

Electricity Transmission Revenue Proposal 2014/15 – 2016/17

Appendix 6A: PB STIPS Report

Fitting probability distributions for SP AusNet reliability data for STPIS Submission (Parsons Brinkerhoff)

Submitted: 28 February 2013

SP AusNet

Fitting probability distributions for SP AusNet reliability data for STPIS Submission

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Distribution

SP AusNet

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Contents

Page number

1.	Intro	duction			1
	1.1	Approach			1
2.	Resu	ults of distribution fitting			2
	2.1	Average outage duration			2
	2.2	Loss of supply event frequency			4
	2.3	Average circuit outage rate			7
3.	Sum	mary of findings		×	20

1. Introduction

Parsons Brinckerhoff has been engaged by SP AusNet to assist with the determination of suitable targets and other attributes for the parameters of its service target performance incentive scheme (STIPS).

The service component of SP AusNet's STIPS will measure performance against the following parameters:

- Average outage duration (1 sub-parameter)
- Loss of supply event frequency (2 sub-parameters)
- Average circuit outage rates (6 sub-parameters).

Parsons Brinckerhoff determined a curve of best fit to SP AusNet's reliability data from the past five years 2008-2012 for each of the sub-parameters and calculated the standard deviation on which proposed caps and collars for this scheme are based.

1.1 Approach

Parsons Brinckerhoff used the @RISK product, a risk analysis and simulation add-in tool for Microsoft Excel, to determine the types of probability distribution that best fit the reliability data.

Recognising the need to present the best fit distribution curve based on the nature of the reliability data, the following distribution parameters were chosen for this exercise.

- Average outage duration data are fitted using continuous probability distributions bounded at a lower limit of zero
- Loss of supply event frequency are fitted with discrete probability distributions
- Availability rates are fitted with continuous probability distributions bounded at a lower limit of zero.

Three key fit statistics were used to measure how well the probability distribution functions fit the input data. For discrete probability distributions, the Chi Squared (ChiSq) fit statistic was used. For non-discrete distributions, the Kolmogorov-Smirnov (K-S) and the Anderson-Darling (A-D) fit statistics were used.

The K-S fit statistic focuses on the differences between the middle of the fitted distribution and the input data. The A-D fit statistic focuses on the difference between the tails of fitted distribution and input data. Where the input data was concentrated around the middle of a distribution curve the K-S fit statistic was used and where the data was near the tails the A-D fit statistic was used. The results from both were compared in each case. Where the input data was both in the middle and the tails of a distribution, the result from the A-D fit statistic was favoured, because the best fit of the data and the distribution curve at the tails improves the calculation of the scheme measures (caps and collars at one or two standard deviations).

Once the probability distribution function of best fit was determined for each sub-parameter the standard deviation of the probability distribution functions were calculated.

Because a probability distribution is being fitted to a dataset of five values only for each sub-parameter, the fit statistics are typically low in value and the curve of best fit is sensitive to small changes in any of the five values. The curve of second best fit was examined to test for any large variations in the calculated standard deviation that might indicate that the curve of best fit should not be used.

2. Results of distribution fitting

2.1 Average outage duration

The average outage duration is a measure of the response time to outages. The optimal performance limit is close to zero, which represents an immediate response; as such a lower limit of zero is set for fitting curves to the data.

The best fit using the A-D fit statistic is the Exponential distribution curve (figure 1), where the duration data is spread across the middle and tails of the distribution. Table 1 shows the statistical results using other distributions to fit the duration data using the A-D fit statistic, where it can be seen the Erlang distribution curve exhibits the second best fit.

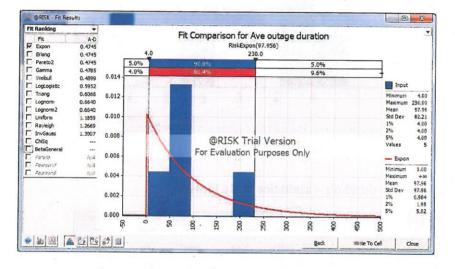




Table 1 Average outage duration - statistics table for A-D

Fit Ranking	-	La Contra Contra	Input	Expon	Erlang	Pareto2	Gamma	Webul
Fit	A-D	- Distribution Statisti	the second s			Turcure	GORRIG	(yelous
Expon	0.4745	Minimum	4.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Erlang	0.4745	Maximum	230.0000	+Infinity	+Infinity	+Infinity *	+Infinity	+Infinity
Pareto2 Gamma	0.4745	Mean	97.9556	97,9556	97.9556	97.9556	97.9556	97.3162
Webul	0.4899	Mode	88.7500 [e	0.0000	0.0000	0.0000	3.1732	12.8495
LogLogistic	0.5952	Median	91.7780	67,8976	67.8976	67.8976	68,7736	72,7936
Triang	0.6068	Std. Deviation	82,2058	97.9556	97.9556	97.9556	95.3559	87.6454
Lognorm	0.6640	Skewness	1.0905	2.0000	2.0000	2.0000	1.9673	1,7059
Lognorm2	0.6640	Kurtosis	5.4675	9,0000	9.0000	9.0000	6,8056	7,2023
Uniform	1.1859	Percentiles			510000	3.0000	00000	7.2023
Rayleigh InvGauss	1.2669	5%	4.0000	5.0245	5.0245	5.0245	5.4470	7.0024
ChiSa	1.3007	10%	4.0000	10.3207	10.3207	10.3207	10,9567	13.3774
i BetaGeneral		15%	4,0000	15,9196	15,9196	15.9196	16.6993	
Pareto	14,14	20%	4,0000	21.8582	21.8582	21.8582	22,7372	19.7531
Pearsons	N;54	25%	71.5000	28, 1801	28, 1801	28,1801		26.2690
) Pearson6	N/A	30%	71,5000	34.9383	34.9383	28.1801	29.1247	33.0109
		35%	71.5000	42.1976	42,1976	and the second se	35.9202	40.0508
		40%	71.5000	50.0382		42.1976	43.1910	47.4610
		45%	91.7780		50.0382	50.0382	51.0182	55.3216
		50 %		58.5615	58.5615	58.5615	59.5028	63.7259
		55%	91.7780	67.8976	67.8976	67.8976	68.7736	72.7936
		60%	91.7780	78.2183	78.2183	78.2183	78.9992	82.6715
			92.5000	89.7558	89.7558	89.7558	90.4073	93.5599
	-	65%	92,5000	102.8360	102.8360	102.8360	103.3166	105.7352
		70%	92.5000	117.9359	117.9359	117.9359	118.1933	119.5986
		75%	92.5000	135.7953	135.7953	135.7953	135.7595	135.7674
		80%	92.5000	157.6535	157.6535	157.6535	157.2240	155.2687
		85%	230.0000	185.8335	185.8335	185.8335	184.8521	180.0151
		90%	230,0000	225.5511	225.5511	225.5511	223.7269	214.2568
	Vital	95%	230.0000	293.4468	293.4485	293.4488	290.0582	271.4739
		*	Ħ					

The best fit using the K-S fit statistic is the Triangle distribution curve (figure 2). Table 2 illustrates other distribution curves fitting the outage duration data using the K-S statistics, the LogLogistic distribution curve exhibits the second best fit for the outage duration data.

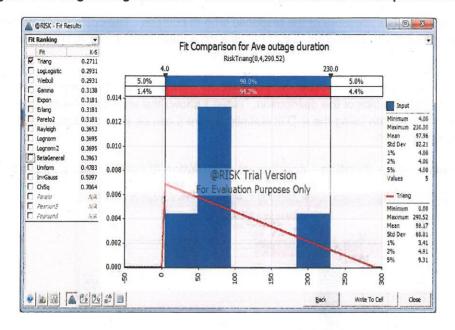


Figure 2 Average outage duration - continuous distribution fit comparison using K-S

Table 2 Average outage duration – statistics table for K-S

@RISK - Fit Res	ults	A REPORT					t	0
Fit Ranking	•		Input	Triang	LogLogistic	Webul	Garima	Expon
Fit	K-S	- Distribution Statist	6cs					
Triang	0.2711	Minimum	4.0000	0.000	0.0000	0.0000	0.0000	0.0000
LogLogistic Webul	0.2931	Maximum	230.0000	290.5189	+Infinity	+Infinity	+Infinity	+Infinity
Gamma	0.2931	Mean	97.9556	98.1730	219.4410	97.3162	97.9556	97.9556
Expon	0.3133	Mode	\$8.7500 [e	4.0000	19.1594	12.8495	3.1732	0.0000
Erlang	0.3181	Median	91.7780	86.5101	72.9474	72.7936	68,7736	67.8976
Pareto2	0.3181	Std. Deviation	82.2058	68.0095	+Infinity	87.6454	96.3559	97.9556
Rayleigh	0.3653	Skewness	1.0905	0.5653	+Infinity	1.7059	1.9673	2.0000
Lognorm	0.3695	Kurtosis	5.4675	2,4000	+Infinity	7.2023	8.8056	9.0000
Lognom2	0.3695	- Percentiles						
BetaGeneral Uniform	0.3963	5%	4.0000	9.3122	8.6013	7.0024	5.4470	5.0245
InvGauss	0.5097	10%	4.0000	16.8124	14.7971	13.3774	10.9567	10.3207
ChiSq	0.7064	15%	4.0000	24.5240	20.7039	19.7531	16.6993	15.9196
Fareto	11.54	20%	4.0000	32.4660	26.6613	26.2690	22.7372	21.8582
Pearson5	N/A	25%	71,5000	40,6602	32.8544	33.0109	29.1247	28,1801
Pearson6	NA	30%	71.5000	49.1325	39.4311	40.0508	35,9202	34,9383
		35%	71,5000	57.9131	46.5386	47.4610 .	43.1910	42.1976
		40%	71,5000	67.0385	54.3448	55,3216	51.0182	50.0382
		45%	91.7780	76.5527	63.0571	63,7269	59,5028	58,5615
		50%	91,7780	86.5101	72.9474	72,7936	68.7736	67,8976
		55%	91.7780	95.9792	84.3890	82,6715	78.9992	78.2183
		60%	92,5000	105.0479	97.9179	93,5599	90,4073	89,7558
		65%	92,5000	119.8329	114.3422	105.7352	103.3166	102.8360
		70%	92,5000	132.4944	134.9527	119.5986	118.1933	117,9359
		75%	92,5000	146.2629	161.9670	135.7674	135.7595	135,7953
		80%	92,5000	161.4925	199, 5900	155.2687	157.2240	157.6535
		85%	230.0000	178.7787	257.0204	180.0151	184.8521	185.8335
		90%	230.0000	199,2834	359.6192	214,2668	223.7269	225.5511
		95%	230.0000	226.0057	618.6654	271.4739	290.0582	293.4488
			19					20011100
ola (33) 🔽	12/26	A statement	22. Mart 2	and and and				

As the data concentrates about both the middle and tails of the distribution, the A-D fit has been selected and the curve of best fit determined as Exponential. The curve of second best fit is the Erlang curve. The standard deviations of the two curves are the same (97.96).

