



# CCF Parameter Estimations 2010

U.S. Nuclear Regulatory Commission, "CCF Parameter  
Estimations, 2010 Update"

This report documents the quantitative results of the common-cause failure (CCF) data collection effort and summarizes the results of the parameter estimation quantification process, performed on CCF data in the U.S. NRC CCF database.

1/26/2012



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This report documents the quantitative results of the common-cause failure (CCF) data collection effort and summarizes the results of the parameter estimation quantification process, performed on CCF data in the U.S. NRC CCF database.

These results are appropriate for use in Probabilistic Risk Assessment studies of commercial nuclear power plants in the U.S.

Included in these results are the applications to be used in the SPAR Version greater than 3.45 models. This is the 2010 update to NUREG/CR-5496, updating data and parameter estimations.

This release, CCF Parameter Estimation for 2010, reflects the CCF data contained within the CCF database, Version 4.5.2010. This version of the CCF database contains data from 1997 to 2010.

The applications contained within were created with a starting date of 1/1/1997. This date was selected in order to use as much of the CCF data as possible, but to avoid using the large number of CCF events in the 1980 to 1996 period since the trend is decreasing significantly from 1980 to 1996.

The way to provide a reference for this update is:

U.S. Nuclear Regulatory Commission, "CCF Parameter Estimations, 2010 Update", <http://nrcoe.inl.gov/results/CCF/ParamEst2010/ccfparamest.htm>, January 2012.



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### *General CCF Information*

A general conclusion from probabilistic risk assessments (PRAs) of commercial nuclear power plants is that common cause failures (CCFs) are significant contributors to the unavailability of safety systems. A CCF event consists of component failures that meet the following four criteria: (1) two or more components fail or are degraded at the same plant and in the same system, (2) component failures occur within a selected period of time such that success of the PRA mission would be uncertain, (3) the component failures result from a single shared cause and are linked by a coupling mechanism such that other components in the group are susceptible to the same cause and failure mode and, (4) the equipment failures are not caused by the failure of equipment outside the established component boundary.

In response to these deficiencies, the Idaho National Laboratory (INL) staff and the Nuclear Regulatory Commission's (NRC) Office of Nuclear Regulatory Research have developed a CCF data collection and analysis system that includes a method for identifying CCF events, coding and classifying those events for use in CCF studies, and a computer system for storing and analyzing the data. The system is based, in part, on previous CCF methods and models and is designed to run on a personal computer (PC). The data collection effort has collected CCF events from 1980 through 2010 for use in CCF analyses. The current data collection effort has separated the data by system. The principal products of this CCF data collection and analysis system (CCF database) are the method for identifying and classifying CCF events, the CCF database containing both CCF events and independent failure counts, and the CCF parameter estimation software.

Three data sources are used to select equipment failure reports to be reviewed for CCF event identification: the Nuclear Plant Reliability Data System (NPRDS), which contained component failure information prior to 1997; the Equipment Performance and Information Exchange (EPIX), which contains component failure information since 1997; and the Sequence Coding and Search System (SCSS), which contains Licensee Event Reports (LERs). All events that meet the above criteria are identified as CCF events and included in the CCF database.





# Industry Component CCF Introduction

This section contains CCF applications created for components pooled at various levels. The first level presented is the industry-wide component specific pooled distribution. The pooled distribution represents the pooling of the more specific distributions shown under the pooled distribution. Typically, the pooling takes place across systems.

It is up to the user to decide the level of pooling that is appropriate to the intended use. If data exist at the system/component level most appropriate to the intended use, and are not sparse, it is recommended to use the more specific data. Otherwise, it is recommended to use the industry level pooled component data. If no pooled components are listed that are similar to the intended use, the use of the Generic Demand, Generic Rate, or the No Data (Prior Only) pooled distribution may be appropriate.

This update to the parameter estimation report includes the SPAR alpha factor basic event name to facilitate the cross reference of this report to the SPAR models. The SPAR basic event name can be found in the title of the application report and in the topic text if SPAR uses the parameter estimate.



## Motor Driven Pumps

### Pooled Motor Driven Pump Distributions

#### MOTOR DRIVEN PUMP FAIL TO START ALL SYSTEMS SPAR: MDP-FS

Component : Motor Driven Pump  
 Failure Mode : Fail to start  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 557.40  
 Total Number of Common-Cause Failure Events: 23

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9608200	0.9750580	0.9758710	0.9865300	0.9755030	3.7868E+02	9.6868E+00
$\alpha_2$	1.35E-02	2.49E-02	2.41E-02	3.92E-02	2.45E-02	9.6868E+00	3.7868E+02

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9650900	0.9762240	0.9767570	0.9855350	0.9768880	5.7666E+02	1.4045E+01
$\alpha_2$	7.22E-03	1.42E-02	1.36E-02	2.30E-02	1.35E-02	8.3706E+00	5.8233E+02
$\alpha_3$	4.08E-03	9.61E-03	9.06E-03	1.70E-02	9.65E-03	5.6739E+00	5.8503E+02

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9667980	0.9763300	0.9767290	0.9844910	0.9773010	7.7044E+02	1.8678E+01
$\alpha_2$	7.37E-03	1.33E-02	1.29E-02	2.06E-02	1.25E-02	1.0495E+01	7.7862E+02
$\alpha_3$	2.72E-03	6.68E-03	6.26E-03	1.20E-02	6.56E-03	5.2679E+00	7.8385E+02
$\alpha_4$	9.84E-04	3.69E-03	3.28E-03	7.81E-03	3.63E-03	2.9155E+00	7.8620E+02

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9710010	0.9788930	0.9792070	0.9857150	0.9804490	1.0000E+03	2.1563E+01
$\alpha_2$	4.88E-03	9.18E-03	8.86E-03	1.46E-02	7.88E-03	9.3749E+00	1.0122E+03
$\alpha_3$	2.99E-03	6.51E-03	6.19E-03	1.11E-02	6.16E-03	6.6546E+00	1.0149E+03
$\alpha_4$	1.41E-03	4.03E-03	3.71E-03	7.74E-03	4.06E-03	4.1161E+00	1.0174E+03
$\alpha_5$	1.48E-04	1.39E-03	1.08E-03	3.68E-03	1.46E-03	1.4170E+00	1.0201E+03

##### CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9739920	0.9808480	0.9811070	0.9868090	0.9826230	1.2002E+03	2.3435E+01
$\alpha_2$	3.48E-03	6.85E-03	6.58E-03	1.11E-02	5.57E-03	8.3787E+00	1.2153E+03
$\alpha_3$	2.48E-03	5.41E-03	5.14E-03	9.25E-03	4.97E-03	6.6207E+00	1.2170E+03
$\alpha_4$	1.57E-03	4.02E-03	3.76E-03	7.38E-03	3.93E-03	4.9226E+00	1.2187E+03
$\alpha_5$	5.70E-04	2.25E-03	1.99E-03	4.84E-03	2.30E-03	2.7582E+00	1.2209E+03
$\alpha_6$	1.40E-05	6.17E-04	3.75E-04	2.04E-03	6.10E-04	7.5524E-01	1.2229E+03

Pooled Motor Driven Pump Distributions

MOTOR DRIVEN PUMP FAIL TO START ALL SYSTEMS SPAR: MDP-FS

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9755030	0.9768880	0.9773010	0.9804490	0.9826230
$\alpha_2$	2.45E-02	1.35E-02	1.25E-02	7.88E-03	5.57E-03
$\alpha_3$		9.65E-03	6.56E-03	6.16E-03	4.97E-03
$\alpha_4$			3.63E-03	4.06E-03	3.93E-03
$\alpha_5$				1.46E-03	2.30E-03
$\alpha_6$					6.10E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.76E-01	9.77E-01	9.77E-01	9.80E-01	9.83E-01
Beta	2.45E-02	2.31E-02	2.27E-02	1.96E-02	1.74E-02
Gamma		4.18E-01	4.49E-01	5.97E-01	6.80E-01
Delta			3.56E-01	4.73E-01	5.79E-01
Epsilon				2.64E-01	4.26E-01
Mu					2.09E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	356.17	534.25	712.33	890.42	1068.50
$N_1$	12.2620	12.8561	11.9692	13.4597	14.7926
$N_2$	9.2523	7.5369	9.2664	7.2607	6.1395
$N_3$		5.4067	4.8636	5.6772	5.4789
$N_4$			2.6928	3.7417	4.3304
$N_5$				1.3447	2.5360
$N_6$					0.6720

Motor Driven Pumps  
Pooled Motor Driven Pump Distributions  
MOTOR DRIVEN PUMP FTR LESS THAN 1H ALL SYSTEMS  
**MOTOR DRIVEN PUMP FTR LESS THAN 1H ALL SYSTEMS**

Component : Motor Driven Pump  
Failure Mode : Fail to Run less than 1 Hour  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 42.80

Total Number of Common-Cause Failure Events: 4

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8985690	0.9573340	0.9641160	0.9928560	0.9566930	4.1909E+01	1.8678E+00
$\alpha_2$	7.15E-03	4.27E-02	3.59E-02	1.01E-01	4.33E-02	1.8678E+00	4.1909E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9147280	0.9572930	0.9610980	0.9868490	0.9529990	7.5785E+01	3.3809E+00
$\alpha_2$	8.00E-03	3.29E-02	2.90E-02	7.10E-02	3.65E-02	2.6037E+00	7.6562E+01
$\alpha_3$	2.48E-04	9.82E-03	6.11E-03	3.20E-02	1.05E-02	7.7722E-01	7.8389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9145520	0.9517650	0.9544500	0.9798040	0.9445280	1.0612E+02	5.3781E+00
$\alpha_2$	1.23E-02	3.56E-02	3.28E-02	6.82E-02	4.31E-02	3.9641E+00	1.0753E+02
$\alpha_3$	3.72E-04	8.43E-03	5.73E-03	2.57E-02	8.44E-03	9.4031E-01	1.1056E+02
$\alpha_4$	1.25E-05	4.25E-03	1.85E-03	1.66E-02	3.95E-03	4.7367E-01	1.1102E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9316870	0.9587200	0.9604300	0.9799160	0.9513600	1.7077E+02	7.3529E+00
$\alpha_2$	8.76E-03	2.41E-02	2.24E-02	4.56E-02	2.79E-02	4.3015E+00	1.7382E+02
$\alpha_3$	2.24E-03	1.18E-02	1.00E-02	2.74E-02	1.43E-02	2.1001E+00	1.7602E+02
$\alpha_4$	9.59E-05	4.23E-03	2.58E-03	1.40E-02	4.84E-03	7.5389E-01	1.7737E+02
$\alpha_5$	9.40E-10	1.11E-03	1.11E-04	5.73E-03	1.60E-03	1.9738E-01	1.7793E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9368060	0.9607400	0.9621630	0.9798080	0.9555920	2.0608E+02	8.4212E+00
$\alpha_2$	6.91E-03	1.95E-02	1.80E-02	3.71E-02	2.07E-02	4.1747E+00	2.1033E+02
$\alpha_3$	2.53E-03	1.13E-02	9.83E-03	2.52E-02	1.38E-02	2.4265E+00	2.1207E+02
$\alpha_4$	4.38E-04	5.60E-03	4.16E-03	1.57E-02	6.53E-03	1.2016E+00	2.1330E+02
$\alpha_5$	6.41E-06	2.20E-03	9.55E-04	8.63E-03	2.69E-03	4.7270E-01	2.1403E+02
$\alpha_6$	3.47E-12	6.79E-04	2.54E-05	3.76E-03	6.70E-04	1.4574E-01	2.1436E+02

Motor Driven Pumps  
Pooled Motor Driven Pump Distributions  
MOTOR DRIVEN PUMP FTR LESS THAN 1H ALL SYSTEMS  
*ALPHA FACTOR and MGL PARAMETERS*

2010

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9566930	0.9529990	0.9445280	0.9513600	0.9555920
$\alpha_2$	4.33E-02	3.65E-02	4.31E-02	2.79E-02	2.07E-02
$\alpha_3$		1.05E-02	8.44E-03	1.43E-02	1.38E-02
$\alpha_4$			3.95E-03	4.84E-03	6.53E-03
$\alpha_5$				1.60E-03	2.69E-03
$\alpha_6$					6.70E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.57E-01	9.53E-01	9.45E-01	9.51E-01	9.56E-01
Beta	4.33E-02	4.70E-02	5.55E-02	4.86E-02	4.44E-02
Gamma		2.24E-01	2.23E-01	4.27E-01	5.33E-01
Delta			3.19E-01	3.10E-01	4.18E-01
Epsilon				2.48E-01	3.39E-01
Mu					2.00E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	28.53	42.80	57.07	71.33	85.60
$N_1$	3.1333	3.4300	2.9160	3.2805	3.5429
$N_2$	1.4333	1.7700	2.7360	2.1873	1.9355
$N_3$		0.5100	0.5360	1.1227	1.2847
$N_4$			0.2510	0.3795	0.6094
$N_5$				0.1251	0.2505
$N_6$					0.0625

Motor Driven Pumps  
Pooled Motor Driven Pump Distributions  
MOTOR DRIVEN PUMP FAIL TO RUN >1H ALL SYSTEMS  
**MOTOR DRIVEN PUMP FAIL TO RUN >1H ALL SYSTEMS**

Component : Motor Driven Pump  
Failure Mode : Fail to Run >1 Hour (Standby equipment)  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 128.20

Total Number of Common-Cause Failure Events: 8

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9340410	0.9687610	0.9721660	0.9918260	0.9700320	8.7273E+01	2.8142E+00
$\alpha_2$	8.18E-03	3.12E-02	2.78E-02	6.60E-02	3.00E-02	2.8142E+00	8.7273E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9320010	0.9611610	0.9632330	0.9832490	0.9603910	1.4173E+02	5.7271E+00
$\alpha_2$	1.23E-02	3.19E-02	2.98E-02	5.87E-02	3.31E-02	4.7035E+00	1.4275E+02
$\alpha_3$	3.80E-04	6.94E-03	4.88E-03	2.06E-02	6.48E-03	1.0236E+00	1.4643E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9370740	0.9615800	0.9630990	0.9808990	0.9616540	1.9399E+02	7.7510E+00
$\alpha_2$	8.88E-03	2.32E-02	2.17E-02	4.29E-02	2.25E-02	4.6842E+00	1.9706E+02
$\alpha_3$	3.08E-03	1.29E-02	1.13E-02	2.80E-02	1.42E-02	2.5933E+00	1.9915E+02
$\alpha_4$	6.89E-06	2.35E-03	1.02E-03	9.18E-03	1.63E-03	4.7347E-01	2.0127E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9476420	0.9665910	0.9676550	0.9818990	0.9676800	2.8065E+02	9.7003E+00
$\alpha_2$	5.97E-03	1.58E-02	1.47E-02	2.95E-02	1.30E-02	4.5989E+00	2.8575E+02
$\alpha_3$	3.15E-03	1.09E-02	9.85E-03	2.25E-02	1.15E-02	3.1788E+00	2.8717E+02
$\alpha_4$	8.69E-04	5.94E-03	4.85E-03	1.47E-02	7.09E-03	1.7252E+00	2.8863E+02
$\alpha_5$	5.76E-10	6.80E-04	6.82E-05	3.52E-03	6.56E-04	1.9738E-01	2.9015E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9528690	0.9693930	0.9702890	0.9828700	0.9718920	3.3805E+02	1.0673E+01
$\alpha_2$	4.13E-03	1.18E-02	1.09E-02	2.26E-02	8.25E-03	4.1164E+00	3.4461E+02
$\alpha_3$	2.66E-03	9.18E-03	8.26E-03	1.88E-02	9.05E-03	3.2010E+00	3.4552E+02
$\alpha_4$	1.20E-03	6.16E-03	5.25E-03	1.43E-02	6.84E-03	2.1495E+00	3.4657E+02
$\alpha_5$	1.80E-04	3.04E-03	2.16E-03	8.91E-03	3.69E-03	1.0608E+00	3.4766E+02
$\alpha_6$	2.13E-12	4.18E-04	1.56E-05	2.31E-03	2.75E-04	1.4574E-01	3.4858E+02

