PROPOSAL

APPENDIX 15.01

Powerlink Queensland
Setting STPIS Values

Delivering better value

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Introduction

The Service Target Performance Incentive Scheme (STPIS) Version 5[1] (hereafter referred to as Version 5) requires Powerlink to propose, in its Revenue Proposal, the following values:

- Performance target, cap and floor for each of the Service Component (SC) parameters and sub-parameters; and
- Performance target, unplanned outage event limit and dollar per dispatch interval (DI) incentive for the Market Impact Component (MIC).

This document describes Powerlink's approach and methodology used to derive the proposed values. Section 1 outlines the approach used to establish and develop a sound methodology. Section 2 contains the methodology that Powerlink used to derive its proposed values.

A summary of Powerlink's proposed STPIS values for both the SC and MIC of the STPIS is provided in Section 3.

[1] *Final STPIS Version 5* (corrected), AER, October 2015.

1 Approach

1.1 Approach – Service Component

Powerlink is required to propose values for the performance targets, caps and floors for the Service Component (SC).[2]

Powerlink has taken a principled approach to calculating these values using a sound methodology that has been established by the AER in its recent regulatory determinations for other transmission network service providers (TNSPs). Powerlink considers this to be a valid approach for determining targets, caps and floors for the SC parameters.

To calculate its performance target, Powerlink averaged the previous five years' historic performance data, consistent with clause 3.2 (f) of Version 5.

In its Draft Decision for SP AusNet's STPIS[3], the AER noted that the following set of principles should be applied when selecting a distribution to calculate caps and floors:

- The chosen distribution should reflect any inherent skewness of the performance data;
- The distribution should not imply that impossible values are reasonably likely. For example, the distribution for an average circuit outage rate sub-parameter should not imply that values below zero per cent are reasonably likely;
- Discrete distributions should be used to represent discrete data. For example, a discrete distribution such as the Poisson distribution should be used when calculating caps and collars for loss of supply sub-parameters. Continuous distributions should not be used;
- Using standard deviations to set caps and collars is appropriate when a normal distribution is selected; and
- When asymmetric distributions are selected, the better measure to use is the percentiles. The 5th and 95th percentiles of an asymmetric distribution are the equivalent of being two standard deviations from the mean in a normal distribution.

Powerlink has applied the AER's principles in its methodology to select suitable distributions to derive its cap and floor values for the 2018-22 regulatory period.

The caps and floors have been calculated by first fitting a statistical distribution to the previous five years' performance data. The caps and floors are then calculated as the 5th and 95th percentiles of the chosen statistical distribution.

Acknowledging the AER's principles above, Powerlink's process of selecting the best fit statistical distribution considered a number of criteria:

- reflect the inherent skewness of the data;
- be bound by the logical limits of the parameter type;
- be discrete when fitting discrete data;
- be continuous when fitting continuous data;
- distribution with fewer parameters are preferred to distributions with more; and

[2] *Final STPIS Version 5* (corrected), AER, October 2015, Section 3.2.
[3] *Draft Decision SP AusNet 2014-15 to 2016-17 STPIS*, AER, August 2013, pp.184-185.

- be a good fit for the performance data.

Powerlink used the @RISK software to assist in selecting the best fit statistical distribution for each set of historic performance data. The software provides 'goodness of fit' data outcomes for each distribution. These 'goodness of fit' statistics are calculated using standard statistical fit tests.

Powerlink had regard to the following inputs to determine the appropriate distribution fit and therefore the caps and floors for each performance measure:

- The results from the @RISK software;
- The AER's principles and methodology; and
- The AER's previous distribution selection preferences.

Powerlink's proposed targets, caps and floors are summarised in Table 24. Details of the selected statistical distribution for each SC parameter and sub-parameter are provided in sections 2.1, 2.2 and 2.3.

1.2 Approach – Market Impact Component

Version 5[4] also requires that Powerlink propose values for the performance target, unplanned outage event limit and dollar per dispatch interval incentive for the MIC.

Powerlink has taken an approach consistent with the methodology that has been established by the AER in appendices C and F of Version 5[5] to calculate these values.

The proposed performance target has been calculated via the following steps:

- calculate a raw performance target, as the mean of five of the previous seven years of data, with the largest and smallest DI counts removed;
- determine 17 per cent of the raw performance target;
- review the previous seven years data, applying the 17 per cent cap value to unplanned outage events and limiting them to 17 per cent of the performance target;
- recalculate the adjusted performance target as the mean of five of the previous seven years of adjusted data, with the largest and smallest DI counts removed; and
- compare the adjusted performance target to a minimum requirement of 100 DIs to determine the proposed performance target.