In comparison, the standard deviation of the best K-S fit curve (Triangle) is significantly less at 68.01. The upper limit of the Triangle curve, however, is bounded at 290.5, which is counter intuitive to the possible performance outcomes. Hence the adoption of this curve to represent the data is inappropriate.

2.2 Loss of supply event frequency

Losses of supply events represent discrete occurrences of failure. In order to best fit the loss of supply events data, discrete distribution curves are used with equal interval binning.

Number of events > 0.05 system minutes

Figure 3 shows the NegBin discrete distribution curve is the best fit for the loss of supply events greater than 0.05 systems. Table 3 is provided to show the variation in statistics for other discrete distribution curves.

Noting that the Chi Squared fit statistics are similar for the top three curves of best fit, and that the standard deviations vary widely, the curve of second best fit (Geometric) and the curve of third best fit (Poisson) were also examined. The standard deviations are 2.45, 2.00 and 1.41 respectively. The relatively high variation in standard deviations indicates some uncertainty in the curve fitting.

The average of the three values (2.45, 2.00, 1.41) is 1.95, close to the standard deviation for the curve of best fit. This indicates that the standard deviation of 2.000 for the curve of best fit (NegBin) is an appropriate value to use in setting caps and collars.

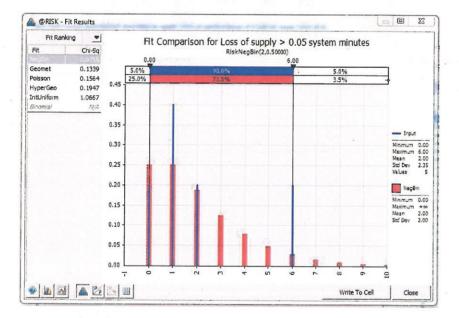


Figure 3 No. of events > 0.05 system minutes - best discrete distribution fit - NegBin

Fit Rankin	g •		Input	NegBin	Geomet	Poisson	HyperGeo	IntUnifo
		Function		=RiskNegBi	=RiskGeom	=RiskPoisso	=RiskHyper	=RiskInt
Fit	Chi-Sq 0.0755	 Distribution Statisti 	cs					
Geomet	0.1339	Minimum	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
and the first state of the state of the	0.1559	Maximum	6.0000	+Infinity	+Infinity	+Infinity	63.0000	6.0000
2005500	0.1947	Mean	2.0000	2.0000	2.0000	2.0000	1.9801	3.0000
HyperGeo IntUniform	and an and the second second	Mode	1.0000	0.0000	0.0000	1.0000	2.0000	0.0000
	1.0667	Median	1.0000	1.0000	1.0000	2.0000	2.0000	3.0000
Binomial	N/A	Std. Deviation	2.3452	2.0000	2.4495	1.4142	1,3836	2.0000
	3-6154	Skewness	1.7444	1.5000	2.0412	0.7071	0.6748	0.0000
	100	Kurtosis	6.3223	6,2500	9.1667	3,5000	3.4219	1.7500
		- Percentiles		1. 2. 1. 1				
	S . 10, 18	5%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	d inter	10%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1 1 1 1 1	15%	0.0000	0.0000	0.0000	1,0000	1.0000	1.0000
	islon er	20%	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000
		25%	1,0000	0.0000	0.0000	1.0000	1.0000	1.0000
		30%	1,0000	1.0000	0.0000	1.0000	1.0000	2.0000
		35%	1.0000	1.0000	1.0000	1.0000	1.0000	2,0000
	2.2.2.1	40%	1,0000	1.0000	1.0000	1,0000	1.0000	2.0000
	e siver	45%	1.0000	1.0000	1.0000	2.0000	2.0000	3.0000
	ALLAN I	50%	1.0000	1.0000	. 1,0000	2,0000	2.0000	3.0000
	1000	55%	1.0000	2.0000	1.0000	2,0000	2.0000	3.0000
		60%	1.0000	2.0000	2.0000	2.0000	2.0000	4.0000
		65%	2.0000	2.0000	2.0000	2,0000	2.0000	4.0000
	1.1.1	70%	2.0000	3.0000	2.0000	3.0000	3.0000	4.0000
	10001	75%	2.0000	3.0000	3.0000	3.0000	3.0000	5.0000
		80%	2.0000	3.0000	3,0000	3.0000	3.0000	5.0000
		85%	6.0000	4.0000	4.0000	3.0000	3.0000	5.0000
		90%	6.0000	5.0000	5.0000	4.0000	4.0000	6.0000
		95%	6.0000	6.0000	7.0000	5.0000	4.0000	6.0000
		.1					1	ÞÍ

Table 3 No. of events > 0.05 system minutes – discrete distributions statistics table

Number of events > 0.30 system minutes

The discrete distribution of best fit for the loss of supply events greater than 0.30 system minutes is the IntUniform curve, giving a standard deviation of 0.816. Table 4 is provided to show the statistics for other discrete distribution curves.

The curve of second best fit (Bionomial) has a significantly worse fit statistic -7.2 compared to 1.6 for the curve of best fit – hence it has not been considered.

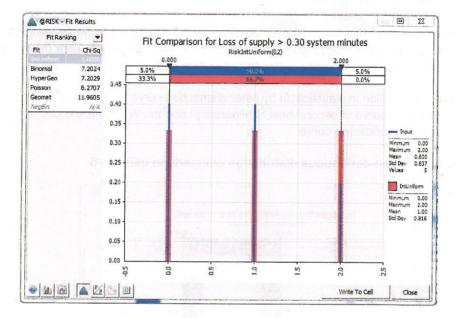


Figure 4 No. of event > 0.30 system minutes – best discrete distribution fit – IntUniform

Table 4 No. of events > 0.30 system minutes - discrete distributions statistics table

Fit Rank	ing 💌		Input	IntUniform	Binomial	HyperGeo	Poisson	Geomet
Fit	Chi-Sq	-}Fit	un martin a		An annual framework (Sport or)			and all some from the second strength of the
IntUniform	1.6000	Function Distribution Statistics	1 march	=RiskIntUni	=RiskBinomi	=RiskHyper	=RiskPoisso	=RiskGeomet(0.55556)
Binomiai	7.2024	Minimum	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HyperGeo	7.2029	Maximum	2.0000	2.0000	2.0000	2.0000	+Infinity	+Infinity
Poissel	8,2707	Mean	0.8000	1.0000	0.8000	0.8000	0.8000	0.8000
Geomet	11.9605	Mode	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000
NegBin	R/A	Median	1.0000	1.0000	1.0000	1,0000	1.0000	0.0000
		Std. Deviation	0.8367	0.8165	0.6928	0.6928	0.8944	1,2000
		Skewness	0.5122	0.0000	0.2887	0.2887	1.1180	2, 1667
		Kurtosis	2.3878	1,5000	2.0833	2.0834	4.2500	9,6944
		- Percentiles						
		5%	0.0000	0.0000	0.0000	0.0000	0.0000	0,0000
		10%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	-	15%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		20%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		25%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		30%	0.0000	0.0000	0,0000	0.0000	0.0000	0.0000
	_	35%	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000
		40%	0.0000	1.0000	1.0000	1.0000	0.0000	0.0000
		45%	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000
		50%	1.0000	1.0000	1.0000	1.0000	1.0000	0,0000
		55%	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000
		60%	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		65%	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		70%	1.0000	2.0000	1.0000	1.0000	1,0000	1,0000
		75%	1.0000	2.0000	1.0000	1.0000	1.0000	1.0000
		80%	1.0000	2.0000	1.0000	1.0000	1.0000	1.0000
	1.620	85%	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
		90%	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
	100	95%	2,0000	2,0000	2.0000	2.0000	2.0000	3.0000

2.3 Average circuit outage rate

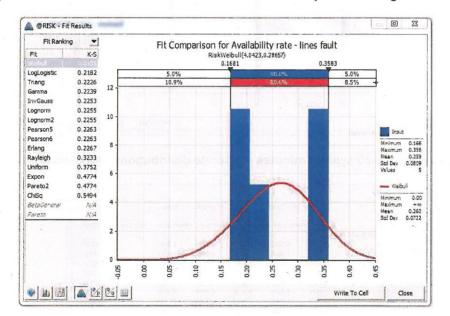
Average circuit outage rates represent measures of availability for components of transmission circuits. The optimal performance limit is 0%, which represents total availability for the component for the year; as such a lower limit of zero is set for fitting non-continuous curves to the data.

The availability rate measures are presented based on the components and nature of availability in the following categories.

Lines outage rate - fault performance

The K-S fit statistic has the Weibull distribution curve delivering the best fit (figure 5), while using the A-D fit statistic, the LogLogistic curve is best fitting (figure 6). As most of the data congregate near the two tails, the A-D fit statistic is preferred (LogLogistic), giving a standard deviation of 0.090.

Tables 5 and 6 present the variation in statistical fit by other distribution curves for K-S and A-D respectively. The standard deviations for the curve of second best fit (Pearson5) and the Weibull are 0.080 and 0.072, being slightly lower than for the preferred curve.