Motor Driven Pumps  
Pooled Motor Driven Pump Distributions  
MOTOR DRIVEN PUMP FAIL TO RUN >1H ALL SYSTEMS  
*ALPHA FACTOR and MGL PARAMETERS*

2010

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9700320	0.9603910	0.9616540	0.9676800	0.9718920
$\alpha_2$	3.00E-02	3.31E-02	2.25E-02	1.30E-02	8.25E-03
$\alpha_3$		6.48E-03	1.42E-02	1.15E-02	9.05E-03
$\alpha_4$			1.63E-03	7.09E-03	6.84E-03
$\alpha_5$				6.56E-04	3.69E-03
$\alpha_6$					2.75E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.70E-01	9.60E-01	9.62E-01	9.68E-01	9.72E-01
Beta	3.00E-02	3.96E-02	3.83E-02	3.23E-02	2.81E-02
Gamma		1.64E-01	4.14E-01	5.97E-01	7.06E-01
Delta			1.03E-01	4.01E-01	5.44E-01
Epsilon				8.48E-02	3.67E-01
Mu					6.94E-02

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	73.26	109.89	146.51	183.14	219.77
$N_1$	3.7673	2.2812	1.3486	1.3532	1.3444
$N_2$	2.3797	3.8698	3.4561	2.4847	1.8772
$N_3$		0.7564	2.1890	2.2014	2.0592
$N_4$			0.2508	1.3508	1.5573
$N_5$				0.1251	0.8386
$N_6$					0.0625



Motor Driven Pumps  
Pooled Motor Driven Pump Distributions  
MOTOR DRIVEN PUMP FAIL TO RUN ALL SYSTEMS SPAR: MDP-FR  
**MOTOR DRIVEN PUMP FAIL TO RUN ALL SYSTEMS SPAR: MDP-FR**

2010

Component : Motor Driven Pump  
Failure Mode : Fail to Run >1 Hour (Standby equipment)  
Fail to Run less than 1 Hour  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 171.00  
Total Number of Common-Cause Failure Events: 12

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9354480	0.9657730	0.9682500	0.9876320	0.9663800	1.1985E+02	4.2475E+00
$\alpha_2$	1.24E-02	3.42E-02	3.18E-02	6.46E-02	3.36E-02	4.2475E+00	1.1985E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9340330	0.9594220	0.9609680	0.9795370	0.9585630	1.8932E+02	8.0071E+00
$\alpha_2$	1.50E-02	3.28E-02	3.12E-02	5.60E-02	3.38E-02	6.4735E+00	1.9085E+02
$\alpha_3$	9.51E-04	7.77E-03	6.18E-03	2.00E-02	7.60E-03	1.5336E+00	1.9579E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9358230	0.9577890	0.9589260	0.9758660	0.9570100	2.5581E+02	1.1274E+01
$\alpha_2$	1.35E-02	2.78E-02	2.66E-02	4.61E-02	2.83E-02	7.4202E+00	2.5966E+02
$\alpha_3$	3.33E-03	1.17E-02	1.05E-02	2.42E-02	1.24E-02	3.1293E+00	2.6395E+02
$\alpha_4$	5.35E-05	2.71E-03	1.61E-03	9.11E-03	2.29E-03	7.2447E-01	2.6636E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9463100	0.9635780	0.9644110	0.9780160	0.9632360	3.5755E+02	1.3515E+01
$\alpha_2$	8.51E-03	1.83E-02	1.74E-02	3.10E-02	1.72E-02	6.7862E+00	3.6428E+02
$\alpha_3$	4.18E-03	1.16E-02	1.07E-02	2.20E-02	1.22E-02	4.3015E+00	3.6676E+02
$\alpha_4$	1.08E-03	5.67E-03	4.81E-03	1.32E-02	6.38E-03	2.1047E+00	3.6896E+02
$\alpha_5$	1.76E-07	8.69E-04	2.38E-04	3.88E-03	9.22E-04	3.2248E-01	3.7074E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9516120	0.9666870	0.9673830	0.9793760	0.9674300	4.2994E+02	1.4816E+01
$\alpha_2$	5.98E-03	1.36E-02	1.29E-02	2.37E-02	1.18E-02	6.0520E+00	4.3870E+02
$\alpha_3$	3.73E-03	1.01E-02	9.36E-03	1.89E-02	1.03E-02	4.4857E+00	4.4027E+02
$\alpha_4$	1.57E-03	6.20E-03	5.48E-03	1.33E-02	6.70E-03	2.7589E+00	4.4200E+02
$\alpha_5$	2.73E-04	2.95E-03	2.25E-03	8.03E-03	3.37E-03	1.3114E+00	4.4344E+02
$\alpha_6$	8.35E-10	4.68E-04	5.40E-05	2.39E-03	3.86E-04	2.0824E-01	4.4455E+02

Pooled Motor Driven Pump Distributions

MOTOR DRIVEN PUMP FAIL TO RUN ALL SYSTEMS SPAR: MDP-FR

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9663800	0.9585630	0.9570100	0.9632360	0.9674300
$\alpha_2$	3.36E-02	3.38E-02	2.83E-02	1.72E-02	1.18E-02
$\alpha_3$		7.60E-03	1.24E-02	1.22E-02	1.03E-02
$\alpha_4$			2.29E-03	6.38E-03	6.70E-03
$\alpha_5$				9.22E-04	3.37E-03
$\alpha_6$					3.86E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.66E-01	9.59E-01	9.57E-01	9.63E-01	9.67E-01
Beta	3.36E-02	4.14E-02	4.30E-02	3.68E-02	3.26E-02
Gamma		1.83E-01	3.43E-01	5.32E-01	6.38E-01
Delta			1.56E-01	3.73E-01	5.03E-01
Epsilon				1.26E-01	3.59E-01
Mu					1.03E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	102.70	154.05	205.41	256.76	308.11
$N_1$	6.9007	5.7112	4.2646	4.6337	4.8873
$N_2$	3.8130	5.6398	6.1921	4.6720	3.8128
$N_3$		1.2664	2.7250	3.3241	3.3439
$N_4$			0.5018	1.7303	2.1667
$N_5$				0.2502	1.0892
$N_6$					0.1250

**Pooled Pump Volutes**

**CLEAN SYSTEM PUMP VOLUTES FAIL TO RUN SPAR: PMP-FR**

**System :** Chemical and volume control  
Component cooling water  
Auxiliary feedwater  
Containment spray recirculation  
Low pressure core spray  
Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
Standby liquid control

**Component :** Motor Driven Pump

**Failure Mode :** Fail to Run (Normally running equipment)  
Fail to Run >1 Hour (Standby equipment)  
Fail to Run less than 1 Hour

**Subcomponent :** Pump

**Start Date :** 1997/01/01

**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 97.00  
Total Number of Common-Cause Failure Events: 3

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9575160	0.9818490	0.9846320	0.9966690	0.9842210	1.1005E+02	2.0345E+00
$\alpha_2$	3.33E-03	1.82E-02	1.54E-02	4.25E-02	1.58E-02	2.0345E+00	1.1005E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9624930	0.9813850	0.9831210	0.9943370	0.9848970	1.7824E+02	3.3809E+00
$\alpha_2$	2.81E-03	1.30E-02	1.12E-02	2.91E-02	1.01E-02	2.3537E+00	1.7927E+02
$\alpha_3$	3.12E-04	5.66E-03	3.98E-03	1.67E-02	5.03E-03	1.0272E+00	1.8059E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9647320	0.9808580	0.9821320	0.9926260	0.9855330	2.4355E+02	4.7531E+00
$\alpha_2$	2.73E-03	1.09E-02	9.65E-03	2.35E-02	7.42E-03	2.7141E+00	2.4559E+02
$\alpha_3$	6.38E-04	5.80E-03	4.54E-03	1.53E-02	5.17E-03	1.4403E+00	2.4686E+02
$\alpha_4$	2.25E-05	2.41E-03	1.27E-03	8.67E-03	1.88E-03	5.9867E-01	2.4770E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9842210	0.9848970	0.9855330
$\alpha_2$	1.58E-02	1.01E-02	7.42E-03
$\alpha_3$		5.03E-03	5.17E-03
$\alpha_4$			1.88E-03

CLEAN SYSTEM PUMP VOLUTES FAIL TO RUN SPAR: PMP-FR

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.84E-01	9.85E-01	9.86E-01
Beta	1.58E-02	1.51E-02	1.45E-02
Gamma		3.33E-01	4.87E-01
Delta			2.66E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4
Adj. Ind. Events	97.00	145.50	194.00
N <sub>1</sub>	2.8000	3.1800	3.4160
N <sub>2</sub>	1.6000	1.5200	1.4860
N <sub>3</sub>		0.7600	1.0360
N <sub>4</sub>			0.3760

**Pooled Clean System Motor Driven Pump Distributions**  
**CLEAN SYSTEM MOTOR DRIVEN PUMPS FAIL TO START SPAR: MDP-FS**

**System :** Chemical and volume control  
 Component cooling water  
 Auxiliary feedwater  
 Containment spray recirculation  
 High pressure core spray  
 High pressure coolant injection  
 High pressure injection  
 Low pressure core spray  
 Reactor core isolation  
 Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
 Standby liquid control

**Component :** Motor Driven Pump

**Failure Mode :** Fail to start

**Start Date :** 1997/01/01

**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 381.00  
 Total Number of Common-Cause Failure Events: 15

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9552730	0.9721350	0.9731390	0.9855530	0.9725900	3.0228E+02	8.6645E+00
$\alpha_2$	1.44E-02	2.79E-02	2.69E-02	4.47E-02	2.74E-02	8.6645E+00	3.0228E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9639610	0.9764120	0.9770780	0.9866010	0.9772600	4.6476E+02	1.1228E+01
$\alpha_2$	5.07E-03	1.19E-02	1.13E-02	2.11E-02	1.09E-02	5.6787E+00	4.7031E+02
$\alpha_3$	4.89E-03	1.17E-02	1.10E-02	2.07E-02	1.19E-02	5.5489E+00	4.7044E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9670490	0.9774790	0.9779790	0.9862160	0.9787930	6.2324E+02	1.4359E+01
$\alpha_2$	5.16E-03	1.10E-02	1.05E-02	1.85E-02	9.77E-03	6.9894E+00	6.3061E+02
$\alpha_3$	2.63E-03	7.08E-03	6.58E-03	1.33E-02	6.97E-03	4.5167E+00	6.3308E+02
$\alpha_4$	1.17E-03	4.47E-03	3.97E-03	9.51E-03	4.46E-03	2.8530E+00	6.3475E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9711420	0.9797600	0.9801400	0.9870710	0.9818320	8.1651E+02	1.6868E+01
$\alpha_2$	3.69E-03	8.02E-03	7.63E-03	1.37E-02	6.23E-03	6.6839E+00	8.2669E+02
$\alpha_3$	2.44E-03	6.11E-03	5.72E-03	1.11E-02	5.60E-03	5.0884E+00	8.2829E+02
$\alpha_4$	1.44E-03	4.45E-03	4.06E-03	8.79E-03	4.55E-03	3.7099E+00	8.2967E+02
$\alpha_5$	1.70E-04	1.66E-03	1.29E-03	4.44E-03	1.79E-03	1.3857E+00	8.3199E+02

Pooled Clean System Motor Driven Pump Distributions

CLEAN SYSTEM MOTOR DRIVEN PUMPS FAIL TO START SPAR: MDP-FS

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9740970	0.9815920	0.9819100	0.9879940	0.9839250	9.8042E+02	1.8386E+01
$\alpha_2$	2.73E-03	6.17E-03	5.84E-03	1.07E-02	4.47E-03	6.1598E+00	9.9265E+02
$\alpha_3$	1.90E-03	4.88E-03	4.55E-03	8.97E-03	4.25E-03	4.8699E+00	9.9394E+02
$\alpha_4$	1.42E-03	4.08E-03	3.76E-03	7.86E-03	3.97E-03	4.0769E+00	9.9473E+02
$\alpha_5$	5.93E-04	2.54E-03	2.22E-03	5.60E-03	2.64E-03	2.5395E+00	9.9627E+02
$\alpha_6$	1.57E-05	7.41E-04	4.45E-04	2.47E-03	7.48E-04	7.3964E-01	9.9807E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9725900	0.9772600	0.9787930	0.9818320	0.9839250
$\alpha_2$	2.74E-02	1.09E-02	9.77E-03	6.23E-03	4.47E-03
$\alpha_3$		1.19E-02	6.97E-03	5.60E-03	4.25E-03
$\alpha_4$			4.46E-03	4.55E-03	3.97E-03
$\alpha_5$				1.79E-03	2.64E-03
$\alpha_6$					7.48E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.73E-01	9.77E-01	9.79E-01	9.82E-01	9.84E-01
Beta	2.74E-02	2.27E-02	2.12E-02	1.82E-02	1.61E-02
Gamma		5.22E-01	5.39E-01	6.57E-01	7.22E-01
Delta			3.90E-01	5.31E-01	6.34E-01
Epsilon				2.83E-01	4.60E-01
Mu					2.21E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	285.39	428.09	570.79	713.48	856.18
$N_1$	6.6400	7.1150	6.3171	6.8643	7.3041
$N_2$	8.2300	4.8450	5.7613	4.5697	3.9206
$N_3$		5.2817	4.1124	4.1110	3.7281
$N_4$			2.6303	3.3355	3.4847
$N_5$				1.3134	2.3173
$N_6$					0.6564

Motor Driven Pumps  
Pooled Clean System Motor Driven Pump Distributions  
CLEAN SYSTEM MDP-FTR LESS THAN 1 HOUR  
**CLEAN SYSTEM MDP-FTR LESS THAN 1 HOUR**

2010

**System :** Chemical and volume control  
Component cooling water  
Auxiliary feedwater  
Containment spray recirculation  
High pressure core spray  
High pressure coolant injection  
High pressure injection  
Low pressure core spray  
Reactor core isolation  
Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
Standby liquid control