The unplanned outage event limit is calculated as 17 per cent of the final performance target.

The dollar per dispatch interval incentive calculation is based on 1 per cent of the maximum allowed revenue (MAR) for the first year of the regulatory period (2017-18) divided by the proposed performance target.

Powerlink's proposed performance target, unplanned outage event limit and dollar per dispatch interval incentive for the MIC are summarised in Table 24. Details of the methodology for the MIC are provided in section 2.4 in this document.

[4] *Final STPIS Version 5* (corrected), AER, October 2015, Section 4.2.
[5] *Final STPIS Version 5* (corrected), AER, October 2015, Appendix C Market Impact Component - Definition, Appendix F Market Impact Component - Application.

2 Setting STPIS Values

2.1 Service Component - Unplanned Outage Circuit Event Rate

The Unplanned Outage Circuit Event Rate parameter measures network reliability by using the aggregate number of fault or forced outages per annum for each of the element transmission types - lines, transformers and reactive plant. The best statistically possible performance rate for this parameter is zero. Therefore, a higher performance rate represents a less reliable network.

For each sub-parameter Powerlink has provided the following information to demonstrate how it selected the best fit statistical distribution:

- Relevant historic performance data;
- Fit comparison chart; and
- Fit result table.

2.1.1 Lines Event Rate – Fault

Powerlink's Lines Fault Event Rate performance history is shown in Table 1.

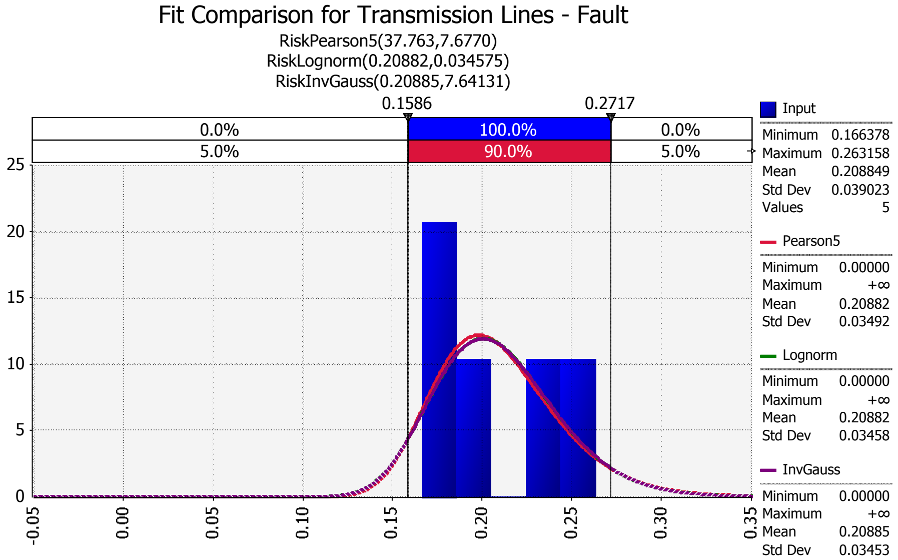
Table 1: SC Lines Event Rate - Fault - Historic Performance

	2011	2012	2013	2014	2015
Lines Event Rate – Fault	26.32	23.36	16.64	19.59	18.52

Powerlink has selected the Pearson5 distribution as the best fit distribution for this parameter.

Pearson5 and Pearson6 score equally highly on Kolmogorov-Smirnov and Anderson-Darling tests. Both distributions produce the same cap and floor values. Pearson5 has been selected as it has fewer parameters. The results from the next best fit distributions all have very similar shapes which produce similar results. See Figure 1 and Table 2 for the comparison.

Figure 1: Lines Event Rate - Fault - Fit Comparison



Source: @RISK

Table 2: Lines Event Rate - Fault - Fit Comparison

Percentiles	Pearson5	Pearson6	LogNormal	Inverse Gaussian
5%	15.86	15.86	15.72	15.73
95%	27.17	27.17	27.00	27.00

2.1.2 Transformer Event Rate – Fault

Powerlink's Transformer Fault Event Rate performance history is shown in Table 3.