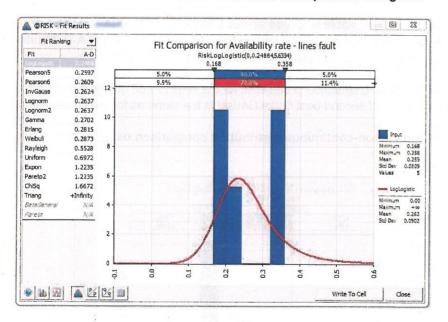




Fit Rankin	g •		Input	Weibull	LogLogistic	Triang	Gamma	InvGauss	Lognorm
Fit	K-S	- Fit							
IN	0.2105	Function		-RiskWeibu	=RiskLogLo	=RiskTriang	=RiskGamm	=RiskInvGa	=RiskLogno =
LogLogistic	0.2182	- Distribution Stati			-				
Trianc	0.2226	Minimum	0.1681	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Gamma	0.2239	Maximum	0.3583	+Infinity	+Infinity	0.3583	+Infinity	+Infinity	+Infinity
InvGauss	0.2253	Mean	0.2590	0.2599	0.2622	0.2389	0.2590	0.2590	0.2592
.ognorm	0.2255	Mode	0.1728 [est]	0.2671	0.2335	0.3583	0.2385	0.2285	0.2294
The second s		Median	0.2437	0.2617	0.2488	0.2534	0.2522	0.2487	0.2488
Lognorm2	0.2255	Std. Deviation	0.0809	0.0722	0.0902	0.0845	0.0729	0.0750	0.0754
Pearson5	0.2263	Skewness	0.2398	-0.0957	2.0116	-0.5657	0.5629	0.8684	0.8977
Pearson6	0.2263	Kurtosis	0.7325	2.7522	17.9225	2.4000	3.4752	4.2569	4.4663
Erlang	0.2267	- Percentiles							Constant 1
Rayleigh	0.3233	5%	0.1681	0.1374	0.1475	0.0801	0.1519	0.1561	0.1557
Uniform	0.3752	10%	0.1681	0.1642	0.1685	0.1133	0.1711	0.1727	0.1727
Expon	0.4774	15%	0.1681	0.1828	0.1829	0.1388	0.1850	0.1851	0.1852
Pareto 2	0.4774	20%	0.1681	0.1977	0,1946	0.1603	0.1965	0.1956	0.1957
ChiSq	0.5494	25%	0.2000	0.2106	0.2048	0.1792	0.2069	0.2051	0.2053
BetaGeneral	NGA.	30%	0,2000	0.2221	0,2141	0,1963	0.2164	0.2140	0.2143
Pareto	N/A	35%	0,2000	0.2327	0.2229	0.2120	0.2256	0.2227	0.2229
		40%	0,2000	0.2427	0.2315	0.2266	0.2345	0.2313	0.2315
		45%	0.2437	0.2523	0.2401	0.2404	0.2433	0.2399	0.2401
		50%	0.2437	0.2617	0.2488	0.2534	0.2522	0.2487	0.2488
		55%	0.2437	0.2711	0.2579	0.2657	0.2613	0.2578	0.2579
		60%	0,3250	0.2804	0.2674	0.2776	0.2708	0.2674	0.2675
		65%	0.3250	0.2900	0.2777	0.2889	0.2809	0.2777	0.2777
		70%	0,3250	0.3000	0.2892	0.2998	0.2917	0.2890	0.2890
	4	75%	0.3250	0.3107	0.3024	0.3103	0.3038	0.3017	0.3016
		80%	0.3250	0.3224	0.3183	0.3205	0.3175	0.3164	0.3163
		85%	0.3583	0.3358	0.3386	0.3304	0.3341	0.3345	0.3344
	213223	90%	0.3583	0.3522	0.3675	0.3399	0.3557	0.3586	0.3586
	1.000	95%	0.3583	0.3759	0,4197	0.3493	0.3894	0.3388	0.3977
			0.5305	1	0.1137	0.3793	0,3034	0.39/3	0.3977

Table 5 Lines - fault non-continuous distribution statistics table for K-S

Figure 6 Lines - fault non-continuous distribution comparison using A-D



Fit Ranking	-		Input	LogLogistic	Pearson5	Pearson6	InvGauss	Lognorm	Lognorm2	
Fit	A-D	- Fit								
File Contraction	A-U	Function		=RiskLogLo	=RiskPears	=RiskPears	=RiskInvGa	=RiskLogno	=RiskLogno	
Pearson5	0.2597	- Distribution Stati	Children and stand in the second strength							
Pearson6	0.2609	Minimum	0.1681	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
InvGauss	0.2609	Maximum	0.3583	+Infinity	+Infinity	+Infinity	+Infinity	+Infinity	+Infinity	
	0.2637	Mean	0.2590	0.2622	0.2597	0.2595	0.2590	0.2592	0.2592	
ognorm		Mode	0.1728 [est]	0.2335	0.2214	0.2237	0.2285	0.2294	0.2294	
.ognorm2	0.2637	Median	0.2437	0.2488	0.2455	0.2464	0.2487	0.2488	0.2488	
Gamma	0.2702	Std. Deviation	0.0809	0,0902	0.0799	0.0786	0.0750	0.0754	0.0754	
Erlang	0.2815	Skewness	0.2398	2.0116	1.3598	1,2273	0.8684	0.8977	0.8977	
Neibull	0.2873	Kurtosis	0.7325	17,9225	6.7989	6.0387	4.2569	4.4663	4.4663	
Rayleigh	0.5528	- Percentiles								
Jniform	0.6972	5%	0.1681	0.1475	0,1588	0.1579	0.1561	0.1557	0.1557	
Expon	1.2235	10%	0.1681	0.1685	0.1739	0.1736	0.1727	0.1727	0.1727	
Pareto 2	1.2235	15%	0.1681	0.1829	0.1852	0.1852	0.1851	0,1852	0.1852	
ChiSq	1.6672	20%	0.1681	0,1946	0.1949	0.1951	0.1956	0.1957	0.1957	
-	+Infinity	25% ·	0.2000	0.2048	0.2037	0,2042	0.2051	0.2053	0.2053	
SetaGeneral	N/A	30%	0.2000	0.2141	0.2121	0.2128	0.2140	0.2143	0.2143	
Pareto	N/A	35%	0.2000	0.2229	0.2204	0,2211	0.2227	0.2229	0.2229	
		40%	0.2000	0.2316	0.2286	0.2294	0.2313	0.2315	0.2315	
		45%	0.2437	0.2401	0.2369	0.2378	0.2399	0.2401	0,2401	
		50%	0.2437	0.2488	0.2455	0.2464	0.2487	0.2488	0.2488	
		55%	0.2437	0.2579	0.2545	0.2554	0.2578	0.2579	0.2579	
		60%	0.3250	0.2674	0.2641	0.2650	0.2674	0.2675	0.2675	
		65%	0.3250	0.2777	0.2746	0.2754	0.2777	0.2777	0.2777	
		70%	0.3250	0.2892	0.2862	0.2869	0.2890	0.2890	0.2890	
	31.2	75%	0,3250	. 0.3024	0.2995	0.3000	0.3017	0.3016	0.3016	
		80%	0,3250	0.3183	0.3152	0.3155	0.3164	0.3163	0.3163	
	1933	85%	0.3583	0.3386	0.3350	0.3348	0.3345	0.3344	0.3344	
	1000	90%	0.3583	0.3675	0.3623	0.3612	0.3586	0.3586	0.3586	
		95%	0.3583	0.4197	0.4083	0.4053	0.3973	0.3977	0.3977	
	10.1	<		1					+	
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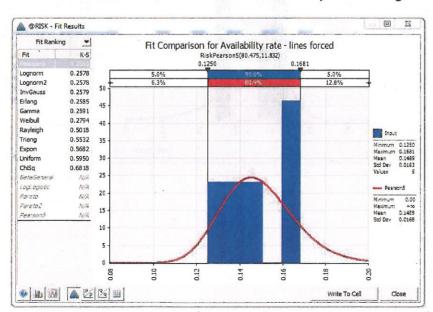
Table 6 Lines – fault non-continuous distribution statistics table for A-D

Lines outage rate – forced outage performance

The data for lines forced to be unavailable is spread across the middle and the tails of the distribution curve. The best fit distribution for the lines forced outage performance for both the K-S and A-D fit statistics is the Pearson5 distribution curve (figure 7 and 8) giving a standard deviation of 0.017.

Tables 7 and 8 illustrate the other distribution fit statistics for the lines forced outage performance. The standard deviation for the curve of second best fit (InvGauss) is the same as for the curve of best fit.

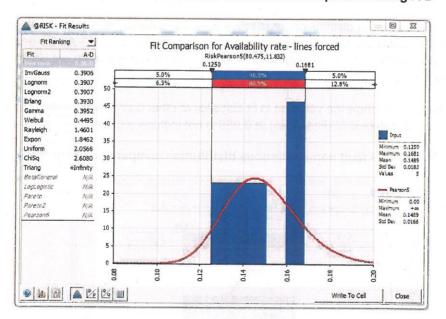
Figure 7 Lines - forced non-continuous distribution comparison using K-S



Fit Rankr	ng 💌		Input	Pearson5	Lognorm	Lognorm2	InvGauss	Erlang	Gamma	
Fit	K-S	- Fit								
PeterionS	0.25%	Function		RiskPears.	=RiskLogno	=RiskLogno	=RiskInvGa	=RiskErlang	RiskGamm	
Lognorm	0.2578	- Distribution Stati	and the second se							
Lognorm2	0.2578	Minimum	0,1250	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
InvGauss	0.2579	Maximum	0,1681	+Infinity	+Infinity	+Infinity	+Infinity	+Infinity	+Infinity	
Erlang	0.2585	Mean	0.1489	0.1489	0.1489	0.1489	0.1489	0.1489	0.1489	
Gamma	0.2591	Mode	0.1670 [est]	0.1452	0.1461	0.1461	0.1461	0.1470	0,1470	
Welbull	0.2794	Median	0,1429	0.1476	0.1479	0.1479	0.1479	0.1482	0.1482	
Rayleigh	0.5018	Std. Deviation	0.0183	0.0168	0.0166	0.0166	0.0165	0.0165	0.0165	
Triang	0.5532	Skewness	-0.0952	0.4574	0.3364	0.3364	0.3348	0.2222	0.2216	
-		Kurtosis	1.2607	3,3963	3.2019	3.2019	3.1868	3.0741	3.0737	
Expon	0.5682	- Percentiles								1
Uniform	0.5950	5%	0.1250	0.1235	0.1232	0.1232	0.1232	0.1227	0,1228	-
ChiSq	0.6818	10%	0.1250	0.1284	0.1283	0.1283	0.1283	0.1281	0,1281	
5eteGeneral	N/A	15%	0.1250	0.1318	0.1318	0.1318	0.1318	0.1318	0.1318	
logiogistic	N/4	20%	0.1250	0.1346	0.1347	0.1347	0.1347	0.1348	0.1348	
Pareto	N/A	25%	0.1417	0.1370	0.1372	0.1372	0,1372	0.1374	0.1374	
Pareto 2	NA	30%	0.1417	0.1393	0.1395	0.1395	0.1395	0.1398	0.1398	
Pearson6	N/4	35%	0.1417	0.1415	0,1417	0.1417	0.1417	0.1420	0,1420	
		40%	0.1417	0.1435	0,1438	0.1438	0.1438		0.1441	
		45%	0.1429	0.1456	0.1459	0.1459	0.1459	0.1462	0.1462	
		50%	0.1429	0,1476	0.1479	0.1479	0.1479	0.1482	0.1482	
	1.11	55%	0.1429	0.1497	0.1500	0,1500	0.1500	0.1503	0.1503	
		60%	0.1667	0.1519	0.1522	0.1522	0.1522	0.1525	0.1505	
	14	65%	0,1667	0.1542	0.1544	0.1544	0.1522	0.1525	0, 1525	
	1.50	70%	0,1667	0.1566	0.1544	0.1544	0.1544	0.154/	a second second	
	1.19	75%	0,1667	0.1500	0.1588				0.1570	
	100	80%	0.1667	0,1595	0.1595	0.1595	0.1595	0.1596	0.1595	
		85%				0.1625	0.1625	0.1626	0.1625	
	196.0	90%	0.1681	0.1661	0.1660	0.1660	0.1660	0.1660	0.1660	
	10.0	and the second se	0.1681	0.1709	0,1706	0.1706	0.1706	0.1704	0.1703	
		95%	0.1681	0,1784	0.1777	0.1777	0.1776	0.1771	0.1770	
									1	
	APP	126 11					WA	ite To Celi	Close	