**Component :** Motor Driven Pump

**Failure Mode :** Fail to Run less than 1 Hour

**Start Date :** 1997/01/01

**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 23.20  
Total Number of Common-Cause Failure Events: 3

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8696580	0.9464930	0.9556130	0.9920580	0.9400050	3.0093E+01	1.7012E+00
$\alpha_2$	7.94E-03	5.35E-02	4.44E-02	1.30E-01	6.00E-02	1.7012E+00	3.0093E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9022760	0.9531070	0.9579560	0.9873490	0.9421700	5.8555E+01	2.8809E+00
$\alpha_2$	6.62E-03	3.42E-02	2.93E-02	7.87E-02	4.13E-02	2.1037E+00	5.9332E+01
$\alpha_3$	3.20E-04	1.27E-02	7.89E-03	4.12E-02	1.66E-02	7.7722E-01	6.0659E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9075840	0.9503560	0.9537340	0.9815800	0.9372370	8.3812E+01	4.3781E+00
$\alpha_2$	9.23E-03	3.36E-02	3.01E-02	6.99E-02	4.32E-02	2.9641E+00	8.5226E+01
$\alpha_3$	4.72E-04	1.07E-02	7.26E-03	3.25E-02	1.33E-02	9.4031E-01	8.7250E+01
$\alpha_4$	1.59E-05	5.37E-03	2.34E-03	2.10E-02	6.24E-03	4.7367E-01	8.7716E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9272970	0.9574330	0.9594610	0.9806310	0.9431910	1.4289E+02	6.3529E+00
$\alpha_2$	7.85E-03	2.44E-02	2.23E-02	4.80E-02	3.07E-02	3.6349E+00	1.4561E+02
$\alpha_3$	1.80E-03	1.18E-02	9.74E-03	2.91E-02	1.59E-02	1.7667E+00	1.4748E+02
$\alpha_4$	1.15E-04	5.05E-03	3.08E-03	1.67E-02	7.66E-03	7.5389E-01	1.4849E+02
$\alpha_5$	1.12E-09	1.32E-03	1.33E-04	6.84E-03	2.52E-03	1.9738E-01	1.4905E+02

Motor Driven Pumps  
Pooled Clean System Motor Driven Pump Distributions  
CLEAN SYSTEM MDP-FTR LESS THAN 1 HOUR  
CCCG = 6

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9319160	0.9587780	0.9604700	0.9798640	0.9465690	1.7261E+02	7.4212E+00
$\alpha_2$	6.80E-03	2.07E-02	1.90E-02	4.06E-02	2.54E-02	3.7303E+00	1.7630E+02
$\alpha_3$	1.95E-03	1.10E-02	9.26E-03	2.61E-02	1.43E-02	1.9820E+00	1.7805E+02
$\alpha_4$	3.84E-04	6.06E-03	4.35E-03	1.75E-02	8.47E-03	1.0905E+00	1.7894E+02
$\alpha_5$	7.64E-06	2.63E-03	1.14E-03	1.03E-02	4.26E-03	4.7270E-01	1.7956E+02
$\alpha_6$	4.14E-12	8.10E-04	3.02E-05	4.48E-03	1.06E-03	1.4574E-01	1.7989E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9400050	0.9421700	0.9372370	0.9431910	0.9465690
$\alpha_2$	6.00E-02	4.13E-02	4.32E-02	3.07E-02	2.54E-02
$\alpha_3$		1.66E-02	1.33E-02	1.59E-02	1.43E-02
$\alpha_4$			6.24E-03	7.66E-03	8.47E-03
$\alpha_5$				2.52E-03	4.26E-03
$\alpha_6$					1.06E-03

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.40E-01	9.42E-01	9.37E-01	9.43E-01	9.47E-01
Beta	6.00E-02	5.78E-02	6.28E-02	5.68E-02	5.34E-02
Gamma		2.87E-01	3.12E-01	4.60E-01	5.26E-01
Delta			3.19E-01	3.90E-01	4.91E-01
Epsilon				2.48E-01	3.86E-01
Mu					2.00E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	17.38	26.07	34.76	43.45	52.13
$N_1$	2.4667	2.9300	2.9160	3.2805	3.5429
$N_2$	1.2667	1.2700	1.7360	1.5207	1.4911
$N_3$		0.5100	0.5360	0.7893	0.8402
$N_4$			0.2510	0.3795	0.4983
$N_5$				0.1251	0.2505
$N_6$					0.0625



Pooled Clean System Motor Driven Pump Distributions

CLEAN SYSTEM MDP-FTR LESS THAN AND > 1 HOUR SPAR: MDP-FR

**CLEAN SYSTEM MDP-FTR LESS THAN AND > 1 HOUR SPAR: MDP-FR**

**System :** Chemical and volume control  
 Component cooling water  
 Auxiliary feedwater  
 Containment spray recirculation  
 High pressure core spray  
 High pressure coolant injection  
 High pressure injection  
 Low pressure core spray  
 Reactor core isolation  
 Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
 Standby liquid control

**Component :** Motor Driven Pump

**Failure Mode :** Fail to Run (Normally running equipment)  
 Fail to Run >1 Hour (Standby equipment)  
 Fail to Run less than 1 Hour

**Start Date :** 1997/01/01

**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 246.60

Total Number of Common-Cause Failure Events: 11

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9530200	0.9739780	0.9755720	0.9895000	0.9748200	1.9157E+02	5.1182E+00
$\alpha_2$	1.05E-02	2.60E-02	2.44E-02	4.70E-02	2.52E-02	5.1182E+00	1.9157E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9546770	0.9717820	0.9728020	0.9853900	0.9726390	2.9727E+02	8.6319E+00
$\alpha_2$	8.83E-03	2.00E-02	1.89E-02	3.46E-02	1.91E-02	6.1047E+00	2.9980E+02
$\alpha_3$	1.92E-03	8.26E-03	7.22E-03	1.82E-02	8.21E-03	2.5272E+00	3.0337E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9593140	0.9734890	0.9742500	0.9850600	0.9750900	4.0105E+02	1.0922E+01
$\alpha_2$	6.32E-03	1.45E-02	1.37E-02	2.53E-02	1.30E-02	5.9661E+00	4.0601E+02
$\alpha_3$	2.79E-03	8.76E-03	7.97E-03	1.74E-02	8.80E-03	3.6070E+00	4.0836E+02
$\alpha_4$	3.20E-04	3.27E-03	2.51E-03	8.83E-03	3.09E-03	1.3487E+00	4.1062E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9639460	0.9756190	0.9761890	0.9853440	0.9780670	5.3872E+02	1.3463E+01
$\alpha_2$	4.69E-03	1.08E-02	1.02E-02	1.89E-02	8.48E-03	5.9530E+00	5.4623E+02
$\alpha_3$	2.89E-03	7.93E-03	7.34E-03	1.50E-02	7.52E-03	4.3779E+00	5.4780E+02
$\alpha_4$	1.04E-03	4.52E-03	3.94E-03	1.00E-02	4.69E-03	2.4970E+00	5.4969E+02
$\alpha_5$	1.37E-05	1.15E-03	6.30E-04	4.05E-03	1.24E-03	6.3488E-01	5.5155E+02

Pooled Clean System Motor Driven Pump Distributions

CLEAN SYSTEM MDP-FTR LESS THAN AND > 1 HOUR SPAR: MDP-FR

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9671180	0.9773650	0.9778460	0.9859820	0.9802020	6.4708E+02	1.4986E+01
$\alpha_2$	3.58E-03	8.49E-03	8.00E-03	1.51E-02	6.25E-03	5.6206E+00	6.5645E+02
$\alpha_3$	2.29E-03	6.41E-03	5.92E-03	1.22E-02	5.74E-03	4.2444E+00	6.5782E+02
$\alpha_4$	1.40E-03	4.84E-03	4.35E-03	9.95E-03	4.83E-03	3.2027E+00	6.5886E+02
$\alpha_5$	2.92E-04	2.35E-03	1.87E-03	6.04E-03	2.46E-03	1.5538E+00	6.6051E+02
$\alpha_6$	2.96E-07	5.51E-04	1.78E-04	2.36E-03	5.20E-04	3.6454E-01	6.6170E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9748200	0.9726390	0.9750900	0.9780670	0.9802020
$\alpha_2$	2.52E-02	1.91E-02	1.30E-02	8.48E-03	6.25E-03
$\alpha_3$		8.21E-03	8.80E-03	7.52E-03	5.74E-03
$\alpha_4$			3.09E-03	4.69E-03	4.83E-03
$\alpha_5$				1.24E-03	2.46E-03
$\alpha_6$					5.20E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.75E-01	9.73E-01	9.75E-01	9.78E-01	9.80E-01
Beta	2.52E-02	2.74E-02	2.49E-02	2.19E-02	1.98E-02
Gamma		3.00E-01	4.77E-01	6.13E-01	6.84E-01
Delta			2.60E-01	4.41E-01	5.76E-01
Epsilon				2.10E-01	3.82E-01
Mu					1.74E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	174.89	262.34	349.79	437.23	524.68
$N_1$	6.4327	5.3780	5.1231	5.3317	5.4585
$N_2$	4.6837	5.2710	4.7380	3.8388	3.3814
$N_3$		2.2600	3.2027	3.4005	3.1026
$N_4$			1.1260	2.1226	2.6105
$N_5$				0.5626	1.3316
$N_6$					0.2813

Motor Driven Pumps  
Pooled Clean System Motor Driven Pump Distributions  
CLEAN SYSTEM MDP-FTR > 1 HOUR  
**CLEAN SYSTEM MDP-FTR > 1 HOUR**

2010

**System :** Chemical and volume control  
Component cooling water  
Auxiliary feedwater  
Containment spray recirculation  
High pressure core spray  
High pressure coolant injection  
High pressure injection  
Low pressure core spray  
Reactor core isolation  
Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
Standby liquid control

**Component :** Motor Driven Pump

**Failure Mode :** Fail to Run >1 Hour (Standby equipment)

**Start Date :** 1997/01/01

**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 46.50  
Total Number of Common-Cause Failure Events: 4

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9040790	0.9592390	0.9655290	0.9928640	0.9592160	4.5532E+01	1.9348E+00
$\alpha_2$	7.14E-03	4.08E-02	3.45E-02	9.59E-02	4.08E-02	1.9348E+00	4.5532E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9164040	0.9574170	0.9609770	0.9862360	0.9536240	8.0983E+01	3.6019E+00
$\alpha_2$	8.84E-03	3.35E-02	2.99E-02	7.05E-02	3.71E-02	2.8347E+00	8.1750E+01
$\alpha_3$	2.19E-04	9.07E-03	5.60E-03	2.97E-02	9.27E-03	7.6722E-01	8.3818E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9295320	0.9619860	0.9645480	0.9856740	0.9624210	1.1448E+02	4.5238E+00
$\alpha_2$	4.79E-03	2.08E-02	1.82E-02	4.59E-02	1.76E-02	2.4801E+00	1.1652E+02
$\alpha_3$	1.69E-03	1.32E-02	1.06E-02	3.37E-02	1.64E-02	1.5710E+00	1.1743E+02
$\alpha_4$	1.16E-05	3.97E-03	1.73E-03	1.55E-02	3.52E-03	4.7267E-01	1.1853E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9420430	0.9661470	0.9677880	0.9846360	0.9679990	1.8141E+02	6.3565E+00
$\alpha_2$	4.32E-03	1.58E-02	1.42E-02	3.31E-02	9.76E-03	2.9740E+00	1.8479E+02
$\alpha_3$	2.19E-03	1.13E-02	9.66E-03	2.63E-02	1.31E-02	2.1302E+00	1.8564E+02
$\alpha_4$	3.30E-04	5.62E-03	3.99E-03	1.65E-02	7.73E-03	1.0550E+00	1.8671E+02
$\alpha_5$	8.85E-10	1.05E-03	1.05E-04	5.44E-03	1.42E-03	1.9728E-01	1.8757E+02

Motor Driven Pumps  
Pooled Clean System Motor Driven Pump Distributions  
CLEAN SYSTEM MDP-FTR > 1 HOUR  
**CCCG = 6**

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9468510	0.9680880	0.9694560	0.9846480	0.9719910	2.1908E+02	7.2218E+00
$\alpha_2$	3.36E-03	1.27E-02	1.13E-02	2.69E-02	6.06E-03	2.8761E+00	2.2343E+02
$\alpha_3$	1.78E-03	9.33E-03	7.93E-03	2.17E-02	9.24E-03	2.1125E+00	2.2419E+02
$\alpha_4$	7.43E-04	6.50E-03	5.12E-03	1.70E-02	8.37E-03	1.4718E+00	2.2483E+02
$\alpha_5$	2.87E-05	2.72E-03	1.46E-03	9.69E-03	3.74E-03	6.1570E-01	2.2569E+02
$\alpha_6$	3.29E-12	6.44E-04	2.40E-05	3.57E-03	5.95E-04	1.4574E-01	2.2616E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9592160	0.9536240	0.9624210	0.9679990	0.9719910
$\alpha_2$	4.08E-02	3.71E-02	1.76E-02	9.76E-03	6.06E-03
$\alpha_3$		9.27E-03	1.64E-02	1.31E-02	9.24E-03
$\alpha_4$			3.52E-03	7.73E-03	8.37E-03
$\alpha_5$				1.42E-03	3.74E-03
$\alpha_6$					5.95E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.59E-01	9.54E-01	9.62E-01	9.68E-01	9.72E-01
Beta	4.08E-02	4.64E-02	3.76E-02	3.20E-02	2.80E-02
Gamma		2.00E-01	5.31E-01	6.95E-01	7.84E-01
Delta			1.76E-01	4.11E-01	5.79E-01
Epsilon				1.55E-01	3.41E-01
Mu					1.37E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	33.82	50.73	67.64	84.55	101.45
$N_1$	1.4660	0.6980	0.7071	0.6971	0.6864
$N_2$	1.5003	2.0010	1.2520	0.8598	0.6369
$N_3$		0.5000	1.1667	1.1528	0.9707
$N_4$			0.2500	0.6806	0.8796
$N_5$				0.1250	0.3935
$N_6$					0.0625

## PWR Containment Spray Pumps

### CONTAINMENT SPRAY MDP-FS

System : Containment spray recirculation  
Component : Motor Driven Pump  
Failure Mode : Fail to start  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 29.00

Total Number of Common-Cause Failure Events: 3

#### ALPHA FACTOR DISTRIBUTIONS

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8766840	0.9430560	0.9497220	0.9865860	0.9377850	4.1146E+01	2.4845E+00
$\alpha_2$	1.34E-02	5.69E-02	5.03E-02	1.23E-01	6.22E-02	2.4845E+00	4.1146E+01

#### ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2
$\alpha_1$	0.9377850
$\alpha_2$	6.22E-02

MGL Parameter	CCCG=2
1-Beta	9.38E-01
Beta	6.22E-02

Avg. Impact Vector	CCCG=2
Adj. Ind. Events	29.00
N <sub>1</sub>	1.9000
N <sub>2</sub>	2.0500

Motor Driven Pumps  
PWR Containment Spray Pumps  
CONTAINMENT SPRAY FTR LESS THAN 1H MDP-FH  
**CONTAINMENT SPRAY FTR LESS THAN 1H MDP-FH**