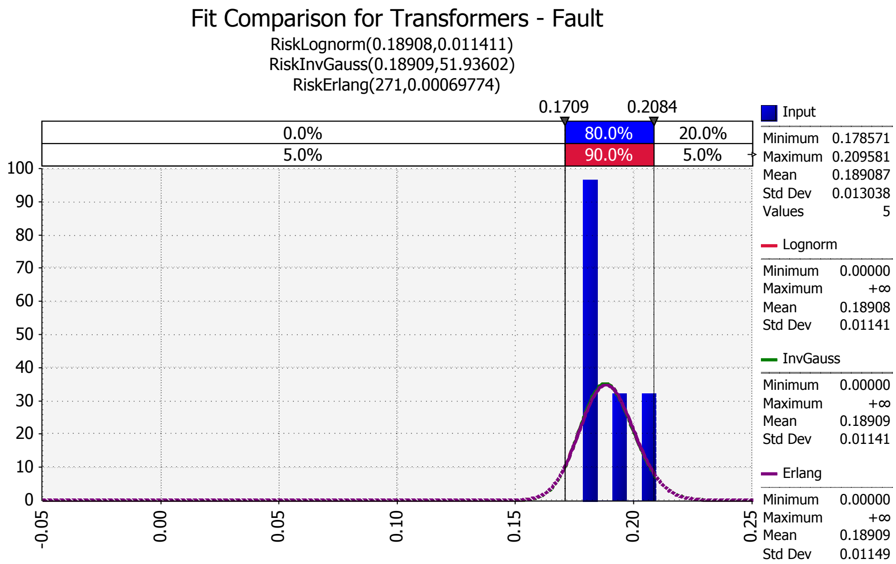
Table 3: SC Transformer Event Rate - Fault - Historic Performance

	2011	2012	2013	2014	2015
Transformer Event Rate – Fault	20.96	17.86	18.40	19.41	17.92

Powerlink has selected the LogNormal distribution as the best fit distribution for this parameter.

The LogNormal distribution has the best fit scores from the Kolmogorov-Smirnov and Anderson-Darling tests. The results from the next best fit distributions all have very similar shapes which produce similar results. See Figure 2 and Table 4 for the comparison.

Figure 2: Transformer Event Rate - Fault - Fit Comparison



Source: @RISK

Table 4: Transformer Event Rate - Fault - Fit Comparison

Percentiles	LogNormal	Inverse Gaussian	Erlang
5%	17.09	17.09	17.06
95%	20.84	20.84	20.84

2.1.3 Reactive Plant Event Rate – Fault

Powerlink's Reactive Plant Fault Event Rate performance history is shown in Table 5.

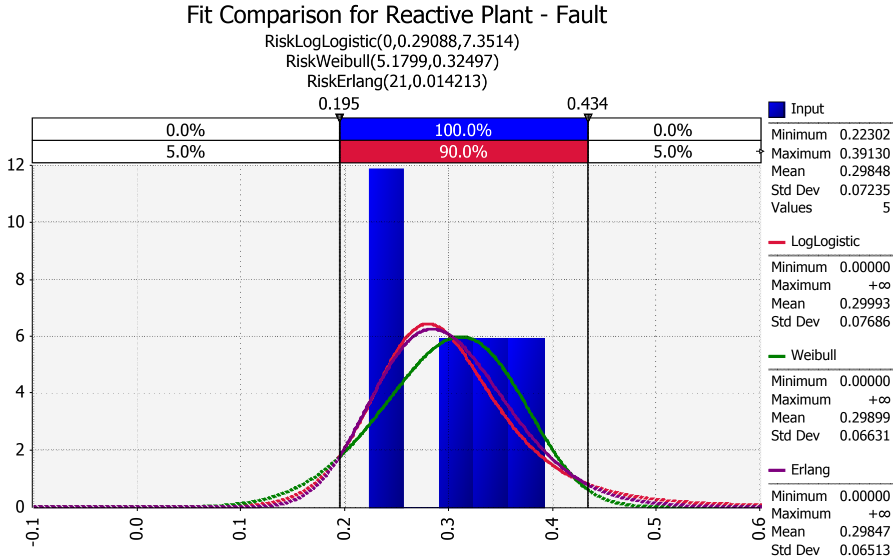
Table 5: SC Reactive Plant Event Rate - Fault - Historic Performance

	2011	2012	2013	2014	2015
Reactive Plant Event Rate – Fault	35.07	39.13	23.66	29.08	22.30

Powerlink has selected the LogLogistic distribution as the best fit distribution for this parameter.

The LogLogistic distribution has the best fit scores from the Kolmogorov-Smirnov and Anderson-Darling tests. For this measure there are no distributions that score consistently high across all tests. After LogLogistic, the next best fit distributions produce similar results. See Figure 3 and Table 6 for the comparison.