Table 7 Lines - forced non-continuous distribution statistics table for K-S

Figure 8 Lines - forced non-continuous distribution comparison using A-D



Fit Rankir	10 1	1994 - 1995 - 1995 - 1995 - 1995 - 1995 - 1995 - 1995 - 1995 - 1995 - 1995 - 1995 - 1995 - 1995 - 1995 - 1995 -	Input	Pearson5	InvGauss	Lognorm	Lognorm2	Erlang	Gamma
Fit	A-D	- Fit							
Warmin 5	H U	Function		RiskPears.	=RiskInvGa	=RiskLogno	=RiskLogno	=RiskErlang.	=RiskGamm
nyGauss	0.3906	- Distribution Stati	and the second sec						
.ognorm	0.3907	Minimum	0,1250	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
.ognorm2	0.3907	Maximum	0,1681	+Infinity	+Infinity	+Infinity	+Infinity	+Infinity	+Infinity
irlang	0.3930	Mean	0.1489	0,1489	0.1489	0.1489	0.1489	0.1489	0.1489
Gamma	0.3950	Mode	0.1670 [est]	0.1452	0.1461	0.1461	0.1461	0.1470	0.1470
Veibull	0.3952	Median	0.1429	0.1476	0.1479	0,1479		0.1482	0.1482
		Std. Deviation	0.0183	0.0168	0,0166	0.0166	0.0166	0.0165	0.0165
tayleigh	1.4601	Skewness	-0.0952	0.4574	0.3348	0.3364	0.3364	0.2222	0.2216
Expon	1.8462	Kurtosis	1.2607	3.3963	3.1868	3,2019	3,2019	3.0741	3.0737
Iniform	2.0566	- Percentiles						E.	at a seal and
ThiSq	2.6080	5%	0.1250	0,1235	0.1232	0.1232	0,1232	0.1227	0.1228
inang	+Infinity	10%	0.1250	0.1284	0.1283	0,1283	0.1283	0,1281	0.1281
SetelGeneral	NA	15%	0.1250	0.1318	0.1318	0.1318	0.1318	0.1318	0.1318
oplogssoc	NIA	20%	0.1250	0.1346	0.1347	0.1347	0.1347	0.1348	0.1348
Pareto	N/A	25%	0.1417	0.1370	0.1372	0.1372	0,1372	0.1374	0.1374
Pareto2	NGA	30%	0,1417	0.1393	0,1395	0.1395	0.1395	0.1398	0.1398
Nearson5	Till.	35%	0.1417	0.1415	0.1417	0.1417	0.1417	0.1420	0.1420
		40%	0.1417	0,1435	0,1438	0.1438	0.1438	0.1441	0.1441
		45%	0,1429	0,1456	0.1459	0,1459	0.1459	0.1462	0.1462
		50%	0,1429	0,1476	0.1479	0.1479	0,1479	0,1482	0,1482
		55%	0.1429	0.1497	0.1500	0,1500	0.1500	0,1503	0.1503
		60%	0.1667	0,1519	0.1522	0.1522	0,1522	0.1525	0.1525
		65%	0.1667	0.1542	0.1544	0.1544	0.1544	0.1547	0.1547
		70%	0,1667	0,1566	0.1568	0.1568	0.1568	0,1571	0,1570
		75%	0,1667	0,1593	0.1595	0.1595	0.1595	0.1596	0,1596
		80%	0.1667	0.1555	0.1595	0.1625	0,1625	0,1626	0,1625
		85%	0,1681	0.1624	0.1625	0.1623	0.1660	0.1660	0.1660
		90%	0.1681	0.1709	0,1706	0.1706	0.1706	0.1704	
			0,1681	0,1709	0.1706	0.1706	0.1708	0.1771	0.1703
		95%	0.1081	0,1/84	0,1776	0.1///	0.1///	0.1771	0.1770

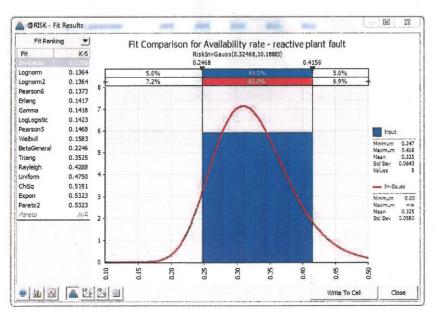
Table 8 Lines - forced non-continuous distribution statistics table for A-D

Reactive plant outage rate - fault performance

Using the K-S fit statistic, the best fit distribution for reactive plant unavailability due to fault is the InvGauss (figure 9), while the A-D fit statistic has the Loglogistic curve as the best fit (figure 10). As the data is spread evenly across the middle and the tails of the distribution curve the A-D fit is preferred (LogLogistic), giving a standard deviation of 0.064.

Tables 9 and 10 are provided to show the variation in fit statistics of other distribution curves. The standard deviation for the curve of second best fit (InvGauss) at 0.058 is not materially different.

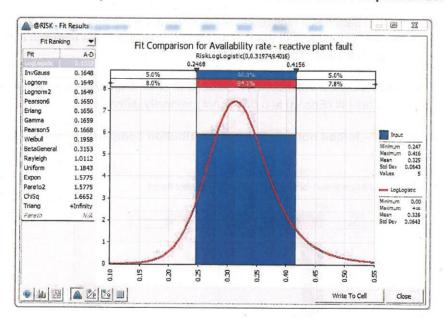




Fit Rankr	ng 💌		Input	InvGauss	Lognorm	Lognorm2	Pearson6	Erlang	Gamma
Fit	K-S	-) Fit Function		Disktower	Dield same	=RiskLogno	D : 10	ni la l	
	0.1359	- Distribution Stati		KISKINVGa	=RISKLOGNO.,	=RiskLogno	=RiskPears	=RiskErlang,.	=RiskGamm
Lognorm	0.1364	Minimum	0,2468	0.0000	0.0000	0.0000	0.0000	0.0000	0 0000
Lognorm2	0.1364	Maximum	0.4156	+Infinity	+Infinity	+Infinity	+Infinity		0.0000
Pearson6	0.1373	Mean	0.3247	0.3247	0.3247	+1ninity 0.3247		+Infinity	+Infinity
Erlang	0.1417	Mode	0.2510 [est]	0.3095			0.3247	0.3247	0.3247
Gamma	0.1418	Median	0.2510 [est] 0.3247		0.3097	0.3097	0.3090	0.3145	0.3145
LogLogistic	0.1423	Std. Deviation	0.3247	0.3196	0.3196	0.3196	0.3193	0.3213	0.3213
Pearson5	0.1468	Skewness		0.0580	0.0580	0.0580	0.0583	0.0574	0.0574
Weibull	0.1583	Kurtosis	0.3711	0.5355	0.5420	0,5420	0.5822	0.3536	- 0.3534
BetaGeneral	0.2246	- Percentiles	2.9009	3.4780	3,5268	3,5268	3.6374	3. 1875	3.1873
Triang	0.3525	5%	0.2468	0.2389					
Rayleigh	0.4288	10%			0.2387	0.2387	0.2391	0,2364	0.2364
Uniform	0,4750	15%	0.2468	0.2546	0.2546	0.2546	0,2548	0.2536	0.2537
ChiSa	0.5191	20%	0.2468	0.2659	0,2660	0.2660	0,2660	0.2657	0.2658
Expon	0.5323		0.2468	0.2752	0.2753	0.2753	0,2753	0.2757	0.2757
Pareto 2	0.5323	25%	0.2857	0.2835	0.2836	0.2836	0,2835	0.2843	0.2844
Fareto	N/A	30%	0.2857	0.2912	0.2912	0.2912	0.2911	0.2923	0.2923
		35%	0.2857	0.2984	0.2985	0.2985	0.2983	0.2998	0.2998
	1.	40%	0.2857	0.3055	0.3056.	0.3056	0.3053	0.3071	0.3071
	1	45%	0.3247	0.3125	0.3126	0.3126	0.3123	0.3142	0.3142
	1000	50%	0.3247	0.3196	0.3196	0.3196	0.3193	0.3213	0.3213
	1	55%	0.3247	0.3268	0.3268	0.3268	0.3265	0.3285	0.3285
		60%	0.3506	0.3343	0.3343	0.3343	0.3340	0.3360	0.3360
		65%	0.3506	0.3423	0.3422	0.3422	0.3419	0.3438	0.3438
	The second	70%	0.3506	0.3508	0.3508	0.3508	0.3505	0.3522	0.3521
	-	75%	0.3506	0.3603	0.3602	0.3602	0,3600	0.3613	0.3613
		80%	0.3506	0.3712	0.3711	0.3711	0.3709	0.3717	0.3717
		85%	0.4156	0.3842	0.3841	0.3841	0.3841	0.3841	0.3841
		90%	0.4156	0.4012	0.4012	0.4012	0.4014	0.4001	0.4000
	1898	95%	0.4156	0.4278	0.4279	0.4279	0.4286	0.4245	0.4244
	10.2			1					

Table 9 Reactive plant - fault non-continuous distribution statistics table for K-S

Figure 10 Reactive plant - fault non-continuous distribution comparison using A-D