2010

System : Containment spray recirculation  
Component : Motor Driven Pump  
Failure Mode : Fail to Run less than 1 Hour  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 7.00  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9017830	0.9754240	0.9898730	0.9999510	1.0000000	1.7246E+01	4.3452E-01
$\alpha_2$	4.52E-05	2.46E-02	1.01E-02	9.82E-02	0.00E+00	4.3452E-01	1.7246E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2
$\alpha_1$	1.0000000
$\alpha_2$	0.00E+00

MGL Parameter	CCCG=2
1-Beta	1.00E+00
Beta	0.00E+00

Avg. Impact Vector	CCCG=2
Adj. Ind. Events	7.00
$N_1$	0.0000
$N_2$	0.0000

Motor Driven Pumps  
PWR Containment Spray Pumps  
CONTAINMENT SPRAY MDP-FTR LESS THAN AND > 1 HOUR  
**CONTAINMENT SPRAY MDP-FTR LESS THAN AND > 1 HOUR**

2010

**System :** Containment spray recirculation  
**Component :** Motor Driven Pump  
**Failure Mode :** Fail to Run >1 Hour (Standby equipment)  
Fail to Run less than 1 Hour  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 12.60  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9252160	0.9813350	0.9923820	0.9999630	1.0000000	2.2846E+01	4.3452E-01
$\alpha_2$	3.40E-05	1.87E-02	7.62E-03	7.48E-02	0.00E+00	4.3452E-01	2.2846E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2
$\alpha_1$	1.0000000
$\alpha_2$	0.00E+00

MGL Parameter	CCCG=2
1-Beta	1.00E+00
Beta	0.00E+00

Avg. Impact Vector	CCCG=2
Adj. Ind. Events	12.60
$N_1$	0.0000
$N_2$	0.0000

Motor Driven Pumps  
PWR Containment Spray Pumps  
CONTAINMENT SPRAY >1H MDP-FR  
**CONTAINMENT SPRAY >1H MDP-FR**

2010

**System :** Containment spray recirculation  
**Component :** Motor Driven Pump  
**Failure Mode :** Fail to Run >1 Hour (Standby equipment)  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 5.60  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8934440	0.9733100	0.9889680	0.9999470	1.0000000	1.5846E+01	4.3452E-01
$\alpha_2$	4.93E-05	2.67E-02	1.10E-02	1.07E-01	0.00E+00	4.3452E-01	1.5846E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2
$\alpha_1$	1.0000000
$\alpha_2$	0.00E+00

MGL Parameter	CCCG=2
1-Beta	1.00E+00
Beta	0.00E+00

Avg. Impact Vector	CCCG=2
Adj. Ind. Events	5.60
$N_1$	0.0000
$N_2$	0.0000



## BWR Residual Heat Removal Pumps

### BWR RHR MDP FAIL TO START

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
 Component : Motor Driven Pump  
 Failure Mode : Fail to start  
 Op. Mode : CCF Event Can Only Happen During Power Operation  
 CCF Event May Occur During Both Power Operation & Shutdown  
 Plant Type : BWR  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 30.00

Total Number of Common-Cause Failure Events: 2

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9089010	0.9719230	0.9823640	0.9993020	0.9800020	2.6579E+01	7.6782E-01
$\alpha_2$	6.95E-04	2.81E-02	1.76E-02	9.11E-02	2.00E-02	7.6782E-01	2.6579E+01

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9125190	0.9619090	0.9673600	0.9926310	0.9591840	5.3055E+01	2.1009E+00
$\alpha_2$	5.40E-03	3.32E-02	2.78E-02	7.98E-02	4.08E-02	1.8337E+00	5.3322E+01
$\alpha_3$	1.69E-07	4.84E-03	9.75E-04	2.30E-02	0.00E+00	2.6722E-01	5.4889E+01

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9072690	0.9518060	0.9555360	0.9835910	0.9375000	7.6136E+01	3.8551E+00
$\alpha_2$	1.20E-02	4.04E-02	3.66E-02	8.17E-02	6.25E-02	3.2281E+00	7.6763E+01
$\alpha_3$	5.68E-06	5.05E-03	1.87E-03	2.09E-02	0.00E+00	4.0431E-01	7.9587E+01
$\alpha_4$	1.20E-08	2.78E-03	3.80E-04	1.39E-02	0.00E+00	2.2267E-01	7.9768E+01

#### ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9800020	0.9591840	0.9375000
$\alpha_2$	2.00E-02	4.08E-02	6.25E-02
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.80E-01	9.59E-01	9.38E-01
Beta	2.00E-02	4.08E-02	6.25E-02
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Motor Driven Pumps  
BWR Residual Heat Removal Pumps  
BWR RHR MDP FAIL TO START

2010

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	15.00	22.50	30.00
<b>N<sub>1</sub></b>	1.3333	1.0000	0.0000
<b>N<sub>2</sub></b>	0.3333	1.0000	2.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

Motor Driven Pumps  
 BWR Residual Heat Removal Pumps  
 BWR RHR MDP FTR LESS THAN 1H  
**BWR RHR MDP FTR LESS THAN 1H**

2010

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
 Component : Motor Driven Pump  
 Failure Mode : Fail to Run less than 1 Hour  
 Op. Mode :  
 Plant Type : BWR  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 2.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8636860	0.9657330	0.9856730	0.9999380	1.0000000	1.2246E+01	4.3452E-01
$\alpha_2$	6.41E-05	3.43E-02	1.43E-02	1.36E-01	0.00E+00	4.3452E-01	1.2246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9040420	0.9662880	0.9752810	0.9977560	1.0000000	3.1555E+01	1.1009E+00
$\alpha_2$	8.16E-04	2.55E-02	1.67E-02	8.05E-02	0.00E+00	8.3366E-01	3.1822E+01
$\alpha_3$	2.88E-07	8.18E-03	1.66E-03	3.88E-02	0.00E+00	2.6722E-01	3.2389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9113590	0.9628920	0.9688970	0.9938680	1.0000000	4.8136E+01	1.8551E+00
$\alpha_2$	2.04E-03	2.46E-02	1.86E-02	6.77E-02	0.00E+00	1.2281E+00	4.8763E+01
$\alpha_3$	9.14E-06	8.09E-03	3.01E-03	3.34E-02	0.00E+00	4.0431E-01	4.9587E+01
$\alpha_4$	1.93E-08	4.45E-03	6.12E-04	2.23E-02	0.00E+00	2.2267E-01	4.9768E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Motor Driven Pumps  
BWR Residual Heat Removal Pumps  
BWR RHR MDP FTR LESS THAN 1H

2010

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	2.00	2.00	2.00
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

Motor Driven Pumps  
 BWR Residual Heat Removal Pumps  
 BWR RHR MDP FAIL TO RUN  
**BWR RHR MDP FAIL TO RUN**

2010

**System :** Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
**Component :** Motor Driven Pump  
**Failure Mode :** Fail to Run (Normally running equipment)  
 Fail to Run >1 Hour (Standby equipment)  
 Fail to Run less than 1 Hour  
**Op. Mode :** CCF Event Can Only Happen During Power Operation  
 CCF Event May Occur During Both Power Operation & Shutdown  
**Plant Type :** BWR  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 8.50  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9093850	0.9773460	0.9906920	0.9999550	1.0000000	1.8746E+01	4.3452E-01
$\alpha_2$	4.16E-05	2.27E-02	9.31E-03	9.06E-02	0.00E+00	4.3452E-01	1.8746E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9197350	0.9718850	0.9794540	0.9981430	1.0000000	3.8055E+01	1.1009E+00
$\alpha_2$	6.78E-04	2.13E-02	1.39E-02	6.73E-02	0.00E+00	8.3366E-01	3.8322E+01
$\alpha_3$	2.40E-07	6.82E-03	1.38E-03	3.24E-02	0.00E+00	2.6722E-01	3.8889E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9214020	0.9671620	0.9725130	0.9945900	1.0000000	5.4636E+01	1.8551E+00
$\alpha_2$	1.80E-03	2.17E-02	1.64E-02	6.00E-02	0.00E+00	1.2281E+00	5.5263E+01
$\alpha_3$	8.07E-06	7.16E-03	2.66E-03	2.96E-02	0.00E+00	4.0431E-01	5.6087E+01
$\alpha_4$	1.70E-08	3.94E-03	5.40E-04	1.97E-02	0.00E+00	2.2267E-01	5.6268E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Motor Driven Pumps  
BWR Residual Heat Removal Pumps  
BWR RHR MDP FAIL TO RUN

2010

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	8.50	8.50	8.50
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

Motor Driven Pumps  
 BWR Residual Heat Removal Pumps  
 BWR RHR MDP FAIL TO RUN >1H  
**BWR RHR MDP FAIL TO RUN >1H**

2010

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
 Component : Motor Driven Pump  
 Failure Mode : Fail to Run >1 Hour (Standby equipment)  
 Op. Mode : CCF Event Can Only Happen During Power Operation  
 CCF Event May Occur During Both Power Operation & Shutdown  
 Plant Type : BWR  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 5.50  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8927940	0.9731450	0.9888970	0.9999460	1.0000000	1.5746E+01	4.3452E-01
$\alpha_2$	4.96E-05	2.69E-02	1.11E-02	1.07E-01	0.00E+00	4.3452E-01	1.5746E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9131810	0.9695520	0.9777180	0.9979800	1.0000000	3.5055E+01	1.1009E+00
$\alpha_2$	7.35E-04	2.31E-02	1.50E-02	7.28E-02	0.00E+00	8.3366E-01	3.5322E+01
$\alpha_3$	2.60E-07	7.39E-03	1.50E-03	3.51E-02	0.00E+00	2.6722E-01	3.5889E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9170660	0.9653200	0.9709530	0.9942790	1.0000000	5.1636E+01	1.8551E+00
$\alpha_2$	1.91E-03	2.30E-02	1.73E-02	6.33E-02	0.00E+00	1.2281E+00	5.2263E+01
$\alpha_3$	8.53E-06	7.56E-03	2.81E-03	3.12E-02	0.00E+00	4.0431E-01	5.3087E+01
$\alpha_4$	1.80E-08	4.16E-03	5.71E-04	2.09E-02	0.00E+00	2.2267E-01	5.3268E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Motor Driven Pumps  
BWR Residual Heat Removal Pumps  
BWR RHR MDP FAIL TO RUN >1H

2010

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	5.50	5.50	5.50
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000



## AFW Motor-Driven Pumps

### AFW MOTOR DRIVEN PUMP FAIL TO START SPAR: AFW-MDP-FS

System : Auxiliary feedwater  
 Component : Motor Driven Pump  
 Failure Mode : Fail to start  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 32.70  
 Total Number of Common-Cause Failure Events: 2

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8847320	0.9508270	0.9582900	0.9913360	0.9476620	3.7406E+01	1.9345E+00
$\alpha_2$	8.66E-03	4.92E-02	4.17E-02	1.15E-01	5.23E-02	1.9345E+00	3.7406E+01

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9127180	0.9573150	0.9614560	0.9877510	0.9523700	6.9545E+01	3.1009E+00
$\alpha_2$	2.84E-03	2.18E-02	1.76E-02	5.52E-02	1.79E-02	1.5837E+00	7.1062E+01
$\alpha_3$	2.54E-03	2.09E-02	1.67E-02	5.37E-02	2.98E-02	1.5172E+00	7.1129E+01

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9227900	0.9590050	0.9619400	0.9851810	0.9569710	9.8956E+01	4.2301E+00
$\alpha_2$	3.40E-03	1.92E-02	1.62E-02	4.52E-02	1.36E-02	1.9781E+00	1.0121E+02
$\alpha_3$	1.44E-03	1.36E-02	1.06E-02	3.60E-02	1.81E-02	1.4043E+00	1.0178E+02
$\alpha_4$	2.71E-04	8.21E-03	5.33E-03	2.60E-02	1.13E-02	8.4767E-01	1.0234E+02

#### ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9476620	0.9523700	0.9569710
$\alpha_2$	5.23E-02	1.79E-02	1.36E-02
$\alpha_3$		2.98E-02	1.81E-02
$\alpha_4$			1.13E-02

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.48E-01	9.52E-01	9.57E-01
Beta	5.23E-02	4.76E-02	4.30E-02
Gamma		6.25E-01	6.84E-01
Delta			3.85E-01

Motor Driven Pumps  
AFW Motor-Driven Pumps

2010

AFW MOTOR DRIVEN PUMP FAIL TO START SPAR: AFW-MDP-FS

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	26.16	39.24	52.32
<b>N<sub>1</sub></b>	1.0000	0.7500	0.5000
<b>N<sub>2</sub></b>	1.5000	0.7500	0.7500
<b>N<sub>3</sub></b>		1.2500	1.0000
<b>N<sub>4</sub></b>			0.6250

AFW MOTOR DRIVEN PUMP FTR LESS THAN 1H SPAR: AFW-MDP-FH  
**AFW MOTOR DRIVEN PUMP FTR LESS THAN 1H SPAR: AFW-MDP-FH**

System : Auxiliary feedwater  
 Component : Motor Driven Pump  
 Failure Mode : Fail to Run less than 1 Hour  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 6.50  
 Total Number of Common-Cause Failure Events: 2

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8683400	0.9604820	0.9761100	0.9992710	0.9622420	1.7043E+01	7.0122E-01
$\alpha_2$	7.26E-04	3.95E-02	2.39E-02	1.32E-01	3.78E-02	7.0122E-01	1.7043E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8909990	0.9539730	0.9612000	0.9922030	0.9236040	3.8985E+01	1.8809E+00
$\alpha_2$	5.28E-03	3.92E-02	3.20E-02	9.81E-02	7.54E-02	1.6037E+00	3.9262E+01
$\alpha_3$	3.46E-07	6.78E-03	1.47E-03	3.18E-02	9.79E-04	2.7722E-01	4.0589E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8901110	0.9447120	0.9495170	0.9828820	0.8838200	5.7722E+01	3.3781E+00
$\alpha_2$	1.13E-02	4.44E-02	3.95E-02	9.43E-02	1.13E-01	2.7141E+00	5.8386E+01
$\alpha_3$	1.40E-05	7.21E-03	2.93E-03	2.89E-02	2.75E-03	4.4031E-01	6.0660E+01
$\alpha_4$	1.67E-08	3.66E-03	5.07E-04	1.83E-02	7.63E-05	2.2367E-01	6.0876E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9622420	0.9236040	0.8838200
$\alpha_2$	3.78E-02	7.54E-02	1.13E-01
$\alpha_3$		9.79E-04	2.75E-03
$\alpha_4$			7.63E-05

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.62E-01	9.24E-01	8.84E-01
Beta	3.78E-02	7.64E-02	1.16E-01
Gamma		1.28E-02	2.43E-02
Delta			2.70E-02

Motor Driven Pumps  
AFW Motor-Driven Pumps

2010

AFW MOTOR DRIVEN PUMP FTR LESS THAN 1H SPAR: AFW-MDP-FH

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	4.33	6.50	8.67
<b>N<sub>1</sub></b>	2.4667	2.9300	2.9160
<b>N<sub>2</sub></b>	0.2667	0.7700	1.4860
<b>N<sub>3</sub></b>		0.0100	0.0360
<b>N<sub>4</sub></b>			0.0010