Figure 3: Reactive Plant Event Rate - Fault - Fit Comparison



Source: @RISK

Table 6: Reactive Plant Event Rate - Fault - Fit Comparison

Percentiles	LogLogistic	Weibull	Erlang
5%	19.49	18.32	20.00
95%	43.42	40.16	41.31

2.1.4 Lines Event Rate – Forced

Powerlink's Lines Forced Event Rate performance history is shown in Table 7.

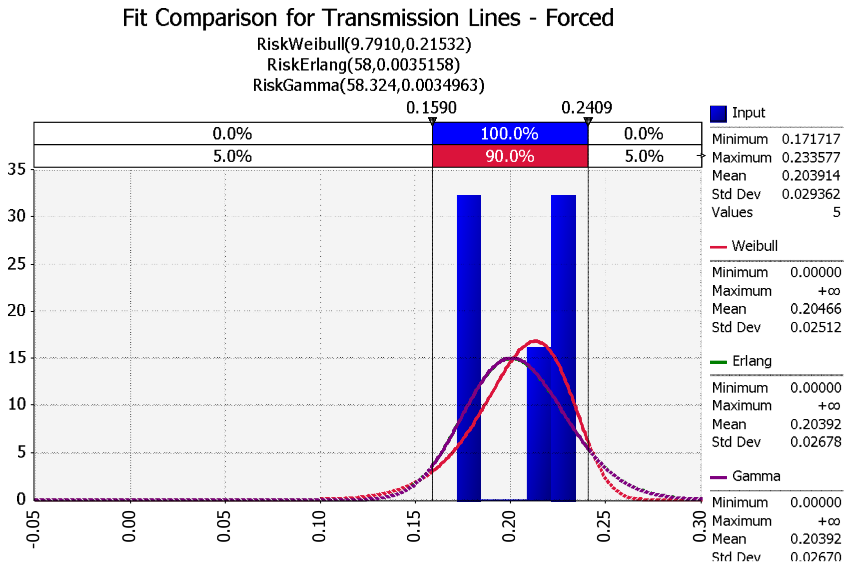
Table 7: SC Lines Event Rate - Forced - Historic Performance

	2011	2012	2013	2014	2015
Lines Event Rate – Forced	17.29	23.36	21.84	22.30	17.17

Powerlink has selected the Weibull distribution as the best fit distribution for this parameter.

The Weibull distribution has the best fit scores from all tests except for Kolmogorov-Smirnov. While the BetaGeneral distribution has the best Kolmogorov-Smirnov score, this distribution did not provide scores for three of the other tests. This was due to divergence caused by the number of parameters in the BetaGeneral distribution. Therefore the BetaGeneral distribution has not been considered as a suitable distribution. See Figure 4 and Table 8 for the comparison.

Figure 4: Lines Event Rate - Forced - Fit Comparison



Source: @RISK

Table 8: Lines Event Rate - Forced - Fit Comparison

Percentiles	Weibull	Erlang	Gamma
5%	15.90	16.20	16.21
95%	24.09	24.99	24.97

2.1.5 Transformer Event Rate – Forced

Powerlink's Transformer Forced Event Rate performance history is shown in Table 9.

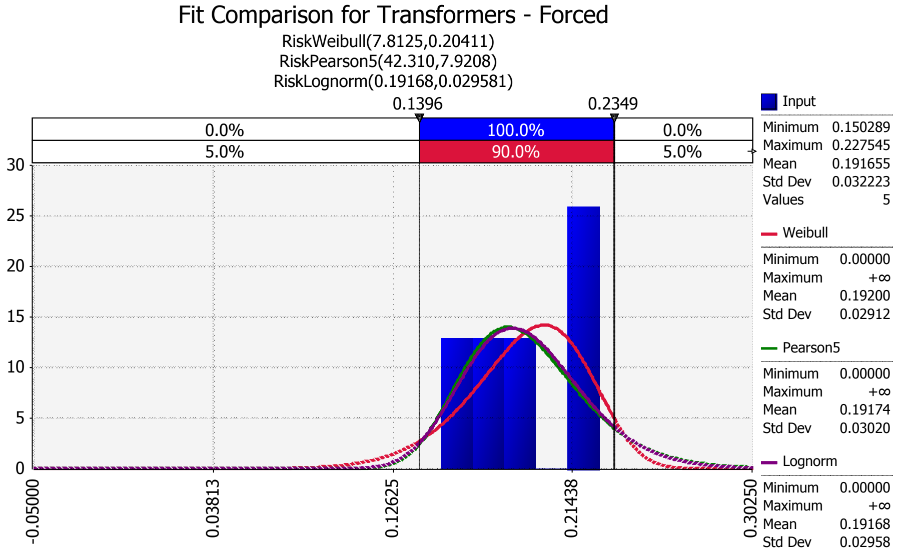
Table 9: SC Transformer Event Rate - Forced - Historic Performance

	2011	2012	2013	2014	2015
Transformer Event Rate – Forced	22.75	17.26	21.96	18.82	15.03

Powerlink has selected the Weibull distribution as the best fit distribution for this parameter.