Fit A-D Function =RiskLog10=Ri	Fit Ranki	ng 💌		Input	LogLogistic	InvGauss	Lognorm	Lognorm2	Pearson6	Erlang
Curricolon Beckscholl Die Statistics Jung 0.1659 0.1650 Mode 0.3247 0.33247 0.3258 0.3556 0.4540 0.5555 0.4540 0.5558 0.4540 <t< th=""><th>Fit</th><th>A-D</th><th>= Fit</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></t<>	Fit	A-D	= Fit							
ImvGauss 0.1649 Mmimum 0.2468 0.0000 0.000	Inclusion .	0.17.2			=RiskLogLo	=RiskInvGa	=RiskLogno	=RiskLogno	=RiskPears	=RiskErlang
Lognorm 0.1649 Maximum 0.4156 +Infinity +Infinit	InvGauss	0,1648		The local data was in the local data and the local	0.0000					
Lognorm2 0.1649 Pearson6 0.1659 Friang 0.1656 Gamma 0.3247 0.32247 0.32247 0.3246 0.3550 0.4580 0.0575 0.0570 0.0570 0.0574 0.3247 0.3246 0.3246 0.3248 0.0344 0.3346 0.3348 0.3343 0.3343 0.3343 0.3343 0.3343 0.3343 0.3343 0.3343 0.3343 0.3343 0.3340 0.3386 0.5596 0.3506 0.3596 0.3506 0.3596 0.3506 0.3596 0.3506 0	Loanorm	0.1649								0.0000
Person6 0.1550 Mode 0.2236 0.3247 0.3258 0.3268 0.3258 0.3258 0.3258 0.3258 0.3258 0.3258 0.3258 0.3267 0.2367 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>and the second second</td> <td></td> <td></td> <td></td>							and the second			
Erlang 0.1656 Mode 0.312b 0.312b 0.3095 0.3055 <td>and the second se</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>0.3247</td>	and the second se									0.3247
Gamma 0.1659 0.3196 0.3287 0.222 0.353 0.0580 0.02571 0.275 <td></td> <td></td> <td>and the second se</td> <td>LI CALL PROPERTY STATE</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>0,3145</td>			and the second se	LI CALL PROPERTY STATE						0,3145
Pearson5 0.1668 Std. Jeviation 0.109-3 0.109300 0.10930										0.3213
Weibull 0.1958 0.3711 1.0005 0.5355 0.5420 0.5355 0.5420 0.5420 0.5355 0.5420 0.5355 0.5420 0.5355 0.5420 0.5355 0.5420 0.5355 0.5420 0.5355 0.5420 0.5355 0.5420 0.5355 0.5420 0.5355 0.5420 0.5355 0.5420 0.5355 0.5420 0.5355 0.5420 0.5355 0.5420 0.5355 0.5420 0.5355 0.5420 0.5355 0.5420 0.5257 0.2387 0.2385 0.2286 0.2387 0.2385 0.2285 0.2285 0.2285 0.2285 0.2285 0.2285 0.2285 0.2285 0.2285 0.2285 0.2285 0.2285 0.2285 0.2285 0.2285 0.2285 0.2285 0.2285										0.0574
BetaGeneral Raykejh 0.3153 1.01758 2.9009 6.895-4 3.4740 3.3286 3.5288 3.6374 3.18 Raykejh 1.0112 Percentiles 5% 0.2388 0.2387 0.2387 0.2397 0.2391 0.23 Pareto 1.1843 10% 0.2468 0.2511 0.2546 0.2546 0.2546 0.2574 0.2375 0.2753 0.2754 0.2984 0.2984										0.3536
Reyleigh 1.0112 5% 0.2468 0.2338 0.2387 0.2387 0.2397 0.2367 0.2659 0.2650 0.2660 0.2560 0.2660 0.2657 0.2753 0.2753 0.2753 0.2753 0.2753 0.2753 0.2753 0.2857 0.2922 0.2912 0.2912 0.2912 0.2912 0.2912 0.2912 0.2912 0.2913 0.3123 0.3123 0.3125 0.3126 0.3126 0.3126 0.3126 0.3126 <td></td> <td></td> <td></td> <td>2.9009</td> <td>6.8954</td> <td>3.4780</td> <td>3,5268</td> <td>3.5268</td> <td>3.6374</td> <td>3.1875</td>				2.9009	6.8954	3.4780	3,5268	3.5268	3.6374	3.1875
Uniform 1.1843 10% 0.2468 0.2358 0.2359 0.2369 0.2364 0.2365 0.2660 0.2660 0.2660 0.2660 0.2660 0.2660 0.2661 0.2752 0.2753 <td></td> <td></td> <td>and all press and the second second second</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>Geo. 19</td>			and all press and the second second second							Geo. 19
Expon 1.5775 1.0% 0.2468 0.2511 0.12466 0.2546 0.2546 0.2546 0.2546 0.2546 0.2546 0.2546 0.2546 0.2546 0.2546 0.2546 0.2546 0.2546 0.2546 0.2546 0.2546 0.2546 0.2546 0.2560 0.2660 0.2650 Paretto2 1.5775 20% 0.2857 0.2752 0.2753 0.285 0.2865 0.2895 0.2983 0.2983 0.2983 0.2983 0.2983 0.2912	No. of Contrast of States and State									0.2364
Pareto2 1.5775 0.2466 0.2639 0.2639 0.2639 0.2639 0.2639 0.2639 0.2639 0.2630 0.2600 0.2753										0.2536
ChiSq 1.6652 0.2857 0.2954 0.2952 0.2953 0.2753 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>0.2657</td>										0.2657
Triang +Infnity 25% 0.2857 0.2952 0.2953 0.2955 0.2912 0.2911 0.292 Pareto 1//4 35% 0.2857 0.2924 0.2912 0.2912 0.2911 0.292 Pareto 1//4 35% 0.2857 0.3924 0.3985 0.2985 0.2983 0.291 0.2911 0.292 40% 0.2857 0.3052 0.3055 0.3056 0.3056 0.3056 0.3056 0.3056 0.3053 0.303 45% 0.3247 0.3197 0.3126 0.3126 0.3196 0.3193 0.334 55% 0.3247 0.3266 0.3268 0.3268 0.3268 0.3265 0.326 60% 0.3506 0.3313 0.3343 0.3343 0.3340 0.3346 65% 0.3506 0.3594 0.3608 0.3508 0.3500 0.350 75% 0.3506 0.3794 0.3603 0.3602 0.3602 0.3600 0.370										0.2757
28xetb 1.35% 0.2357 0.2322 0.2312 0.313 135% 0.2357 0.3062 0.3055 0.3056 0.3056 0.3053 0.303 45% 0.3247 0.3197 0.3196 0.3196 0.3196 0.3196 0.3196 0.3245 0.324 55% 0.3247 0.3266 0.3266 0.3268 0.3265 0.324 60% 0.3506 0.3338 0.3343 0.3343 0.3343 0.3340 0.3340 65% 0.3506 0.3506 0.3549 0.3508 0.3505 0.353 75% 0.3506 0.3594 0.3603 0.3602 0.3600 0.360 60% 0.3506 0.3575 0.3711 0.3711 0.3711 0.3711 <										0.2843
35% 0.12857 0.2964 0.12964 0.12858 0.2963 0.2964 0.2963 0.2964 0.2963 0.3965 0.3965 0.3965 0.3126 0.3125 0.3125 0.3125 0.3125 0.3126 0.3126 0.3126 0.3265 0.3265 0.3265 0.3263 0.3366 0.3266 0.3266 0.3266 0.3266 0.3364 0.3343 0.3343 0.3343 0.3340 0.3341 0.3341 0.3341 0.3360 0.3506 0.3705 0.3712 0.3711 0.3711 0.3709 0.3708<	1	and the second								0.2923
45% 0.3247 0.3130 0.3125 0.3126 0.3126 0.3123 0.312 50% 0.3247 0.3197 0.3196 0.3196 0.3196 0.3196 0.3196 0.3196 0.3196 0.3196 0.3196 0.3196 0.3196 0.3196 0.3196 0.3196 0.3268 0.3265 0.323 0.343 0.3343 0.3343 0.3340 0.3340 0.3340 0.3340 0.3346 0.3265 0.3268 0.3268 0.3268 0.3268 0.3266 0.3396 0.3443 0.3443 0.3340 0.3340 0.3340 0.3340 0.3340 0.3342 0.3422 0.3422 0.3412 0.3415 0.3506 <	Pareto	/1(/4							0.2983	0.2998
50% 0.3247 0.3197 0.3196 0.3196 0.3196 0.3193 0.325 55% 0.3247 0.3266 0.3268 0.3268 0.3268 0.3268 0.3268 0.3268 0.3268 0.3268 0.3268 0.3268 0.3268 0.3268 0.3268 0.3268 0.3268 0.3268 0.3268 0.3343 0.3343 0.3343 0.3343 0.3343 0.3343 0.3343 0.3342 0.3419 0.34 65% 0.3506 0.3415 0.3422 0.3422 0.3419 0.34 70% 0.3506 0.3504 0.3508 0.3508 0.3508 0.3505 0.35 75% 0.3506 0.3504 0.3602 0.3602 0.3600 0.36 80% 0.3506 0.3705 0.3712 0.3711 0.3711 0.3711 0.3709 0.37 85% 0.4156 0.4039 0.4012 0.4012 0.4012 0.4014 0.404			and the second se			0.3055	0.3056	0.3056	0.3053	0.3071
55% 0.3247 0.3266 0.3268 0.3268 0.3265 0.32 60% 0.3506 0.3333 0.3343 0.3343 0.3343 0.3343 0.3343 0.3343 0.3343 0.3343 0.3343 0.3343 0.3345 0.3265 0.3265 0.3265 0.3265 0.3265 0.3345 0.3342 0.3342 0.3412 0.3412 0.3412 0.3412 0.3412 0.3412 0.3412 0.3412 0.3506 0.3505 0.355 0.5505 0.355 7.55% 0.3506 0.3504 0.3603 0.3602 0.3602 0.3600 0.3606 0.3705 0.3711 0.3711 0.3711 0.3709 0.37 85% 0.4156 0.3645 0.3841 0.38				0.3247	0.3130	0.3125	0.3126	0.3126	0.3123	0.3142
60% 0.3506 0.3338 0.3343 0.3343 0.3340 0.3340 65% 0.3506 0.3415 0.3423 0.3422 0.3422 0.3422 0.3422 0.3422 0.3422 0.3422 0.3422 0.3422 0.3423 0.3506 0.349 0.3506 0.349 0.3508 0.3508 0.3505 0.353 75% 0.3506 0.3594 0.3603 0.3602 0.3602 0.3600 0.356 80% 0.3506 0.3705 0.3712 0.3711 0.3711 0.3709 0.37 85% 0.4156 0.3632 0.3642 0.3841			50%	0.3247	0.3197	0.3196	0.3196	0.3196	0.3193	0.3213
65% 0.3506 0.3415 0.3423 0.3422 0.3422 0.3419 0.341 70% 0.3506 0.3499 0.3508 0.3508 0.3508 0.3505 0.35 75% 0.3506 0.3549 0.3602 0.3602 0.3602 0.3600 0.360 80% 0.3506 0.3705 0.3711 0.3711 0.3711 0.3741 0.3841 0.38 85% 0.4156 0.3845 0.3841 0.3841 0.3841 0.3841 0.3841 0.410		1.	55%	0,3247	0.3266	0.3268	0.3268	0.3268	0.3265	0.3285
70% 0.3506 0.3499 0.3508 0.3508 0.3508 0.3505 0.35 75% 0.3506 0.3594 0.3603 0.3602 0.3602 0.3600 0.36 80% 0.3506 0.3705 0.3711 0.3711 0.3711 0.3709 0.37 85% 0.4156 0.3845 0.3842 0.3841 0.3841 0.3841 0.3841 0.4941 0.38 90% 0.4156 0.4039 0.4012 0.4012 0.4014 0.4014			60%	0.3506	0.3338	0.3343	0.3343	0.3343	0.3340	0.3360
75% 0.3506 0.3594 0.3603 0.3602 0.3602 0.3600 0.360 60% 0.3506 0.3705 0.3712 0.3711 0.3711 0.3709 0.37 85% 0.4156 0.3842 0.3841 0.3841 0.3841 0.3841 0.3841 0.3841 0.3841 0.3841 0.3841 0.3841 0.4012 0.4014 0.401			65%	0.3506	0.3415	0.3423	0.3422	0.3422	0.3419	0.3438
80% 0.3506 0.3705 0.3712 0.3711 0.3711 0.3709 0.37 85% 0.4156 0.3845 0.3842 0.3841 0.4012 0.4012 0.4014			70%	0.3506	0,3499	0.3508	0.3508	0.3508	0.3505	0.3522
85% 0.4156 0.3845 0.3842 0.3841 <td></td> <td></td> <td>75%</td> <td>0.3506</td> <td>0.3594</td> <td>0.3603</td> <td>0.3602</td> <td>0.3602</td> <td>0.3600</td> <td>0.3613</td>			75%	0.3506	0.3594	0.3603	0.3602	0.3602	0.3600	0.3613
90% 0.4156 0.4039 0.4012 0.4012 0.4012 0.4014 0.40			80%	0.3506	0.3705	0.3712	0.3711	0.3711	0.3709	0.3717
		1000	85%	0.4156	0.3845	0.3842	0.3841	0.3841	0.3841	0.3841
95% 0.4156 0.4373 0.4278 0.4279 0.4279 0.4286 0.42			90%	0.4156	0.4039	0.4012	0.4012	0.4012	0.4014	0.4001
			95%	0.4156	0.4373	0.4278	0.4279	0.4279	0.4286	0.4245
		17/11/20			1					