Motor Driven Pumps  
 AFW Motor-Driven Pumps  
 AFW MOTOR DRIVEN PUMP FAIL TO RUN SPAR: AFW-MDP-FR  
**AFW MOTOR DRIVEN PUMP FAIL TO RUN SPAR: AFW-MDP-FR**

2010

System : Auxiliary feedwater  
 Component : Motor Driven Pump  
 Failure Mode : Fail to Run >1 Hour (Standby equipment)  
 Fail to Run less than 1 Hour  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 14.20  
 Total Number of Common-Cause Failure Events: 2

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8974100	0.9693580	0.9816310	0.9994410	0.9781450	2.2183E+01	7.0122E-01
$\alpha_2$	5.56E-04	3.06E-02	1.84E-02	1.03E-01	2.19E-02	7.0122E-01	2.2183E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9079610	0.9612710	0.9674320	0.9934740	0.9564490	4.6685E+01	1.8809E+00
$\alpha_2$	4.42E-03	3.30E-02	2.68E-02	8.28E-02	4.30E-02	1.6037E+00	4.6962E+01
$\alpha_3$	2.91E-07	5.71E-03	1.23E-03	2.68E-02	5.58E-04	2.7722E-01	4.8289E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9056260	0.9526620	0.9568380	0.9853980	0.9348280	6.7982E+01	3.3781E+00
$\alpha_2$	9.66E-03	3.80E-02	3.38E-02	8.09E-02	6.36E-02	2.7141E+00	6.8646E+01
$\alpha_3$	1.19E-05	6.17E-03	2.51E-03	2.47E-02	1.54E-03	4.4031E-01	7.0920E+01
$\alpha_4$	1.43E-08	3.13E-03	4.33E-04	1.57E-02	4.28E-05	2.2367E-01	7.1136E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9781450	0.9564490	0.9348280
$\alpha_2$	2.19E-02	4.30E-02	6.36E-02
$\alpha_3$		5.58E-04	1.54E-03
$\alpha_4$			4.28E-05

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.78E-01	9.56E-01	9.35E-01
Beta	2.19E-02	4.36E-02	6.52E-02
Gamma		1.28E-02	2.43E-02
Delta			2.70E-02

Motor Driven Pumps  
AFW Motor-Driven Pumps

2010

AFW MOTOR DRIVEN PUMP FAIL TO RUN SPAR: AFW-MDP-FR

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	9.47	14.20	18.93
<b>N<sub>1</sub></b>	2.4667	2.9300	2.9160
<b>N<sub>2</sub></b>	0.2667	0.7700	1.4860
<b>N<sub>3</sub></b>		0.0100	0.0360
<b>N<sub>4</sub></b>			0.0010

Motor Driven Pumps  
 AFW Motor-Driven Pumps  
 AFW MOTOR DRIVEN PUMP FAIL TO RUN >1H  
**AFW MOTOR DRIVEN PUMP FAIL TO RUN >1H**

2010

System : Auxiliary feedwater  
 Component : Motor Driven Pump  
 Failure Mode : Fail to Run >1 Hour (Standby equipment)  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 7.70  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9054820	0.9763600	0.9902730	0.9999530	1.0000000	1.7946E+01	4.3452E-01
$\alpha_2$	4.34E-05	2.36E-02	9.73E-03	9.45E-02	0.00E+00	4.3452E-01	1.7946E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9180860	0.9712980	0.9790180	0.9981030	1.0000000	3.7255E+01	1.1009E+00
$\alpha_2$	6.92E-04	2.17E-02	1.41E-02	6.87E-02	0.00E+00	8.3366E-01	3.7522E+01
$\alpha_3$	2.45E-07	6.97E-03	1.41E-03	3.30E-02	0.00E+00	2.6722E-01	3.8089E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9202950	0.9666900	0.9721130	0.9945110	1.0000000	5.3836E+01	1.8551E+00
$\alpha_2$	1.83E-03	2.21E-02	1.66E-02	6.08E-02	0.00E+00	1.2281E+00	5.4463E+01
$\alpha_3$	8.19E-06	7.26E-03	2.70E-03	3.00E-02	0.00E+00	4.0431E-01	5.5287E+01
$\alpha_4$	1.73E-08	4.00E-03	5.48E-04	2.00E-02	0.00E+00	2.2267E-01	5.5468E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Motor Driven Pumps  
AFW Motor-Driven Pumps

2010

AFW MOTOR DRIVEN PUMP FAIL TO RUN >1H

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4
Adj. Ind. Events	7.70	7.70	7.70
N <sub>1</sub>	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000
N <sub>4</sub>			0.0000



**AFW Pump Volutes**

**AFW PUMP VOLUTES (MDP,TDP,EDP) FAIL TO RUN SPAR: AFW-PMP-FR**

**System :** Auxiliary feedwater  
**Component :** Motor Driven Pump  
 Turbine Driven Pump  
**Failure Mode :** Fail to Run >1 Hour (Standby equipment)  
 Fail to Run less than 1 Hour  
**Subcomponent :** Pump  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 17.10  
 Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9330100	0.9819910	0.9911350	0.9999000	0.9947370	2.9146E+01	5.3452E-01
$\alpha_2$	1.02E-04	1.80E-02	8.86E-03	6.70E-02	5.26E-03	5.3452E-01	2.9146E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9380380	0.9766010	0.9817430	0.9975760	0.9901270	5.7635E+01	1.3809E+00
$\alpha_2$	1.23E-03	1.87E-02	1.36E-02	5.36E-02	9.52E-03	1.1037E+00	5.7912E+01
$\alpha_3$	2.39E-07	4.70E-03	1.01E-03	2.20E-02	3.53E-04	2.7722E-01	5.8739E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9382970	0.9722280	0.9758250	0.9938590	0.9861050	8.3252E+01	2.3781E+00
$\alpha_2$	2.93E-03	2.00E-02	1.64E-02	4.94E-02	1.29E-02	1.7141E+00	8.3916E+01
$\alpha_3$	9.93E-06	5.14E-03	2.09E-03	2.06E-02	9.56E-04	4.4031E-01	8.5190E+01
$\alpha_4$	1.19E-08	2.61E-03	3.61E-04	1.31E-02	2.66E-05	2.2367E-01	8.5406E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9947370	0.9901270	0.9861050
$\alpha_2$	5.26E-03	9.52E-03	1.29E-02
$\alpha_3$		3.53E-04	9.56E-04
$\alpha_4$			2.66E-05

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.95E-01	9.90E-01	9.86E-01
Beta	5.26E-03	9.87E-03	1.39E-02
Gamma		3.57E-02	7.07E-02
Delta			2.70E-02

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	17.10	25.65	34.20
<b>N<sub>1</sub></b>	1.8000	2.4300	2.9160
<b>N<sub>2</sub></b>	0.1000	0.2700	0.4860
<b>N<sub>3</sub></b>		0.0100	0.0360
<b>N<sub>4</sub></b>			0.0010

Motor Driven Pumps  
 Emergency Service Water Pump  
 NORMALLY RUNNING SERVICE WATER MDP FAIL TO START

2010

**Emergency Service Water Pump**  
**NORMALLY RUNNING SERVICE WATER MDP FAIL TO START**

System : Normally operating service water  
 Component : Motor Driven Pump  
 Failure Mode : Fail to start  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 73.70  
 Total Number of Common-Cause Failure Events: 5

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9506320	0.9836610	0.9887650	0.9992430	0.9891160	5.7392E+01	9.5332E-01
$\alpha_2$	7.54E-04	1.63E-02	1.12E-02	4.94E-02	1.09E-02	9.5332E-01	5.7392E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9474110	0.9762850	0.9793440	0.9947050	0.9815620	9.9098E+01	2.4072E+00
$\alpha_2$	3.61E-03	1.99E-02	1.68E-02	4.66E-02	1.67E-02	2.0150E+00	9.9490E+01
$\alpha_3$	3.53E-06	3.86E-03	1.38E-03	1.61E-02	1.76E-03	3.9222E-01	1.0111E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9443140	0.9706920	0.9728830	0.9895900	0.9754800	1.3754E+02	4.1527E+00
$\alpha_2$	6.63E-03	2.27E-02	2.05E-02	4.63E-02	2.12E-02	3.2119E+00	1.3848E+02
$\alpha_3$	6.31E-05	4.63E-03	2.60E-03	1.61E-02	2.68E-03	6.5561E-01	1.4104E+02
$\alpha_4$	1.34E-07	2.01E-03	4.52E-04	9.35E-03	6.67E-04	2.8517E-01	1.4141E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9505580	0.9713290	0.9727740	0.9871780	0.9771660	2.0996E+02	6.1974E+00
$\alpha_2$	5.98E-03	1.78E-02	1.64E-02	3.47E-02	1.49E-02	3.8528E+00	2.1230E+02
$\alpha_3$	1.14E-03	7.91E-03	6.45E-03	1.97E-02	6.29E-03	1.7103E+00	2.1445E+02
$\alpha_4$	1.31E-05	2.46E-03	1.18E-03	9.22E-03	1.34E-03	5.3069E-01	2.1563E+02
$\alpha_5$	7.77E-16	4.79E-04	3.51E-06	2.78E-03	2.69E-04	1.0358E-01	2.1605E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9534900	0.9720600	0.9732580	0.9865290	0.9784690	2.5310E+02	7.2748E+00
$\alpha_2$	4.92E-03	1.47E-02	1.35E-02	2.87E-02	1.15E-02	3.8351E+00	2.5654E+02
$\alpha_3$	1.49E-03	7.96E-03	6.74E-03	1.86E-02	6.69E-03	2.0731E+00	2.5830E+02
$\alpha_4$	1.66E-04	3.66E-03	2.49E-03	1.11E-02	2.58E-03	9.5172E-01	2.5942E+02
$\alpha_5$	2.07E-07	1.21E-03	3.22E-04	5.46E-03	6.74E-04	3.1600E-01	2.6006E+02
$\alpha_6$	1.60E-16	3.80E-04	2.10E-06	2.21E-03	1.12E-04	9.8837E-02	2.6028E+02

Motor Driven Pumps  
 Emergency Service Water Pump  
 NORMALLY RUNNING SERVICE WATER MDP FAIL TO START

2010

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9891160	0.9815620	0.9754800	0.9771660	0.9784690
$\alpha_2$	1.09E-02	1.67E-02	2.12E-02	1.49E-02	1.15E-02
$\alpha_3$		1.76E-03	2.68E-03	6.29E-03	6.69E-03
$\alpha_4$			6.67E-04	1.34E-03	2.58E-03
$\alpha_5$				2.69E-04	6.74E-04
$\alpha_6$					1.12E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.89E-01	9.82E-01	9.75E-01	9.77E-01	9.78E-01
Beta	1.09E-02	1.84E-02	2.45E-02	2.28E-02	2.15E-02
Gamma		9.57E-02	1.37E-01	3.46E-01	4.67E-01
Delta			1.99E-01	2.04E-01	3.35E-01
Epsilon				1.67E-01	2.33E-01
Mu					1.43E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	43.35	65.03	86.71	108.38	130.06
$N_1$	3.7958	4.5125	4.6950	5.4168	6.0957
$N_2$	0.5188	1.1813	1.9838	1.7386	1.5959
$N_3$		0.1250	0.2513	0.7329	0.9313
$N_4$			0.0625	0.1563	0.3595
$N_5$				0.0313	0.0938
$N_6$					0.0156

Motor Driven Pumps  
 Emergency Service Water Pump  
 NORMALLY RUNNING SERVICE WATER MDP FAIL TO RUN  
**NORMALLY RUNNING SERVICE WATER MDP FAIL TO RUN**

2010

System : Normally operating service water  
 Component : Motor Driven Pump  
 Failure Mode : Fail to Run (Normally running equipment)  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 54.60  
 Total Number of Common-Cause Failure Events: 6

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8947800	0.9557440	0.9627810	0.9926080	0.9545300	4.0229E+01	1.8628E+00
$\alpha_2$	7.39E-03	4.43E-02	3.72E-02	1.05E-01	4.55E-02	1.8628E+00	4.0229E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9121510	0.9560180	0.9599380	0.9864810	0.9506370	7.3263E+01	3.3705E+00
$\alpha_2$	5.24E-03	2.73E-02	2.33E-02	6.32E-02	2.74E-02	2.0955E+00	7.4538E+01
$\alpha_3$	1.48E-03	1.66E-02	1.27E-02	4.54E-02	2.19E-02	1.2750E+00	7.5358E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9183780	0.9550630	0.9578450	0.9822520	0.9500640	1.0342E+02	4.8661E+00
$\alpha_2$	7.48E-03	2.73E-02	2.45E-02	5.70E-02	2.87E-02	2.9611E+00	1.0532E+02
$\alpha_3$	8.28E-04	1.09E-02	8.08E-03	3.07E-02	1.29E-02	1.1813E+00	1.0710E+02
$\alpha_4$	1.32E-04	6.68E-03	3.99E-03	2.24E-02	8.31E-03	7.2367E-01	1.0756E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9302890	0.9578900	0.9596360	0.9795310	0.9490200	1.6680E+02	7.3327E+00
$\alpha_2$	8.88E-03	2.46E-02	2.28E-02	4.64E-02	2.91E-02	4.2769E+00	1.6986E+02
$\alpha_3$	1.59E-03	1.03E-02	8.48E-03	2.52E-02	1.09E-02	1.7910E+00	1.7234E+02
$\alpha_4$	2.39E-04	5.41E-03	3.67E-03	1.65E-02	7.63E-03	9.4229E-01	1.7319E+02
$\alpha_5$	3.77E-07	1.85E-03	5.07E-04	8.27E-03	3.36E-03	3.2248E-01	1.7381E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9326490	0.9576840	0.9591360	0.9777710	0.9480590	2.0074E+02	8.8698E+00
$\alpha_2$	8.84E-03	2.28E-02	2.13E-02	4.19E-02	2.88E-02	4.7844E+00	2.0483E+02
$\alpha_3$	1.92E-03	1.01E-02	8.55E-03	2.34E-02	1.09E-02	2.1090E+00	2.0750E+02
$\alpha_4$	3.96E-04	5.51E-03	4.04E-03	1.56E-02	6.36E-03	1.1543E+00	2.0846E+02
$\alpha_5$	3.05E-05	2.93E-03	1.57E-03	1.04E-02	4.43E-03	6.1390E-01	2.0900E+02
$\alpha_6$	1.77E-09	9.93E-04	1.15E-04	5.07E-03	1.41E-03	2.0824E-01	2.0940E+02

Motor Driven Pumps  
 Emergency Service Water Pump  
 NORMALLY RUNNING SERVICE WATER MDP FAIL TO RUN  
*ALPHA FACTOR and MGL PARAMETERS*

2010

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9545300	0.9506370	0.9500640	0.9490200	0.9480590
$\alpha_2$	4.55E-02	2.74E-02	2.87E-02	2.91E-02	2.88E-02
$\alpha_3$		2.19E-02	1.29E-02	1.09E-02	1.09E-02
$\alpha_4$			8.31E-03	7.63E-03	6.36E-03
$\alpha_5$				3.36E-03	4.43E-03
$\alpha_6$					1.41E-03