The Weibull distribution has the best fit scores from all tests except for Anderson-Darling. After the Weibull distribution, there is no clear next best fit distribution. Where a distribution scores well for one test it tends to score less well on others. As there is no distribution that scores as consistently well as Weibull, no other distributions have been considered as a suitable distribution. See Figure 5 and Table 10 for the comparison.

Figure 5: Transformer Event Rate - Forced - Fit Comparison



Source: @RISK

Table 10: Transformer Event Rate - Forced - Fit Comparison

Percentiles	Weibull	Pearson5	LogNormal
5%	13.96	14.79	14.72
95%	23.49	24.59	24.38

2.1.6 Reactive Plant Event Rate – Forced

Powerlink's Reactive Plant Forced Event Rate performance history is shown in Table 11.

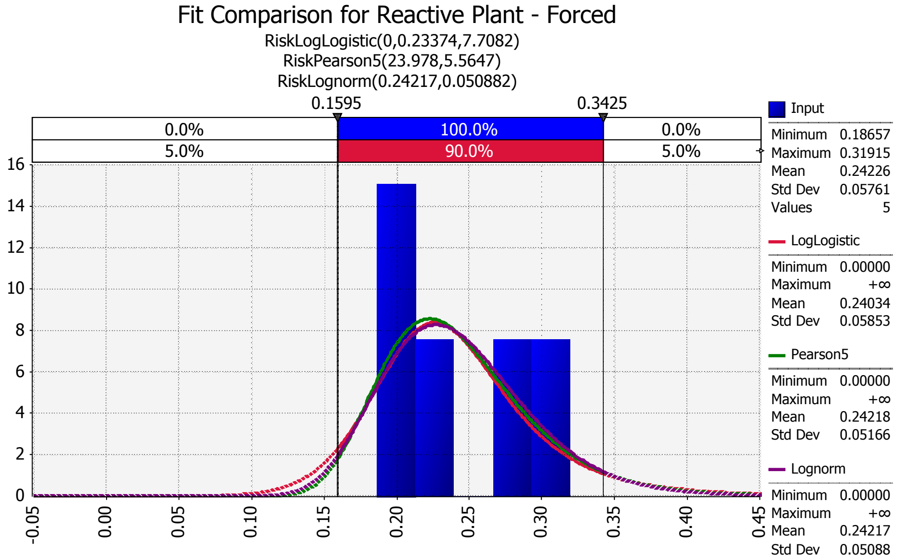
Table 11: SC Reactive Plant Event Rate - Forced - Historic Performance

	2011	2012	2013	2014	2015
Reactive Plant Event Rate – Forced	18.66	21.74	28.67	31.91	20.14

Powerlink has selected the LogLogistic distribution as the best fit distribution for this parameter.

The LogLogistic distribution has the best fit scores from the Kolmogorov-Smirnov and Anderson-Darling tests. The results from the next best fit distributions all have very similar shapes which produce similar results. See Figure 6 and Table 12 for the comparison.

Figure 6: Reactive Plant Event Rate - Forced - Fit Comparison



Source: @RISK

Table 12: Reactive Plant Event Rate - Forced - Fit Comparison

Percentiles	LogLogistic	Pearson5	LogNormal
5%	15.95	17.09	16.84
95%	34.25	33.66	33.36

2.2 Service Component – Loss of Supply Event Frequency

The Loss of Supply Event Frequency parameter measures network reliability by counting the number of loss of supply events on Powerlink's network that impact Powerlink customers. Performance is measured in system minutes which are calculated using the energy not supplied for each supply interruption, divided by Powerlink's peak demand value. The number of events where system minutes exceed each threshold is summed per annum. The best statistically possible performance for this parameter is zero. Therefore, a higher number of event counts represents a less reliable network.

As the Loss of Supply Event Frequency parameter represents discrete data, the calculated target is rounded to the nearest whole number.

2.2.1 Frequency of Small Loss of Supply Events greater than 0.05 System Minutes (X Threshold)

Powerlink's Loss of Supply Event Frequency greater than 0.05 system minutes performance history is shown in Table 13.