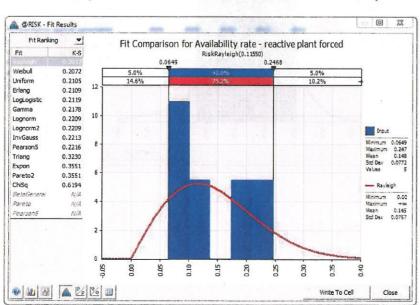
Table 10 Reactive plant - fault non-continuous distribution statistics table for A-D

Reactive plant outage rate - forced outage performance

Reactive plant forced unavailability data has a high representation in the middle and right tail of the distribution. The best fit distribution curve for both the K-S and A-D fit statistics is the Rayleigh distribution curve (figures 11 and 12), giving a standard deviation of 0.076.

Tables 11 and 12 are provided to show the variation in fit statistics of other distribution curves. The standard deviation for the curve of second best fit (Erlang) at 0.074 is not materially different.

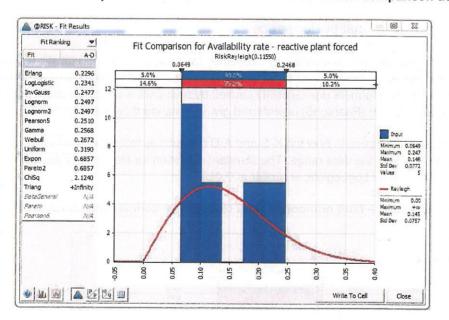




Fit Rankin	9 1	- Fit	Input	Rayleigh	Weibull	Uniform	Erlang	LogLogistic	Gamma	1
Fit	K-S	Function		Dield sulai	DieldAteileus	-Dield In Gra	=RiskErlang	Dialdanata	D'I.C.	-
	0.2/17	- Distribution Stati		RISARD VIEL.	HOSKYYEDU	#RiskUnitor	=Riskenang	=RISKLOGLO	#RUSKGamm	.*
Weibull	0.2072	Minimum	0.0649	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-
Uniform	0.2105	Maximum	0,2468	+Infinity	+Infinity	0.3084	+Infinity	+Infinity	+Infinity	
Erlang	0.2109	Mean	0.1481	0.1448	0.1489	0.1542	0.1481	0.1556	a second second second second	
LogLogistic	0.2119	Mode	0.0695 [est]	0.1155	0.1325	0.0000	0.1401	0.1556	0.1481	
Gamma	0.2178	Median	0.0093 [ESQ 0.1299	0.1155	0.1325	0.1542		0.1086	0.1142	
Lognorm	0.2209	Std. Deviation	0.0772	0.1360	0.0675		0.1359		0.1369	
Lognorm2	0.2209	Skewness	0.3700	0.6311		0.0890	0.0740	0.1106	0.0708	
InvGauss	0.2213	Kurtosis	0.8587	3,2451	0.4323	0.0000	1.0000	14.8754	0.9562	
Pearson5	0.2216	- Percentiles	0,6367	3.2451	2.9378	1.8000	4.5000	+Infinity	4.3715	
Triang	0.3230	5%	0.0649	0.0370	0.0473		0.0506			2
Expon	0.3551	10%	0.0649	0.0370		0.0154	and the second second	0.0532	0.0537	
Pareto2	0.3551	15%	0.0649		0.0643	0.0308	0.0646	0.0671	0.0676	
ChiSa	0.6194	20%		0.0659	0.0774	0.0463	0.0755	0.0774	0.0783	
BetaGeneral	N/A	25%	0.0649	0.0772	0.0886	0.0617	0.0850	0.0862	0.0877	
Pareto	NA		0.0909	0.0876	0.0987	0.0771	0.0938	0.0942	0.0963	
Pearsoné	NA	30%	0.0909	0.0976	0.1082	0.0925	0.1023	0.1018	0.1045	
		35%	0.0909	0.1072	0.1173	0.1080	0.1106	0.1092	0.1125	
		40%	0.0909	0.1167	0.1261	0.1234	0.1189	0.1167	0,1205	
		45%	0.1299	0,1263	0.1349	0.1388	0.1273	0.1243	0.1286	
	1.	50%	0.1299	0.1360	0,1437	0.1542	0.1359	0.1323	0.1369	
		55%	0.1299	0.1460	0.1526	0.1696	0.1450	0.1407	0.1456	
		60%	0,2078	0.1564	0.1619	0,1851	0,1545	0.1499	0.1548	
		65%	0.2078	0.1674	0,1715	0.2005	0.1649	0.1601	0.1647	
	114	70%	0.2078	0.1792	0.1818	0,2159	0.1763	0.1718	0.1755	
	1	75%	0.2078	0.1923	0.1931	0.2313	0.1891	0.1857	0.1878	
	1.00	80%	0.2078	0.2072	0.2058	0.2468	0.2041	0.2030	0.2020	
	1	85%	0.2468	0.2250	0.2208	0.2622	0.2226	0.2260	0.2195	
	11 14	90%	0.2468	0.2479	0,2398	0.2776	0.2473	0.2608	0.2429	
	L'AND	95%	0.2468	0.2827	0.2683	0.2930	0.2870	0.3285	0.2803	
		(1				F	
1 day 1 mil a	A IPZI	86 1						te To Cell	Close	

Table 11 Reactive plant - forced non-continuous distribution statistics table for K-S

Figure 12 Reactive plant - forced non-continuous distribution comparison using A-D



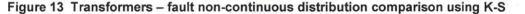
Fit Ranki	ng 💌	- Fit	Input	Rayleigh	Erlang	LogLogistic	InvGauss	Lognorm	Lognorm2
Fit	A-D	- Fit Function		Diel Desdat	Distribute	Disk and a	Disking	Diald same	=Riski.ogno
Rindert	0.2172	- Distribution Statis		-RISKRAYIEL.	-Riskenang	-KISKLOGLO	=RSKINVGa.	-RiskLogno	=RISKLOGHO.
Erlang	0.2296	Minimum	0.0649	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LogLogistic	0.2341	Maximum	0.2468	+Infinity	+Infinity	+Infinity	+Infinity	+Infinity	+Infinity
InvGauss	0.2477	Mean	0.1481	0.1448	0,1481	0,1556	0.1481	0,1488	0.1488
Lognorm	0.2497	Mode	0.0695 [est]	0.1155	0.1481	0.1556	0.0995	0.1488	0.1026
Lognorm2	0,2497	Median	and the day and the state						
Pearson5	0.2510	Std. Deviation	0.1299	0.1360	0.1359	0.1323	0.1306	0.1315	
Gamma	0.2568		0.0772	0.0757	0.0740	0.1106	0.0772	0.0790	0.0790
Weibull	0.2672	Skewness	0.3700	0.6311	1.0000	14.8754	1.5652	1.7407	
Uniform	0,3190	Kurtosis	0.8587	3.2451	4.5000	+Infinity	7.0832	8.8303	8.8303
Expon	0.6857	- Percentiles	0.000		0.0506		0.0500	0.0500	0.0500
Pareto2	0.6857	5% 10%	0.0649	0.0370	0.0506	0.0532	0.0588	0.0580	0.0580
ChiSq	2.1240	15%			0.0646				
Triang	+Infinity		0.0549	0.0659	0.0755	0.0774	0.0782	0.0785	0.0785
BataGeneral	N/A	20%	0.0649	0.0772	0.0850	0.0862	0.0859	0.0865	0.0865
Pareto	NA	25%	0.0909	0.0876	0.0938	0.0942	0.0933	0.0940	0.0940
Pearson6	N/A	30%	0.0909	0.0976	0.1023	0.1018	0.1004	0.1013	0.1013
46.50110	197	35%	0.0909	0.1072	0.1106	0,1092	0.1076	0.1085	0.1085
		40%	0.0909	0.1167	0.1189	0.1167	0.1150	0.1159	0.1159
		45%	0.1299	0.1263	0.1273	0.1243	0.1226	0.1235	0.1235
		50%	0,1299	0.1360	0.1359	0.1323	0.1306	0.1315	0.1315
		55%	0.1299	0.1460	0.1450	0.1407	0.1391	0.1400	0.1400
		60%	0.2078	0.1564	0.1545	0.1499	0.1484	0.1492	
		65%	0.2078	0.1674	0.1649	0.1601	0.1587	0.1593	0.1593
		70%	0.2078	0.1792	0.1763	0.1718	0.1702	0.1707	0.1707
		75%	0.2078	0,1923	0.1891	0.1857	0.1836	0.1840	0,1840
	N. P	80%	0.2078	0.2072	0.2041	0.2030	0.1997	0.1999	0.1999
	1001	85%	0.2468	0.2250	0.2226	0.2260	0.2202	0.2203	0.2203
	1129	90%	0.2468	0.2479	0.2473	0.2608	0.2487	0.2489	0.2489
	112.24	95%	0.2468	0.2827	0.2870	0.3285	0.2968	0.2983	0.2983
	S. S. Lines	4			1				+