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.55E-01	9.51E-01	9.50E-01	9.49E-01	9.48E-01
Beta	4.55E-02	4.94E-02	4.99E-02	5.10E-02	5.19E-02
Gamma		4.44E-01	4.24E-01	4.30E-01	4.46E-01
Delta			3.92E-01	5.01E-01	5.27E-01
Epsilon				3.06E-01	4.79E-01
Mu					2.42E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	26.19	39.28	52.37	65.47	78.56
$N_1$	3.7933	4.4283	4.9157	5.1654	5.2422
$N_2$	1.4283	1.2618	1.7330	2.1627	2.5452
$N_3$		1.0078	0.7770	0.8136	0.9672
$N_4$			0.5010	0.5679	0.5621
$N_5$				0.2502	0.3917
$N_6$					0.1250

Motor Driven Pumps  
 Emergency Service Water Pump  
 STANDBY SERVICE WATER MDP FAIL TO START  
**STANDBY SERVICE WATER MDP FAIL TO START**

2010

System : Standby service water  
 Component : Motor Driven Pump  
 Failure Mode : Fail to start  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 69.20  
 Total Number of Common-Cause Failure Events: 3

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9301870	0.9769450	0.9841820	0.9989710	0.9832190	3.9752E+01	9.3812E-01
$\alpha_2$	1.03E-03	2.31E-02	1.58E-02	6.98E-02	1.68E-02	9.3812E-01	3.9752E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9248970	0.9651390	0.9692040	0.9914850	0.9658670	7.2304E+01	2.6116E+00
$\alpha_2$	6.83E-03	3.13E-02	2.72E-02	6.97E-02	3.41E-02	2.3444E+00	7.2571E+01
$\alpha_3$	1.24E-07	3.57E-03	7.16E-04	1.69E-02	0.00E+00	2.6722E-01	7.4648E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9296490	0.9635420	0.9664170	0.9876070	0.9653500	1.0245E+02	3.8765E+00
$\alpha_2$	6.60E-03	2.59E-02	2.29E-02	5.51E-02	2.61E-02	2.7495E+00	1.0358E+02
$\alpha_3$	3.38E-04	8.51E-03	5.69E-03	2.63E-02	8.57E-03	9.0431E-01	1.0542E+02
$\alpha_4$	9.00E-09	2.09E-03	2.86E-04	1.05E-02	0.00E+00	2.2267E-01	1.0610E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9428250	0.9676150	0.9694100	0.9862660	0.9718880	1.6654E+02	5.5740E+00
$\alpha_2$	5.00E-03	1.78E-02	1.60E-02	3.69E-02	1.32E-02	3.0666E+00	1.6905E+02
$\alpha_3$	1.65E-03	1.05E-02	8.69E-03	2.56E-02	1.15E-02	1.8107E+00	1.7030E+02
$\alpha_4$	4.06E-05	3.63E-03	1.97E-03	1.28E-02	3.45E-03	6.2439E-01	1.7149E+02
$\alpha_5$	3.46E-21	4.20E-04	2.37E-07	2.43E-03	0.00E+00	7.2277E-02	1.7204E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9477100	0.9695130	0.9710070	0.9862100	0.9762560	2.0137E+02	6.3321E+00
$\alpha_2$	3.63E-03	1.38E-02	1.23E-02	2.92E-02	7.20E-03	2.8622E+00	2.0484E+02
$\alpha_3$	1.65E-03	9.44E-03	7.92E-03	2.24E-02	9.47E-03	1.9612E+00	2.0574E+02
$\alpha_4$	3.21E-04	5.19E-03	3.71E-03	1.51E-02	5.62E-03	1.0783E+00	2.0662E+02
$\alpha_5$	6.21E-07	1.67E-03	5.09E-04	7.29E-03	1.45E-03	3.4720E-01	2.0735E+02
$\alpha_6$	6.78E-19	4.01E-04	7.00E-07	2.34E-03	0.00E+00	8.3237E-02	2.0762E+02

Motor Driven Pumps  
 Emergency Service Water Pump  
 STANDBY SERVICE WATER MDP FAIL TO START  
*ALPHA FACTOR and MGL PARAMETERS*

2010

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9832190	0.9658670	0.9653500	0.9718880	0.9762560
$\alpha_2$	1.68E-02	3.41E-02	2.61E-02	1.32E-02	7.20E-03
$\alpha_3$		0.00E+00	8.57E-03	1.15E-02	9.47E-03
$\alpha_4$			0.00E+00	3.45E-03	5.62E-03
$\alpha_5$				0.00E+00	1.45E-03
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.83E-01	9.66E-01	9.65E-01	9.72E-01	9.76E-01
Beta	1.68E-02	3.41E-02	3.46E-02	2.81E-02	2.37E-02
Gamma		0.00E+00	2.47E-01	5.32E-01	6.97E-01
Delta			0.00E+00	2.31E-01	4.27E-01
Epsilon				0.00E+00	2.05E-01
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	27.68	41.52	55.36	69.20	83.04
$N_1$	1.8262	1.2286	0.9571	1.1786	1.3929
$N_2$	0.5036	1.5107	1.5214	0.9524	0.6230
$N_3$		0.0000	0.5000	0.8333	0.8194
$N_4$			0.0000	0.2500	0.4861
$N_5$				0.0000	0.1250
$N_6$					0.0000



Motor Driven Pumps  
 Emergency Service Water Pump  
 STANDBY SERVICE WATER MDP FAIL TO RUN  
**STANDBY SERVICE WATER MDP FAIL TO RUN**

2010

System : Standby service water  
 Component : Motor Driven Pump  
 Failure Mode : Fail to Run (Normally running equipment)  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 6.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8959650	0.9739500	0.9892430	0.9999480	1.0000000	1.6246E+01	4.3452E-01
$\alpha_2$	4.81E-05	2.60E-02	1.08E-02	1.04E-01	0.00E+00	4.3452E-01	1.6246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9143470	0.9699670	0.9780280	0.9980130	1.0000000	3.5555E+01	1.1009E+00
$\alpha_2$	7.25E-04	2.27E-02	1.48E-02	7.18E-02	0.00E+00	8.3366E-01	3.5822E+01
$\alpha_3$	2.56E-07	7.29E-03	1.48E-03	3.46E-02	0.00E+00	2.6722E-01	3.6389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9178250	0.9665410	0.9712250	0.9943340	1.0000000	5.2136E+01	1.8551E+00
$\alpha_2$	1.89E-03	2.27E-02	1.72E-02	6.27E-02	0.00E+00	1.2281E+00	5.2763E+01
$\alpha_3$	8.45E-06	7.49E-03	2.78E-03	3.09E-02	0.00E+00	4.0431E-01	5.3587E+01
$\alpha_4$	1.78E-08	4.12E-03	5.66E-04	2.07E-02	0.00E+00	2.2267E-01	5.3768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9337450	0.9665250	0.9694270	0.9893730	1.0000000	1.0216E+02	3.5382E+00
$\alpha_2$	3.85E-03	2.00E-02	1.71E-02	4.62E-02	0.00E+00	2.1142E+00	1.0358E+02
$\alpha_3$	4.52E-04	9.25E-03	6.39E-03	2.78E-02	0.00E+00	9.7738E-01	1.0472E+02
$\alpha_4$	2.33E-06	3.54E-03	1.19E-03	1.50E-02	0.00E+00	3.7439E-01	1.0532E+02
$\alpha_5$	5.65E-21	6.84E-04	3.87E-07	3.96E-03	0.00E+00	7.2277E-02	1.0563E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9366750	0.9663680	0.9687880	0.9877920	1.0000000	1.2294E+02	4.2787E+00
$\alpha_2$	3.62E-03	1.76E-02	1.51E-02	4.00E-02	0.00E+00	2.2392E+00	1.2498E+02
$\alpha_3$	6.32E-04	8.98E-03	6.57E-03	2.55E-02	0.00E+00	1.1418E+00	1.2608E+02
$\alpha_4$	4.16E-05	4.66E-03	2.44E-03	1.68E-02	0.00E+00	5.9222E-01	1.2663E+02
$\alpha_5$	7.30E-09	1.75E-03	2.37E-04	8.75E-03	0.00E+00	2.2220E-01	1.2700E+02
$\alpha_6$	1.11E-18	6.54E-04	1.14E-06	3.82E-03	0.00E+00	8.3237E-02	1.2714E+02

Motor Driven Pumps  
 Emergency Service Water Pump  
 STANDBY SERVICE WATER MDP FAIL TO RUN

2010

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	6.00	6.00	6.00	6.00	6.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

Motor Driven Pumps  
 Emergency Service Water Pump  
 SERVICE WATER MDP FAIL TO START SPAR:ESW-MDP-FS  
**SERVICE WATER MDP FAIL TO START SPAR:ESW-MDP-FS**

2010

**System :** Normally operating service water  
 Standby service water  
**Component :** Motor Driven Pump  
**Failure Mode :** Fail to start  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 142.90  
 Total Number of Common-Cause Failure Events: 8

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9571730	0.9835900	0.9870600	0.9981410	0.9869090	8.7318E+01	1.4568E+00
$\alpha_2$	1.86E-03	1.64E-02	1.29E-02	4.28E-02	1.31E-02	1.4568E+00	8.7318E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9483280	0.9732380	0.9753680	0.9908770	0.9756610	1.4248E+02	3.9179E+00
$\alpha_2$	7.59E-03	2.41E-02	2.19E-02	4.79E-02	2.33E-02	3.5257E+00	1.4287E+02
$\alpha_3$	2.44E-06	2.68E-03	9.54E-04	1.12E-02	1.08E-03	3.9222E-01	1.4601E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9469800	0.9692620	0.9708060	0.9862680	0.9717470	1.9469E+02	6.1741E+00
$\alpha_2$	9.07E-03	2.36E-02	2.20E-02	4.34E-02	2.29E-02	4.7333E+00	1.9613E+02
$\alpha_3$	4.15E-04	5.75E-03	4.22E-03	1.63E-02	4.91E-03	1.1556E+00	1.9971E+02
$\alpha_4$	9.45E-08	1.42E-03	3.19E-04	6.60E-03	4.09E-04	2.8517E-01	2.0058E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9539000	0.9715730	0.9726500	0.9855560	0.9752800	2.8139E+02	8.2331E+00
$\alpha_2$	6.43E-03	1.66E-02	1.55E-02	3.05E-02	1.42E-02	4.8052E+00	2.8482E+02
$\alpha_3$	2.06E-03	8.78E-03	7.68E-03	1.93E-02	8.25E-03	2.5436E+00	2.8708E+02
$\alpha_4$	6.84E-05	2.70E-03	1.67E-03	8.81E-03	2.14E-03	7.8069E-01	2.8884E+02
$\alpha_5$	5.79E-16	3.58E-04	2.62E-06	2.07E-03	1.65E-04	1.0358E-01	2.8952E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9576120	0.9732030	0.9741020	0.9857150	0.9777440	3.3878E+02	9.3283E+00
$\alpha_2$	4.73E-03	1.28E-02	1.19E-02	2.40E-02	9.78E-03	4.4581E+00	3.4365E+02
$\alpha_3$	2.20E-03	8.31E-03	7.39E-03	1.76E-02	7.72E-03	2.8926E+00	3.4522E+02
$\alpha_4$	4.52E-04	4.13E-03	3.23E-03	1.09E-02	3.73E-03	1.4378E+00	3.4667E+02
$\alpha_5$	2.45E-06	1.27E-03	5.12E-04	5.09E-03	9.64E-04	4.4100E-01	3.4767E+02
$\alpha_6$	1.20E-16	2.84E-04	1.57E-06	1.65E-03	6.88E-05	9.8837E-02	3.4801E+02

Motor Driven Pumps  
 Emergency Service Water Pump  
 SERVICE WATER MDP FAIL TO START SPAR:ESW-MDP-FS

2010

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9869090	0.9756610	0.9717470	0.9752800	0.9777440
$\alpha_2$	1.31E-02	2.33E-02	2.29E-02	1.42E-02	9.78E-03
$\alpha_3$		1.08E-03	4.91E-03	8.25E-03	7.72E-03
$\alpha_4$			4.09E-04	2.14E-03	3.73E-03
$\alpha_5$				1.65E-04	9.64E-04
$\alpha_6$					6.88E-05

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.87E-01	9.76E-01	9.72E-01	9.75E-01	9.78E-01
Beta	1.31E-02	2.43E-02	2.83E-02	2.47E-02	2.23E-02
Gamma		4.44E-02	1.88E-01	4.27E-01	5.61E-01
Delta			7.68E-02	2.18E-01	3.82E-01
Epsilon				7.15E-02	2.17E-01
Mu					6.66E-02

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	71.45	107.18	142.90	178.63	214.35
$N_1$	5.6220	5.7411	5.6521	6.5954	7.4886
$N_2$	1.0223	2.6920	3.5052	2.6910	2.2189
$N_3$		0.1250	0.7513	1.5662	1.7508
$N_4$			0.0625	0.4063	0.8456
$N_5$				0.0313	0.2188
$N_6$					0.0156

Motor Driven Pumps  
 Emergency Service Water Pump  
 SERVICE WATER MDP FAIL TO RUN SPAR:ESW-MDP-FR  
**SERVICE WATER MDP FAIL TO RUN SPAR:ESW-MDP-FR**

2010

**System :** Normally operating service water  
 Standby service water  
**Component :** Motor Driven Pump  
**Failure Mode :** Fail to Run (Normally running equipment)  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 60.60  
 Total Number of Common-Cause Failure Events: 6

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9013690	0.9585690	0.9651890	0.9930940	0.9583360	4.3099E+01	1.8628E+00
$\alpha_2$	6.91E-03	4.14E-02	3.48E-02	9.86E-02	4.17E-02	1.8628E+00	4.3099E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9167600	0.9583650	0.9620940	0.9872180	0.9548770	7.7583E+01	3.3705E+00
$\alpha_2$	4.95E-03	2.59E-02	2.21E-02	5.98E-02	2.51E-02	2.0955E+00	7.8858E+01
$\alpha_3$	1.40E-03	1.57E-02	1.20E-02	4.30E-02	2.00E-02	1.2750E+00	7.9678E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9224430	0.9573320	0.9599820	0.9831640	0.9544180	1.0918E+02	4.8661E+00
$\alpha_2$	7.09E-03	2.60E-02	2.32E-02	5.41E-02	2.62E-02	2.9611E+00	1.1108E+02
$\alpha_3$	7.85E-04	1.04E-02	7.67E-03	2.91E-02	1.18E-02	1.1813E+00	1.1286E+02
$\alpha_4$	1.25E-04	6.35E-03	3.79E-03	2.13E-02	7.58E-03	7.2367E-01	1.1332E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9330220	0.9595600	0.9612380	0.9803540	0.9535110	1.7399E+02	7.3327E+00
$\alpha_2$	8.52E-03	2.36E-02	2.19E-02	4.46E-02	2.65E-02	4.2769E+00	1.7705E+02
$\alpha_3$	1.53E-03	9.88E-03	8.14E-03	2.42E-02	9.97E-03	1.7910E+00	1.7953E+02
$\alpha_4$	2.30E-04	5.20E-03	3.53E-03	1.59E-02	6.96E-03	9.4229E-01	1.8038E+02
$\alpha_5$	3.62E-07	1.78E-03	4.87E-04	7.94E-03	3.07E-03	3.2248E-01	1.8100E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9352880	0.9593570	0.9607570	0.9786600	0.9526790	2.0937E+02	8.8698E+00
$\alpha_2$	8.49E-03	2.19E-02	2.05E-02	4.03E-02	2.62E-02	4.7844E+00	2.1346E+02
$\alpha_3$	1.84E-03	9.66E-03	8.21E-03	2.24E-02	9.97E-03	2.1090E+00	2.1613E+02
$\alpha_4$	3.80E-04	5.29E-03	3.88E-03	1.50E-02	5.79E-03	1.1543E+00	2.1709E+02
$\alpha_5$	2.93E-05	2.81E-03	1.51E-03	1.00E-02	4.04E-03	6.1390E-01	2.1763E+02
$\alpha_6$	1.70E-09	9.54E-04	1.10E-04	4.87E-03	1.29E-03	2.0824E-01	2.1803E+02