Table 13: SC LOS Event Frequency > 0.05 System Minutes - Historic Performance

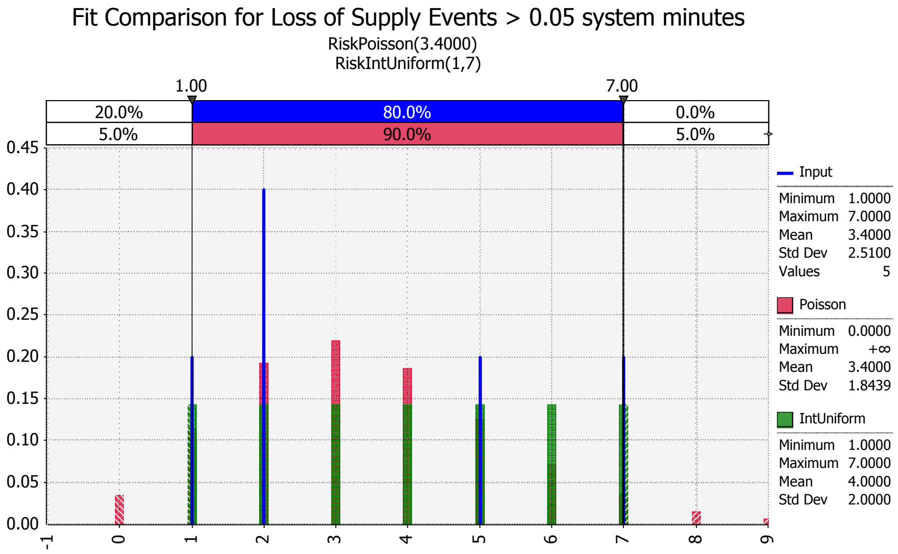
	2011	2012	2013	2014	2015
Loss of Supply Event > 0.05 System Minutes	7	2	1	5	2

Powerlink has selected the Poisson distribution as the best fit distribution for this parameter.

The Poisson distribution has the best score from the Akaike Information Criterion (AIC) and also shares the highest score with the other distributions for the Chi-Squared test.
The Integer Uniform distribution has the best score from the Bayesian Information Criterion (BIC) and, similarly with the Poisson distribution, shares the highest score for the Chi-Squared test.

Both distributions result in a cap of 1 event and floor of 7 events. Powerlink has selected the Poisson distribution as it has the advantage of having fewer parameters. See Figure 7 and Table 14 for the comparison.

Figure 7: Loss of Supply X Threshold - Fit Comparison



Source: @RISK

Table 14: Loss of Supply X Threshold - Fit Comparison

Percentiles	Poisson	Integer Uniform
5%	1	1
95%	7	7

2.2.2 Frequency of Large Loss of Supply Events greater than 0.40 System Minutes (Y Threshold)

Powerlink's Loss of Supply Event Frequency greater than 0.40 system minutes performance history is shown in Table 15.

Table 15: SC LOS Event Frequency > 0.40 System Minutes - Historic Performance

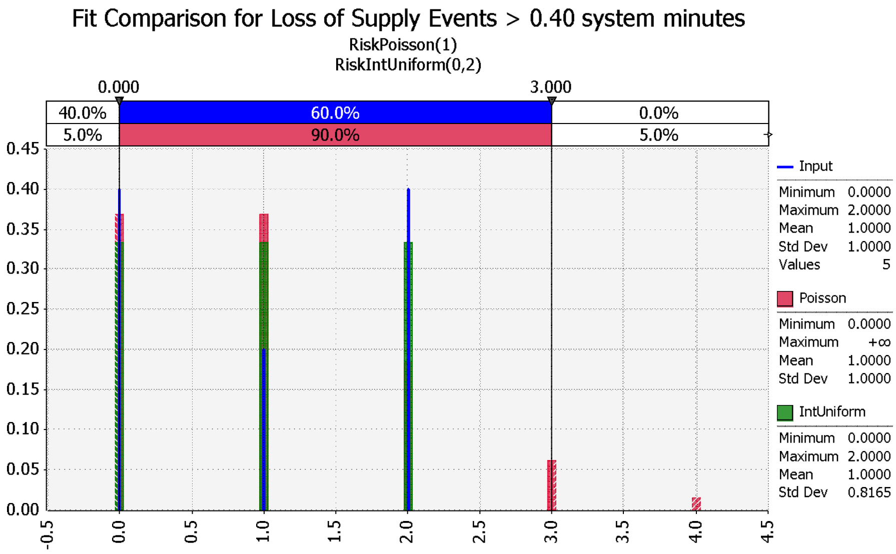
	2011	2012	2013	2014	2015
Loss of Supply Event > 0.40 System Minutes	2	0	0	2	1

Powerlink has selected the Poisson distribution as the best fit distribution for this parameter.