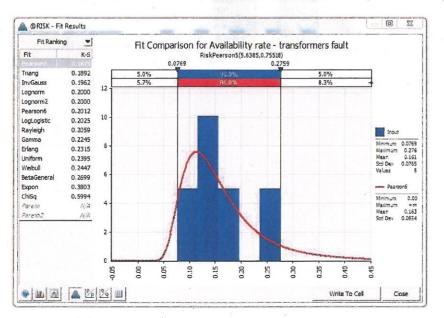
Table 12 Reactive plant - forced non-continuous distribution statistics table for A-D

Transformers outage rate - fault performance

The best fitting curve for Transformers unavailability caused by fault using the K-S fit statistic is the Pearson5 distribution (figure 13) curve while the A-D fit statistic has the LogLogistic distribution curve as the best fit (figure 14). As the data for Transformers unavailability caused by fault data is concentrated in the middle of the distribution, the K-S fit statistic (Pearson5) is preferred giving a standard deviation of 0.085.

Tables 13 and 14 show the difference in how the K-S and A-D fit statistics rated the distribution curves according their goodness of fit to the data range. The standard deviation for the curve of second best fit (Triang) is lower at 0.069, and for LogLogistic is similar at 0.089.

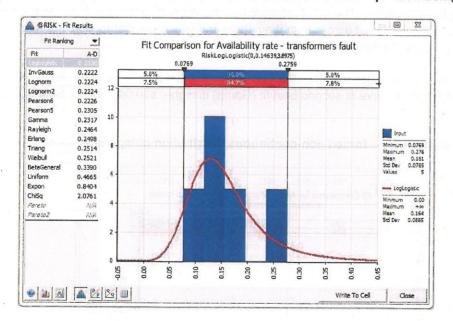




Fit Ranking	-		Input	Pearson5	Triang	InvGauss	Lognorm	Lognorm2	Pearson6
Fit	K-S	-'Fit							
Petrono		Function	and the second	=RiskPears	=RiskTriang	=RiskInvGa	=RiskLogno	=RiskLogno =	RiskPears
Triang	0.1892	- Distribution Statis	and a second part of a second						
InvGauss	0.1962	Minimum	0.0769	0.0000	0.0000	0.0000	0.0000		0.0000
Lognorm	0.2000	Maximum	0.2759	+Infinity	0.3334	+Infinity	+Infinity	+Infinity	+Infinity
Lognorm2	0.2000	Mean	0.1607		0.1532	0.1607	0.1610	0.1610	0.1611
Pearson6	0.2012	Mode	0.0819 [est]	0.1138	0.1261	0.1196	0.1219	0.1219	0.1229
LogLogistic	0.2025	Median	0.1316	0.1422	0.1475	0.1463	0,1467	0.1467	0.1468
Rayleigh	0.2059	Std. Deviation	0.0765	0.0854	0.0687	0.0719	0.0726	0.0726	0.0733
Gamma	0.2245	Skewness	0.8432	2.8918	0.2305	1.3421	1.4454	1.4454	1.5405
Erlang		Kurtosis	3.3453	26.8605	2.4000	6.0022	6.9311	6.9311	7.8496
Uniform	0.2395	- Percentiles	-			of and			
Weibull	0.2393	5%	0.0769	0.0753	0.0458	0.0728	0.0723	0.0723	0.0721
BetaGeneral	0.2447	10%	0.0769	0.0857	0.0648	0.0845	0.0845	0.0845	0.0845
	The course of the second se	15%	0.0769	0.0938	0.0794	0.0937	0.0939	0.0939	0.0941
Expon	0.3803	20%	0.0769	0.1010	0.0917	0.1017	0.1021	0.1021	0,1023
ChiSq	0.5994	25%	0.1261	0.1077	0.1025	0.1092	0.1098	0.1098	0.1100
Pareta	NA	30%	0.1261	0.1144	0.1123	0.1165	0.1171	0.1171	0.1173
Pareto2	N/A	35%	0.1261	0.1210	0.1213	0.1237	0.1243	0.1243	0.1245
	1995	40%	0.1261	0.1278	0.1297	0.1310	0.1316	0.1316	0.1317
		45%	0.1316	0.1348	0.1384	0.1385	0.1390	0.1390	0.1391
	3.68	50%	0.1316	0.1422	0.1475	0.1463	0.1467	0.1467	0.1468
		55%	0.1316	0.1503	0.1570	0.1545	0.1549	0.1549	0.1549
	1.1.1	60%	0.1933	0.1590	0.1671	0.1634	0.1636	0.1636	0.1636
	1.20	65%	0.1933	0.1688	0.1779	0.1731	0.1732	0.1732	0.1731
	1.195	70%	0,1933	0.1800	0.1894	0.1840	0.1839	0.1839	0.1837
	1.23	75%	0, 1933	0.1931	0.2019	0.1964	0.1962	0.1962	0.1959
	12.354	80%	0,1933	0.2093	0.2158	0.2112	0.2108	0.2108	0.2105
		85%	0.2759	0.2306	0.2316	0.2298	0.2292	0.2292	0.2289
		90%	0.2759	0.2614	0,2503	0.2553	0.2547	0.2547	0.2545
		95%	0.2759	0.3177	0.2746	0.2979	0.2979	0.2979	0,2982
			11	0.51/7	0.2140	0.27/9	0.27/9	0.27/9	0.2982
A	1	26							12.

Table 13 Transformers - fault non-continuous distribution statistics table for K-S

Figure 14 Transformers - fault non-continuous distribution comparison using A-D



Fit Rankir	ng 💌		Input	LogLogistic	InvGauss	Lognorm	Lognorm2	Pearson6	Pearson5
Fit	A-D	- Fit							
Contraction in	0.110	Function		=RiskLogLo	=RiskInvGa	=RiskLogno	=RiskLogno	=RiskPears	=RiskPears
InvGauss	0.2222	- Distribution Statis	and the second second second	Storing					
Lognorm	0.2224	Minimum	0.0769	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Lognorm2	0.2224	Maximum	0.2759	+Infinity	+Infinity	+Infinity	+Infinity	+Infinity	+Infinity
Pearson6	0.2226	Mean	0.1607	0.1635	0.1607		0.1610	0.1611	0.1628
	0.2226	Mode	0.0819 [est]	0.1279	0.1196	0.1219	0.1219	0.1229	0.1138
Pearson5		Median	0.1316	0.1464	0.1463	0.1467	0.1467	0.1468	0.1422
Gamma	0.2317	Std. Deviation	0.0765	0,0885	0.0719	0.0725	0.0726	0.0733	0.0854
Rayleigh	0.2464	Skevness	0.8432	4.6772	1.3421	1,4454	1.4454	1.5405	2.8918
Erlang	0.2498	Kurtosis	3.3453	+Infinity	6.0022	6.9311	6.9311	7.8496	26.8605
Triang	0.2514	- Percentiles							
Weibull	0.2521	5%	0.0769	0.0688	0.0728	0.0723	0.0723	0.0721	0.0753
BetaGeneral	0,3390	10%	0.0769	0.0833	0.0845	0.0845	0.0845	0.0845	0.0857
Uniform	0.4665	15%	0.0769	0.0938	0.0937	0.0939	0.0939	0.0941	0.0938
Expon	0.8404	20%	0.0769	0,1026	0.1017	0.1021	0.1021	0.1023	0.1010
ChiSq	2.0761	25%	0.1261	0.1104	0.1092	0.1098	0.1098	0.1100	0.1077
Fareto	N/4	30%	0.1261	0.1178	0.1165	0.1171	0.1171	0.1173	0.1144
Pareto2	14/2	35%	0,1261	0.1249	0.1237	0.1243	0.1243	0,1245	0.1210
	1 martin	40%	0.1261	0.1319	0.1310		0.1316	0.1317	0.1278
		45%	0.1316	0.1390	0.1385	0.1390	0.1390	0.1391	0.1348
		50%	0.1316	0.1464	0.1463		0.1467	0.1468	0.1422
		55%	0.1316	0.1541	0.1545	0.1549	0.1549	0.1549	0.1503
		60%	0.1933	0.1624	0.1634		0.1636	0.1636	0.1590
		65%	0,1933	0.1716	0.1731	0.1732	0.1732	0,1731	0.1688
		70%	0.1933	0.1819	0.1731	0.1732	0.1839	0.1837	0.1800
		75%	0.1933	0.1819	0.1840		0.1859	0.1857	0.1800
				Contraction of the second second	and the second second				
		80%	0.1933	0.2089	0.2112	0.2108	0.2108	0.2105	0.2093
		85%	0.2759	0.2285	0.2298	0.2292	0.2292	0.2289	0.2306
		90%	0.2759	0,2573	0.2553	0.2547	0.2547	0.2545	0.2614
		95%	0.2759	0.3116	0.2979	0.2979	0.2979	0,2982	0.3177
		4		2. 2. 1. 1					•

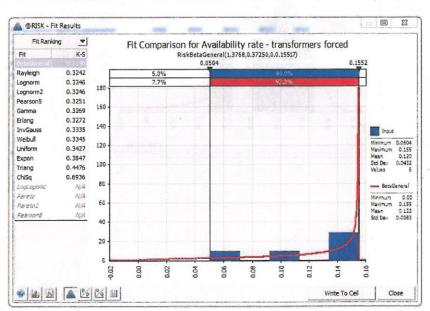
Table 14 Transformers - fault non-continuous distribution statistics table for A-D

Transformers outage rate - forced outage performance.

The data for forced unavailability of transformers is best fitted with a BetaGeneral distribution curve (figure 15) according to the K-S fit statistic. The A-D fit statistic has the Weibull distribution curve as the best fit (figure 16). As the data is distributed across both the middle and tails of the distribution, the A-D fit statistic is preferred (Weibull), giving a standard deviation of 0.034.

Tables 15 and 16 presents the variation in the distribution curve statistics between K-S and A-D fit statistics. The standard deviation for the curve of second best fit (Gama) is higher at 0.045 and for BetaGeneral is similar at 0.038.