Motor Driven Pumps  
 Emergency Service Water Pump  
 SERVICE WATER MDP FAIL TO RUN SPAR:ESW-MDP-FR  
*ALPHA FACTOR and MGL PARAMETERS*

2010

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9583360	0.9548770	0.9544180	0.9535110	0.9526790
$\alpha_2$	4.17E-02	2.51E-02	2.62E-02	2.65E-02	2.62E-02
$\alpha_3$		2.00E-02	1.18E-02	9.97E-03	9.97E-03
$\alpha_4$			7.58E-03	6.96E-03	5.79E-03
$\alpha_5$				3.07E-03	4.04E-03
$\alpha_6$					1.29E-03

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.58E-01	9.55E-01	9.54E-01	9.54E-01	9.53E-01
Beta	4.17E-02	4.51E-02	4.56E-02	4.65E-02	4.73E-02
Gamma		4.44E-01	4.24E-01	4.30E-01	4.46E-01
Delta			3.92E-01	5.01E-01	5.27E-01
Epsilon				3.06E-01	4.79E-01
Mu					2.42E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	29.06	43.60	58.13	72.66	87.19
$N_1$	3.7933	4.4283	4.9157	5.1654	5.2422
$N_2$	1.4283	1.2618	1.7330	2.1627	2.5452
$N_3$		1.0078	0.7770	0.8136	0.9672
$N_4$			0.5010	0.5679	0.5621
$N_5$				0.2502	0.3917
$N_6$					0.1250

Motor Driven Pumps  
PWR High Pressure Safety Injection Pump  
HIGH PRESSURE INJECTION MOTOR DRIVEN PUMP FAIL TO START

2010

**PWR High Pressure Safety Injection Pump**  
**HIGH PRESSURE INJECTION MOTOR DRIVEN PUMP FAIL TO START**

**System :** Chemical and volume control  
High pressure injection  
**Component :** Motor Driven Pump  
**Failure Mode :** Fail to start  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 143.10  
Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9756040	0.9907320	0.9927470	0.9989830	0.9930600	1.5335E+02	1.4345E+00
$\alpha_2$	1.02E-03	9.27E-03	7.26E-03	2.44E-02	6.94E-03	1.4345E+00	1.5335E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9801560	0.9914700	0.9927560	0.9983840	0.9953630	2.4421E+02	2.1009E+00
$\alpha_2$	5.19E-04	5.41E-03	4.15E-03	1.46E-02	2.32E-03	1.3337E+00	2.4498E+02
$\alpha_3$	7.47E-05	3.11E-03	1.91E-03	1.02E-02	2.32E-03	7.6722E-01	2.4554E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9819300	0.9914820	0.9924410	0.9977720	0.9965180	3.3234E+02	2.8551E+00
$\alpha_2$	5.06E-04	4.41E-03	3.47E-03	1.15E-02	8.70E-04	1.4781E+00	3.3372E+02
$\alpha_3$	1.06E-04	2.70E-03	1.80E-03	8.36E-03	1.74E-03	9.0431E-01	3.3429E+02
$\alpha_4$	4.09E-06	1.41E-03	6.10E-04	5.52E-03	8.70E-04	4.7267E-01	3.3472E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9930600	0.9953630	0.9965180
$\alpha_2$	6.94E-03	2.32E-03	8.70E-04
$\alpha_3$		2.32E-03	1.74E-03
$\alpha_4$			8.70E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.93E-01	9.95E-01	9.97E-01
Beta	6.94E-03	4.64E-03	3.48E-03
Gamma		5.00E-01	7.50E-01
Delta			3.33E-01

PWR High Pressure Safety Injection Pump

HIGH PRESSURE INJECTION MOTOR DRIVEN PUMP FAIL TO START

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4
Adj. Ind. Events	143.10	214.65	286.20
N <sub>1</sub>	0.0000	0.0000	0.0000
N <sub>2</sub>	1.0000	0.5000	0.2500
N <sub>3</sub>		0.5000	0.5000
N <sub>4</sub>			0.2500



Motor Driven Pumps  
PWR High Pressure Safety Injection Pump  
HIGH PRESSURE INJECTION MOTOR DRIVEN PUMP FTR LESS THAN 1H  
**HIGH PRESSURE INJECTION MOTOR DRIVEN PUMP FTR LESS THAN 1H**

2010

**System :** Chemical and volume control  
High pressure injection  
**Component :** Motor Driven Pump  
**Failure Mode :** Fail to Run less than 1 Hour  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 2.50  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8687700	0.9670330	0.9862440	0.9999400	1.0000000	1.2746E+01	4.3452E-01
$\alpha_2$	6.16E-05	3.30E-02	1.38E-02	1.31E-01	0.00E+00	4.3452E-01	1.2746E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9054640	0.9667970	0.9756610	0.9977910	1.0000000	3.2055E+01	1.1009E+00
$\alpha_2$	8.04E-04	2.51E-02	1.64E-02	7.93E-02	0.00E+00	8.3366E-01	3.2322E+01
$\alpha_3$	2.84E-07	8.06E-03	1.63E-03	3.82E-02	0.00E+00	2.6722E-01	3.2889E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9122220	0.9632590	0.9692100	0.9939300	1.0000000	4.8636E+01	1.8551E+00
$\alpha_2$	2.02E-03	2.43E-02	1.84E-02	6.70E-02	0.00E+00	1.2281E+00	4.9263E+01
$\alpha_3$	9.04E-06	8.01E-03	2.98E-03	3.31E-02	0.00E+00	4.0431E-01	5.0087E+01
$\alpha_4$	1.91E-08	4.41E-03	6.05E-04	2.21E-02	0.00E+00	2.2267E-01	5.0268E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

PWR High Pressure Safety Injection Pump

HIGH PRESSURE INJECTION MOTOR DRIVEN PUMP FTR LESS THAN 1H

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	2.50	2.50	2.50
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

Motor Driven Pumps  
PWR High Pressure Safety Injection Pump  
HIGH PRESSURE INJECTION MOTOR DRIVEN PUMP FAIL TO RUN  
**HIGH PRESSURE INJECTION MOTOR DRIVEN PUMP FAIL TO RUN**

2010

**System :** Chemical and volume control  
High pressure injection  
**Component :** Motor Driven Pump  
**Failure Mode :** Fail to Run (Normally running equipment)  
Fail to Run >1 Hour (Standby equipment)  
Fail to Run less than 1 Hour  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 135.80  
Total Number of Common-Cause Failure Events: 5

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9549480	0.9796430	0.9822570	0.9954100	0.9816360	1.1717E+02	2.4348E+00
$\alpha_2$	4.59E-03	2.04E-02	1.77E-02	4.51E-02	1.84E-02	2.4348E+00	1.1717E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9556200	0.9760680	0.9777040	0.9909440	0.9783410	1.8769E+02	4.6019E+00
$\alpha_2$	5.93E-03	1.86E-02	1.70E-02	3.70E-02	1.70E-02	3.5847E+00	1.8871E+02
$\alpha_3$	2.84E-04	5.29E-03	3.70E-03	1.57E-02	4.64E-03	1.0172E+00	1.9127E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9606790	0.9774990	0.9787020	0.9902030	0.9811190	2.5626E+02	5.8988E+00
$\alpha_2$	3.60E-03	1.23E-02	1.11E-02	2.52E-02	9.35E-03	3.2301E+00	2.5893E+02
$\alpha_3$	1.47E-03	7.90E-03	6.69E-03	1.85E-02	7.78E-03	2.0710E+00	2.6009E+02
$\alpha_4$	2.12E-05	2.28E-03	1.20E-03	8.21E-03	1.75E-03	5.9767E-01	2.6156E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9816360	0.9783410	0.9811190
$\alpha_2$	1.84E-02	1.70E-02	9.35E-03
$\alpha_3$		4.64E-03	7.78E-03
$\alpha_4$			1.75E-03

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.82E-01	9.78E-01	9.81E-01
Beta	1.84E-02	2.17E-02	1.89E-02
Gamma		2.14E-01	5.05E-01
Delta			1.84E-01

PWR High Pressure Safety Injection Pump

HIGH PRESSURE INJECTION MOTOR DRIVEN PUMP FAIL TO RUN

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	104.46	156.69	208.92
<b>N<sub>1</sub></b>	2.4660	1.4480	1.2071
<b>N<sub>2</sub></b>	2.0003	2.7510	2.0020
<b>N<sub>3</sub></b>		0.7500	1.6667
<b>N<sub>4</sub></b>			0.3750

Motor Driven Pumps  
PWR High Pressure Safety Injection Pump  
HIGH PRESSURE INJECTION MOTOR DRIVEN PUMP FAIL TO RUN >1H  
**HIGH PRESSURE INJECTION MOTOR DRIVEN PUMP FAIL TO RUN >1H**

2010

**System :** Chemical and volume control  
High pressure injection  
**Component :** Motor Driven Pump  
**Failure Mode :** Fail to Run (Normally running equipment)  
Fail to Run >1 Hour (Standby equipment)  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 133.30

Total Number of Common-Cause Failure Events: 5

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9542190	0.9793110	0.9819660	0.9953340	0.9813070	1.1525E+02	2.4348E+00
$\alpha_2$	4.67E-03	2.07E-02	1.80E-02	4.58E-02	1.87E-02	2.4348E+00	1.1525E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9549510	0.9757040	0.9773630	0.9908050	0.9779480	1.8481E+02	4.6019E+00
$\alpha_2$	6.02E-03	1.89E-02	1.73E-02	3.75E-02	1.73E-02	3.5847E+00	1.8583E+02
$\alpha_3$	2.89E-04	5.37E-03	3.76E-03	1.59E-02	4.72E-03	1.0172E+00	1.8839E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9600980	0.9771650	0.9783890	0.9900560	0.9807750	2.5242E+02	5.8988E+00
$\alpha_2$	3.65E-03	1.25E-02	1.13E-02	2.56E-02	9.52E-03	3.2301E+00	2.5509E+02
$\alpha_3$	1.50E-03	8.02E-03	6.79E-03	1.87E-02	7.92E-03	2.0710E+00	2.5625E+02
$\alpha_4$	2.15E-05	2.31E-03	1.22E-03	8.33E-03	1.78E-03	5.9767E-01	2.5772E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9813070	0.9779480	0.9807750
$\alpha_2$	1.87E-02	1.73E-02	9.52E-03
$\alpha_3$		4.72E-03	7.92E-03
$\alpha_4$			1.78E-03

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.81E-01	9.78E-01	9.81E-01
Beta	1.87E-02	2.21E-02	1.92E-02
Gamma		2.14E-01	5.05E-01
Delta			1.84E-01

PWR High Pressure Safety Injection Pump

HIGH PRESSURE INJECTION MOTOR DRIVEN PUMP FAIL TO RUN >1H

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	102.54	153.81	205.08
<b>N<sub>1</sub></b>	2.4660	1.4480	1.2071
<b>N<sub>2</sub></b>	2.0003	2.7510	2.0020
<b>N<sub>3</sub></b>		0.7500	1.6667
<b>N<sub>4</sub></b>			0.3750

## PWR Residual Heat Removal Pump

### PWR RHR MDP FAIL TO START

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
Component : Motor Driven Pump  
Failure Mode : Fail to start  
Op. Mode : CCF Event Can Only Happen During Power Operation  
CCF Event May Occur During Both Power Operation & Shutdown  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 33.50

Total Number of Common-Cause Failure Events: 3

### ALPHA FACTOR DISTRIBUTIONS

#### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9048220	0.9619520	0.9690180	0.9948830	0.9628450	4.0566E+01	1.6045E+00
$\alpha_2$	5.12E-03	3.80E-02	3.10E-02	9.52E-02	3.72E-02	1.6045E+00	4.0566E+01

#### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9281530	0.9668900	0.9708430	0.9920950	0.9687360	7.4600E+01	2.5546E+00
$\alpha_2$	3.47E-03	2.28E-02	1.88E-02	5.58E-02	1.99E-02	1.7592E+00	7.5395E+01
$\alpha_3$	2.80E-04	1.03E-02	6.50E-03	3.33E-02	1.14E-02	7.9542E-01	7.6359E+01

#### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9344890	0.9666210	0.9694270	0.9891500	0.9707450	1.0574E+02	3.6514E+00
$\alpha_2$	3.94E-03	1.98E-02	1.70E-02	4.55E-02	1.53E-02	2.1700E+00	1.0722E+02
$\alpha_3$	4.79E-04	9.17E-03	6.41E-03	2.73E-02	9.76E-03	1.0036E+00	1.0839E+02
$\alpha_4$	1.35E-05	4.37E-03	1.92E-03	1.70E-02	4.15E-03	4.7777E-01	1.0891E+02

### ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9628450	0.9687360	0.9707450
$\alpha_2$	3.72E-02	1.99E-02	1.53E-02
$\alpha_3$		1.14E-02	9.76E-03
$\alpha_4$			4.15E-03

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.63E-01	9.69E-01	9.71E-01
Beta	3.72E-02	3.13E-02	2.93E-02
Gamma		3.63E-01	4.76E-01
Delta			2.99E-01

Motor Driven Pumps  
PWR Residual Heat Removal Pump  
PWR RHR MDP FAIL TO START

2010

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	28.76	43.13	57.51
<b>N<sub>1</sub></b>	1.5600	1.9145	2.0960
<b>N<sub>2</sub></b>	1.1700	0.9255	0.9419
<b>N<sub>3</sub></b>		0.5282	0.5993
<b>N<sub>4</sub></b>			0.2551



Motor Driven Pumps  
PWR Residual Heat Removal Pump  
PWR RHR MDP FTR LESS THAN 1H  
**PWR RHR MDP FTR LESS THAN 1H**