The Poisson distribution has the best scores from the Akaike Information Criterion (AIC). The Integer Uniform distribution has the best scores from the Bayesian Information Criterion (BIC) and the Chi-Squared test.

Both distributions result in a cap of 0 events. The Poisson distribution gives a floor of 3 events whereas the Integer Uniform distribution gives a floor of 2 events. As the Poisson distribution has the advantage of having fewer parameters, it has been selected. See Figure 8 and Table 16 for the comparison.

Figure 8: Loss of Supply Y Threshold - Fit Comparison



Source: @RISK

Table 16: Loss of Supply Y Threshold - Fit Comparison

Percentiles	Poisson	Integer Uniform
5%	0	0
95%	3	2

2.3 Service Component – Average Outage Duration

The Average Outage Duration parameter measures network reliability by measuring the average time it takes for a TNSP to restore loss of supply events. The average outage duration (in minutes) is calculated by dividing the annual cumulative summation of the loss of supply event duration time by the number of loss of supply events. The best statistically possible performance for this parameter is zero minutes. Therefore longer average outage duration minutes represents a less reliable network.

Powerlink's Average Outage Duration performance history is shown in Table 17.

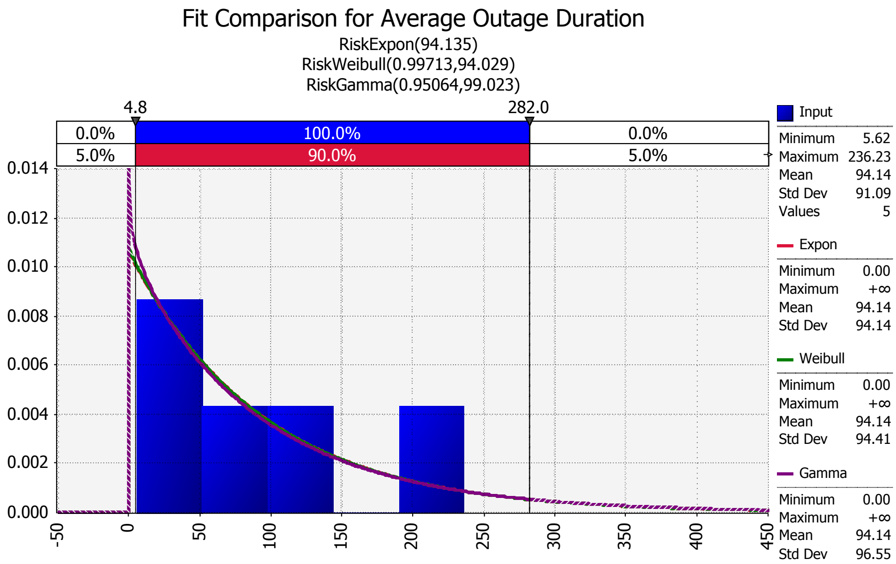
Table 17: SC Average Outage Duration - Historic Performance

	2011	2012	2013	2014	2015
Average Outage Duration (mins)	86.77	26.09	5.62	115.97	236.23

Powerlink has selected the Exponential distribution as the best fit distribution for this parameter.

The Exponential distribution scores highest on all but the Anderson-Darling test. The Pert distribution scores highest on the Kolmogorov-Smirnov test but has not been considered due to the number of parameters that it uses. The next best fit distributions provide similar results to the Exponential distribution. See Figure 9 and Table 18 for the comparison.

Figure 9: Average Outage Duration - Fit Comparison



Source: @RISK

Table 18: Average Outage Duration - Fit Comparison

Percentiles	Exponential	Weibull	Gamma
5%	4.83	4.78	4.24
95%	282.00	282.58	287.11

2.4 Market Impact Component

Version 5[6] also requires that Powerlink propose values for the performance target, unplanned outage event limit and dollar per dispatch interval incentive for the MIC.

Powerlink has taken an approach consistent with the methodology that has been established by the AER in appendices C and F of Version 5[7] to calculate these values.

2.4.1 Performance Target and Unplanned Outage Event Limit

Powerlink applied a two-step approach to determine its proposed performance target and unplanned outage event limit:

1. Calculate the raw performance target and raw unplanned outage event limit; and
2. Calculate the adjusted performance target and adjusted unplanned outage event limit.