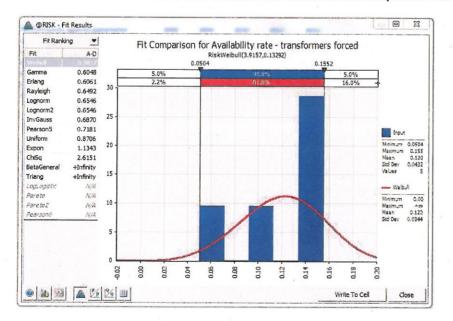




Fit Connect Co	K-S 0.3242 0.3246 0.3246 0.3251 0.3269 0.3272 0.3335	- Fit Function Distribution Stati Minimum Maximum Mean Mode Median	stics 0.0504 0.1552 0.1198	=RiskBetaG 0.0000 0.1552	0.0000	=RiskLogno	1000	=RiskPears.,	=RiskGamm
Lognorm Lognorm2 Pearson5 Gamma Erlang InvGauss Weibull	0.3242 0.3246 0.3246 0.3251 0.3251 0.3269 0.3272	- Distribution Stati Minimum Maximum Mean Mode	stics 0.0504 0.1552 0.1198	0.0000	0.0000	10000	1000	=RiskPears.,	=RiskGamm
Lognorm Lognorm2 Pearson5 Gamma Erlang InvGauss Weibull	0.3246 0.3246 0.3251 0.3269 0.3272	Minimum Maximum Mean Mode	0.0504 0.1552 0.1198			0.0000			
Lognorm2 Pearson5 Gamma Erlang InvGauss Weibull	0.3246 0.3251 0.3269 0.3272	Maximum Mean Mode	0.1552 0.1198						
Lognorm2 Pearson5 Gamma Erlang InvGauss Aleibull	0.3251 0.3269 0.3272	Mean Mode	0.1198	0.1552			0.0000	0.0000	0.0000
Gamma Erlang InvGauss Weibull	0.3251 0.3269 0.3272	Mode			+Infinity	+Infinity	+Infinity	+Infinity	+Infinity
Erlang InvGauss Weibull	0.3269 0.3272			0.1221	0.1116	0.1215	0.1215	0.1250	0.1198
InvGauss Neibull	0.3272	Median	0.0530 [est]	0.1552	0.0890	0.0935	0.0935	0.0843	0.1026
InvGauss Weibull		internet and the second	0.1429	0.1386	0.1048	0.1113	0.1113	0.1076	0.1141
Weibull		Std. Deviation	0.0432	0.0383	0.0583	0.0531	0.0531	0.0705	0.0454
	0.3345	Skewness	-1.3663	-1.2404	0.6311	1.3945	1.3945	3.3120	0.7575
or ne or the	0.3427	Kurtosis	4.1651	3.5586	3.2451	6.6461	6.6461	39, 1476	3.8607
Expon	0.3847	- Percentiles				CELEBRE C	1993		
Triang	0.4476	5%	0.0504	0.0380	0.0285	0.0560	0.0560	0.0554	0.0561
ChiSq	0.6936	10%	0.0504	0.0598	0.0409	0.0651	0.0651	0.0633	0.0666
Loci ocistic	0.0930 ASA	15%	0.0504	0.0767	0.0507	0.0722	0.0722	0.0696	0.0743
Pareio	N/A	20%	0.0504	0.0906	0.0595	0.0783	0.0783	0.0751	0.0809
Pareto2	1.	25%	0.1053	0.1022	0.0675	0.0840	0.0840	0.0804	0.0869
Pearson6	NA	30%	0.1053	0.1121	0.0752	0.0894	0.0894	0.0856	0.0925
rearsone	NA	35%	0.1053	0.1204	0.0826	0.0948	0.0948	0.0908	0.0980
		40%	0.1053	0.1275	0.0900	0.1001	0.1001	0.0961	0.1033
	100	45%	0.1429	0.1335	0.0973	0.1056	0.1056	0.1017	0.1087
		50%	0.1429	0.1386	0.1048	0.1113	0.1113	0.1076	0.1141
	18	55%	0.1429	0.1428	0.1125	0.1173	0.1173	0.1139	0.1198
	11.51	60%	0.1453	0.1462	0.1205	0.1238	0.1238	0.1209	0.1257
	0.00	65%	0.1453	0.1489	0.1290	0.1308	0.1308	0.1288	0.1320
	1.00	70%	0.1453	0.1511	0.1381	0.1386	0.1386	0.1378	0.1388
	100	75%	0.1453	0.1527	0.1482	0,1476	0.1476	0.1484	0.1465
	1	80%	0.1453	0.1538	0.1597	0.1583	0.1583	0.1616	0.1554
		85%	0.1552	0.1545	0.1734	0.1717	0.1717	0.1790	0.1662
	1.01	90%	0,1552	0.1550	0.1910	0.1902	0.1902	0.2044	0.1804
	1	95%	0,1552	0.1551	0.2179	0.2214	0.2214	0.2515	0.2029
	2010		JIIOJL		1	VILL11	0.2217	0.2313	0.2029

Table 15 Transformers - forced non-continuous distribution statistics table for K-S

Figure 16 Transformers - forced non-continuous distribution comparison using A-D



Fit Rank	ng 💌		Input	Weibuli	Gamma	Erlang	Rayleigh	Lognorm	Lognorm2	
Fit	A-D	- Fit Function		Rick Melhu =	RickGamm =	RickErland	-DickRavlei	=RiskLoano :	-Ricklagoo	- inter
	0.5817	- Distribution Stati			Conversion -	- Carden Kan Igra	- and a great	-realize griefit	-idadeografi	1
Gamma	0.6048	Minimum	0.0504	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1
Erlang	0.6061	Maximum	0.1552	+Infinity	+Infinity	+Infinity	+Infinity	+Infinity	+Infinity	12
Rayleigh	0.6492	Mean	0,1198	0.1203	0.1198	0.1198	0.1116	0.1215	0.1215	12
Lognorm	0.6546	Mode	0.0530 [est]	0.1233	0.1026	0.1027	0.0890	0.0935	0.0935	
Lognorm2	0.6546	Median	0,1429	0.1210	0.1141	0.1141	0.1048	0.1113	0.1113	1
InvGauss	0.6870	Std. Deviation	0.0432	0.0344	0.0454	0.0453	0.0583	0.0531	0.0531	1
Pearson5	0.7181	Skewness	-1.3663	-0.0700	0.7575	0.7559	0.6311	1,3945	1.3945	1
Uniform	0.8706	Kurtosis	4.1651	2,7396	3.8607	3.8571	3.2451	6.6461	6.6461	1
Expon	1.1343	- Percentiles		217530	5.0007	5.0371	U.L.IJI	0.0104	0.0.01	1
ChiSq	2.6151	5%	0.0504	0.0623	0.0561	0.0562	0.0285	0.0560	0.0560	
BetaGeneral	+Infinity	10%	0.0504	0.0748	0.0666	0.0667	0.0409	0.0651	0.0651	
Triang	+Infinity	15%	0.0504	0.0836	0.0743	0.0744	0.0507	0.0722	0.0722	
optopistic	Ni/A	20%	0,0504	0.0906	0.0809	0.0810	0.0595	0.0783	0.0783	
Pareto	NA	25%	0,1053	0.0967	0.0869	0.0870	0.0675	0.0840	0.0840	
Pareto 2	N/A	30%	0.1053	0.1022	0.0925	0.0926	0.0752	0.0894	0.0894	
Fearsonő	N/4	35%	0.1053	0.1072	0.0980	0.0980	0.0826	0.0948	0.0948	
		40%	0.1053	0.1120	0.1033	0.1034	0.0900	0,1001	0,1001	
		45%	0,1429	0.1166	0.1087	0.1087	0,0973	0.1056	0.1056	
		50%	0.1429	0.1210	0.1141	0.1141	0.1048	0.1113	0.1113	
		55%	0,1429	0.1255	0.1198	0.1198	0.1125	0.1173	0.1173	
		60%	0.1453	0.1300	0.1257	0.1257	0.1205	0.1238	0.1238	
		65%	0.1453	0.1346	0,1320	0.1320	0,1290	0,1308	0,1308	
		70%	0.1453	0.1394	0.1388	0.1388	0.1381	0.1386	0.1386	
		75%	0.1453	0.1445	0.1465	0.1465	0.1482	0.1476	0.1476	
		80%	0,1453	0.1501	0.1554	0.1553	0.1597	0.1583	0.1583	
		85%	0.1552	0.1565	0.1662	0.1661	0.1734	0.1717	0.1717	
		90%	0,1552	0,1645	0.1804	0.1803	0.1910	0.1902	0.1902	
		95%	0.1552	0.1759	0.2029	0.2027	0.2179	0.2214	0.2214	
		(1					
1 10. 1 100	- fine	12/1						*		

Table 16 Transformers - forced non-continuous distribution statistics table for A-D

3. Summary of findings

Table 17 summarises the probability distribution functions that have been chosen to best fit the parameter data (table 18). In Parsons Brinckerhoff's view this approach is robust and does not seem to be sensitive to the choice of distribution function, because the results were close for the next best fit distributions. The approach is also consistent with the Australian Energy Regulator's previous regulatory decisions to use a curve of best fit approach.

Table 17 Summary of best fit distributions

Parameter	Best fit distribution	Standard Deviation
Average outage duration	Exponential	97.96
No. of events >0.05 system minutes	NegBin	2.000
No. of events >0.30 system minutes	IntUniform	0.816
Lines outage rate - fault	LogLogistic	0.090
Lines outage rate - forced outage	Pearson5	0.017
Reactive plant outage rate - fault	LogLogistic	0.064
Reactive plant outage rate - forced outage	Rayleigh	0.076
Transformers outage rate - fault	Pearson5	0.085
Transformers outage rate - forced outage	Weibull	0.034

Table 18 Reliability Data 2008-2012

Parameter	2008	2009	2010	2011	2012
Average outage duration	71.5	91.8	92.5	4.0	230.0
No. of events >0.05 system minutes	1	6	1	0	2
No. of events >0.30 system minutes	1	2	0	0	1
Lines outage rate - fault	20.0%	35.8%	16.8%	24.4%	32.5%
Lines outage rate - forced outage	16.7%	12.5%	14.3%	16.8%	14.2%
Reactive plant outage rate - fault	28.6%	35.1%	24.7%	32.5%	41.6%
Reactive plant outage rate - forced outage	6.5%	9.1%	13.0%	24.7%	20.8%
Transformers outage rate - fault	13.2%	27.6%	7.7%	12.6%	19.3%
Transformers outage rate - forced outage	10.5%	15.5%	14.5%	5.0%	14.3%