Calculate Raw Performance Target and Raw Unplanned Outage Event Limit

Powerlink's historic performance data is shown in Table 19.

Table 19: MIC - Raw Historic Performance

	2009	2010	2011	2012	2013	2014	2015
Planned Outage Events	70	1378	36	105	81	3936	65
Unplanned Outage Events	73	27	1	0	16	5	1
Total DIs for the year	143	1405	37*	105	97	3941*	66

* The largest and smallest DI counts.

To calculate the raw performance target, Powerlink removed the largest and smallest counts of bound DIs from the most recent seven years' data and averaged the remaining five years. This calculated number was rounded to the nearest whole number.

Powerlink then calculated the raw unplanned outage event limit by applying the cap of 17 per cent to the raw performance target.

The calculated raw performance target and raw unplanned outage event limit are shown in Table 20.

Table 20: MIC - Raw Performance Target and Unplanned Outage Event Limit

Raw Performance Target	Raw Unplanned Outage Event Limit
363	62

6 *Final STPIS Version 5* (corrected), AER, October 2015, Section 4.2.
7 *Final STPIS Version 5* (corrected), AER, October 2015, Appendix C Market Impact Component – Definition, Appendix F Market Impact Component - Application.

Calculate Adjusted Performance Target and Adjusted Unplanned Outage Event Limit

Powerlink reviewed its unplanned outage events for all seven years and capped any unplanned outage event by the raw unplanned outage event limit. The adjusted historic performance data set is shown in Table 21.

Table 21: MIC - Adjusted Historic Performance

	2009	2010	2011	2012	2013	2014	2015
Planned Outage Events	70	1378	36	105	81	3936	65
Unplanned Outage Events (17% cap applied)	62*	27	1	0	16	5	1
Total DIs for the year	132	1405	37**	105	97	3941**	66

* Adjusted number of unplanned outage events.
** The largest and smallest DI counts.

To calculate the adjusted performance target, Powerlink removed the largest and smallest counts of bound DIs from the most recent seven years' adjusted historic data and averaged the remaining five years. This calculated number was rounded to the nearest whole number.

Powerlink then calculated the adjusted unplanned outage event limit by applying the cap of 17 per cent to the adjusted performance target.

As Powerlink's adjusted performance target exceeded the minimum of 100 DIs, no further adjustment was necessary.

Powerlink's proposed performance target and unplanned outage event limit values for the MIC are shown in Table 22 and also are summarised in Table 24.

Table 22: MIC - Adjusted Performance Target and Unplanned Outage Event Limit

Adjusted Performance Target	Adjusted Unplanned Outage Event Limit
361	61

2.4.2 Dollar per Dispatch Interval Incentive

Powerlink calculated the dollar per dispatch interval incentive by taking 1 per cent of the MAR for the first year of the regulatory period, divided by the performance target as follows:

$$\frac{1\% \times \$767.4 \text{ million (MAR)}}{361} = \$21,257$$

Powerlink's proposed dollar per dispatch interval incentive for the MIC is shown in Table 23 and also is summarised in Table 24, assuming a MAR of $767.4 million.

Table 23: MIC - Dollar per Dispatch Interval Incentive

Dollar per Dispatch Interval Incentive
$21,257

3 Powerlink's Proposed STPIS Values

Table 24 provides a summary of Powerlink's proposed STPIS values for both the SC and MIC of the STPIS.

Table 24: Powerlink's Proposed STPIS Values

SC Parameter	Floor	Target	Cap	Distribution
Unplanned Outage Circuit Event Rate				
Lines Event Rate – Fault	27.17	20.88	15.86	Pearson5
Transformer Event Rate – Fault	20.84	18.91	17.09	LogNormal
Reactive Plant Event Rate – Fault	43.42	29.85	19.49	LogLogistic
Lines Event Rate – Forced	24.09	20.39	15.90	Weibull
Transformer Event Rate – Forced	23.49	19.17	13.96	Weibull
Reactive Plant Event Rate – Forced	34.25	24.23	15.95	LogLogistic
Loss of Supply Event Frequency				
Greater than 0.05 System Minutes	7	3	1	Poisson
Greater than 0.40 System Minutes	3	1	0	Poisson
Average Outage Duration	282.00	94.14	4.83	Exponential

MIC Parameter	Performance Target	Unplanned Outage Event Limit	Dollar per Dispatch Interval Incentive
Market Impact Component	361	61	$21,257