2010

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
Component : Motor Driven Pump  
Failure Mode : Fail to Run less than 1 Hour  
Op. Mode : CCF Event Can Only Happen During Power Operation  
CCF Event May Occur During Both Power Operation & Shutdown  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 3.10  
Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.7559040	0.9029460	0.9208280	0.9885570	0.7560980	1.3346E+01	1.4345E+00
$\alpha_2$	1.14E-02	9.71E-02	7.92E-02	2.44E-01	2.44E-01	1.4345E+00	1.3346E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8683020	0.9421330	0.9501000	0.9886510	0.8230090	3.4205E+01	2.1009E+00
$\alpha_2$	3.62E-03	3.67E-02	2.86E-02	9.78E-02	8.85E-02	1.3337E+00	3.4972E+01
$\alpha_3$	5.18E-04	2.11E-02	1.32E-02	6.88E-02	8.85E-02	7.6722E-01	3.5539E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8921340	0.9482690	0.9536140	0.9861190	0.8611110	5.2336E+01	2.8551E+00
$\alpha_2$	3.13E-03	2.68E-02	2.13E-02	6.92E-02	3.47E-02	1.4781E+00	5.3713E+01
$\alpha_3$	6.56E-04	1.64E-02	1.10E-02	5.04E-02	6.94E-02	9.0431E-01	5.4287E+01
$\alpha_4$	2.51E-05	8.56E-03	3.74E-03	3.34E-02	3.47E-02	4.7267E-01	5.4718E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.7560980	0.8230090	0.8611110
$\alpha_2$	2.44E-01	8.85E-02	3.47E-02
$\alpha_3$		8.85E-02	6.94E-02
$\alpha_4$			3.47E-02

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	7.56E-01	8.23E-01	8.61E-01
Beta	2.44E-01	1.77E-01	1.39E-01
Gamma		5.00E-01	7.50E-01
Delta			3.33E-01

Motor Driven Pumps  
PWR Residual Heat Removal Pump  
PWR RHR MDP FTR LESS THAN 1H

2010

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	3.10	4.65	6.20
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	1.0000	0.5000	0.2500
<b>N<sub>3</sub></b>		0.5000	0.5000
<b>N<sub>4</sub></b>			0.2500

Motor Driven Pumps  
PWR Residual Heat Removal Pump  
PWR RHR MDP FAIL TO RUN  
**PWR RHR MDP FAIL TO RUN**

2010

**System :** Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
**Component :** Motor Driven Pump  
**Failure Mode :** Fail to Run >1 Hour (Standby equipment)  
Fail to Run less than 1 Hour  
**Op. Mode :** CCF Event Can Only Happen During Power Operation  
CCF Event May Occur During Both Power Operation & Shutdown  
**Plant Type :** PWR  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 10.10  
Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8315110	0.9341380	0.9470550	0.9924380	0.9099100	2.0346E+01	1.4345E+00
$\alpha_2$	7.56E-03	6.59E-02	5.29E-02	1.68E-01	9.01E-02	1.4345E+00	2.0346E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8972310	0.9551140	0.9614590	0.9912720	0.9380800	4.4705E+01	2.1009E+00
$\alpha_2$	2.79E-03	2.85E-02	2.21E-02	7.62E-02	3.10E-02	1.3337E+00	4.5472E+01
$\alpha_3$	3.99E-04	1.64E-02	1.02E-02	5.35E-02	3.10E-02	7.6722E-01	4.6039E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9135850	0.9587360	0.9630890	0.9889930	0.9528300	6.6336E+01	2.8551E+00
$\alpha_2$	2.49E-03	2.14E-02	1.69E-02	5.54E-02	1.18E-02	1.4781E+00	6.7713E+01
$\alpha_3$	5.22E-04	1.31E-02	8.77E-03	4.03E-02	2.36E-02	9.0431E-01	6.8287E+01
$\alpha_4$	2.00E-05	6.83E-03	2.98E-03	2.67E-02	1.18E-02	4.7267E-01	6.8718E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9099100	0.9380800	0.9528300
$\alpha_2$	9.01E-02	3.10E-02	1.18E-02
$\alpha_3$		3.10E-02	2.36E-02
$\alpha_4$			1.18E-02

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.10E-01	9.38E-01	9.53E-01
Beta	9.01E-02	6.19E-02	4.72E-02
Gamma		5.00E-01	7.50E-01
Delta			3.33E-01

Motor Driven Pumps  
PWR Residual Heat Removal Pump  
PWR RHR MDP FAIL TO RUN

2010

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	10.10	15.15	20.20
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	1.0000	0.5000	0.2500
<b>N<sub>3</sub></b>		0.5000	0.5000
<b>N<sub>4</sub></b>			0.2500

Motor Driven Pumps  
PWR Residual Heat Removal Pump  
PWR RHR MDP FAIL TO RUN >1H  
**PWR RHR MDP FAIL TO RUN >1H**

2010

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
Component : Motor Driven Pump  
Failure Mode : Fail to Run >1 Hour (Standby equipment)  
Op. Mode : CCF Event Can Only Happen During Power Operation  
CCF Event May Occur During Both Power Operation & Shutdown  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 7.00  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9017830	0.9754240	0.9898730	0.9999510	1.0000000	1.7246E+01	4.3452E-01
$\alpha_2$	4.52E-05	2.46E-02	1.01E-02	9.82E-02	0.00E+00	4.3452E-01	1.7246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9165860	0.9707650	0.9786210	0.9980670	1.0000000	3.6555E+01	1.1009E+00
$\alpha_2$	7.05E-04	2.21E-02	1.44E-02	7.00E-02	0.00E+00	8.3366E-01	3.6822E+01
$\alpha_3$	2.49E-07	7.10E-03	1.44E-03	3.37E-02	0.00E+00	2.6722E-01	3.7389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9192920	0.9662660	0.9717540	0.9944390	1.0000000	5.3136E+01	1.8551E+00
$\alpha_2$	1.85E-03	2.23E-02	1.68E-02	6.16E-02	0.00E+00	1.2281E+00	5.3763E+01
$\alpha_3$	8.29E-06	7.35E-03	2.73E-03	3.04E-02	0.00E+00	4.0431E-01	5.4587E+01
$\alpha_4$	1.75E-08	4.05E-03	5.55E-04	2.03E-02	0.00E+00	2.2267E-01	5.4768E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Motor Driven Pumps  
PWR Residual Heat Removal Pump  
PWR RHR MDP FAIL TO RUN >1H

2010

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	7.00	7.00	7.00
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

**BWR Standby Liquid Control Pump**

**STANDBY LIQUID CONTROL MDP FAIL TO START SPAR: SLC-MDP-FS**

System : Standby liquid control  
 Component : Motor Driven Pump  
 Failure Mode : Fail to start  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 14.50  
 Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9303290	0.9824790	0.9926940	0.9999600	0.9993190	2.4926E+01	4.4452E-01
$\alpha_2$	3.66E-05	1.75E-02	7.31E-03	6.97E-02	6.81E-04	4.4452E-01	2.4926E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2
$\alpha_1$	0.9993190
$\alpha_2$	6.81E-04

MGL Parameter	CCCG=2
1-Beta	9.99E-01
Beta	6.81E-04

Avg. Impact Vector	CCCG=2
Adj. Ind. Events	14.50
N <sub>1</sub>	0.1800
N <sub>2</sub>	0.0100

Motor Driven Pumps  
 BWR Standby Liquid Control Pump  
 STANDBY LIQUID CONTROL MDP FAIL TO RUN SPAR: SLC-MDP-FR  
**STANDBY LIQUID CONTROL MDP FAIL TO RUN SPAR: SLC-MDP-FR**

2010

**System :** Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
**Component :** Motor Driven Pump  
**Failure Mode :** Fail to Run >1 Hour (Standby equipment)  
 Fail to Run less than 1 Hour  
**Op. Mode :** CCF Event Can Only Happen During Power Operation  
 CCF Event May Occur During Both Power Operation & Shutdown  
**Plant Type :** PWR  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 10.10  
 Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8315110	0.9341380	0.9470550	0.9924380	0.9099100	2.0346E+01	1.4345E+00
$\alpha_2$	7.56E-03	6.59E-02	5.29E-02	1.68E-01	9.01E-02	1.4345E+00	2.0346E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2
$\alpha_1$	0.9099100
$\alpha_2$	9.01E-02

MGL Parameter	CCCG=2
1-Beta	9.10E-01
Beta	9.01E-02

Avg. Impact Vector	CCCG=2
Adj. Ind. Events	10.10
$N_1$	0.0000
$N_2$	1.0000



Motor Driven Pumps  
 BWR Standby Liquid Control Pump  
 STANDBY LIQUID CONTROL MDP FAIL TO RUN >1H  
**STANDBY LIQUID CONTROL MDP FAIL TO RUN >1H**

2010

System : Standby liquid control  
 Component : Motor Driven Pump  
 Failure Mode : Fail to Run >1 Hour (Standby equipment)  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 2.20  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8657670	0.9662650	0.9859070	0.9999390	1.0000000	1.2446E+01	4.3452E-01
$\alpha_2$	6.31E-05	3.37E-02	1.41E-02	1.34E-01	0.00E+00	4.3452E-01	1.2446E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2
$\alpha_1$	1.0000000
$\alpha_2$	0.00E+00

MGL Parameter	CCCG=2
1-Beta	1.00E+00
Beta	0.00E+00

Avg. Impact Vector	CCCG=2
Adj. Ind. Events	2.20
$N_1$	0.0000
$N_2$	0.0000

**Component Cooling Water Pumps**

**CCW MOTOR DRIVEN PUMP FAIL TO START SPAR: CCW-MDP-FS**

System : Component cooling water  
 Component : Motor Driven Pump  
 Failure Mode : Fail to start  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 79.70  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9806290	0.9951920	0.9980790	0.9999920	1.0000000	8.9946E+01	4.3452E-01
$\alpha_2$	8.56E-06	4.81E-03	1.92E-03	1.94E-02	0.00E+00	4.3452E-01	8.9946E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9712540	0.9900240	0.9927850	0.9993480	1.0000000	1.0925E+02	1.1009E+00
$\alpha_2$	2.37E-04	7.55E-03	4.86E-03	2.41E-02	0.00E+00	8.3366E-01	1.0952E+02
$\alpha_3$	8.42E-08	2.42E-03	4.85E-04	1.15E-02	0.00E+00	2.6722E-01	1.1008E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3
$\alpha_1$	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00

MGL Parameter	CCCG=2	CCCG=3
1-Beta	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00
Gamma		0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3
Adj. Ind. Events	79.70	79.70
$N_1$	0.0000	0.0000
$N_2$	0.0000	0.0000
$N_3$		0.0000

Motor Driven Pumps  
 Component Cooling Water Pumps  
 CCW MOTOR DRIVEN PUMP FAIL TO RUN SPAR: CCW-MDP-FR  
**CCW MOTOR DRIVEN PUMP FAIL TO RUN SPAR: CCW-MDP-FR**

2010

System : Component cooling water  
 Component : Motor Driven Pump  
 Failure Mode : Fail to Run (Normally running equipment)  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 54.50  
 Total Number of Common-Cause Failure Events: 2

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9114470	0.9652970	0.9721280	0.9957350	0.9672290	4.2219E+01	1.5178E+00
$\alpha_2$	4.26E-03	3.47E-02	2.79E-02	8.86E-02	3.28E-02	1.5178E+00	4.2219E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9342170	0.9704720	0.9743250	0.9935480	0.9744690	7.7265E+01	2.3509E+00
$\alpha_2$	8.57E-04	1.36E-02	9.81E-03	3.94E-02	5.11E-03	1.0837E+00	7.8532E+01
$\alpha_3$	1.40E-03	1.59E-02	1.21E-02	4.36E-02	2.04E-02	1.2672E+00	7.8349E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3
$\alpha_1$	0.9672290	0.9744690
$\alpha_2$	3.28E-02	5.11E-03
$\alpha_3$		2.04E-02

MGL Parameter	CCCG=2	CCCG=3
1-Beta	9.67E-01	9.74E-01
Beta	3.28E-02	2.55E-02
Gamma		8.00E-01

Avg. Impact Vector	CCCG=2	CCCG=3
Adj. Ind. Events	31.14	46.71
$N_1$	0.8333	1.0000
$N_2$	1.0833	0.2500
$N_3$		1.0000

## Positive Displacement Pumps

### POSITIVE DISPLACEMENT PUMP FAIL TO START

Component : Motor Driven Pump  
 Failure Mode : Fail to start  
 Component Group : Positive Displacement  
 Start Date : 1998/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 89.60  
 Total Number of Common-Cause Failure Events: 1

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9823140	0.9955760	0.9981920	0.9999920	0.9998890	1.0003E+02	4.4452E-01
$\alpha_2$	9.04E-06	4.42E-03	1.81E-03	1.77E-02	1.11E-04	4.4452E-01	1.0003E+02

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9804610	0.9931720	0.9950280	0.9995290	0.9997920	1.6420E+02	1.1289E+00
$\alpha_2$	1.79E-04	5.21E-03	3.39E-03	1.64E-02	2.00E-04	8.6066E-01	1.6447E+02
$\alpha_3$	5.85E-08	1.62E-03	3.26E-04	7.69E-03	7.43E-06	2.6822E-01	1.6506E+02

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9798920	0.9916170	0.9930050	0.9985880	0.9997090	2.2563E+02	1.9074E+00
$\alpha_2$	4.95E-04	5.61E-03	4.25E-03	1.54E-02	2.71E-04	1.2767E+00	2.2626E+02
$\alpha_3$	2.12E-06	1.79E-03	6.67E-04	7.39E-03	2.01E-05	4.0791E-01	2.2713E+02
$\alpha_4$	4.22E-09	9.79E-04	1.33E-04	4.90E-03	5.57E-07	2.2277E-01	2.2731E+02

#### ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9998890	0.9997920	0.9997090
$\alpha_2$	1.11E-04	2.00E-04	2.71E-04
$\alpha_3$		7.43E-06	2.01E-05
$\alpha_4$			5.57E-07

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	1.11E-04	2.08E-04	2.91E-04
Gamma		3.57E-02	7.07E-02
Delta			2.70E-02

Motor Driven Pumps

2010

Positive Displacement Pumps

POSITIVE DISPLACEMENT PUMP FAIL TO START

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	89.60	134.40	179.20
<b>N<sub>1</sub></b>	0.1800	0.2430	0.2916
<b>N<sub>2</sub></b>	0.0100	0.0270	0.0486
<b>N<sub>3</sub></b>		0.0010	0.0036
<b>N<sub>4</sub></b>			0.0001

Motor Driven Pumps  
 Positive Displacement Pumps  
 POSITIVE DISPLACEMENT PUMP FAIL TO RUN  
**POSITIVE DISPLACEMENT PUMP FAIL TO RUN**

2010

Component : Motor Driven Pump  
 Failure Mode : Fail to Run (Normally running equipment)  
 Component Group : Positive Displacement  
 Start Date : 1998/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 86.20  
 Total Number of Common-Cause Failure Events: 2

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9577590	0.9845660	0.9882850	0.9986410	0.9883390	8.0873E+01	1.2678E+00
$\alpha_2$	1.36E-03	1.54E-02	1.17E-02	4.22E-02	1.17E-02	1.2678E+00	8.0873E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9532970	0.9773390	0.9796280	0.9935700	0.9811660	1.3374E+02	3.1009E+00
$\alpha_2$	4.52E-03	1.89E-02	1.66E-02	4.11E-02	1.65E-02	2.5837E+00	1.3426E+02
$\alpha_3$	1.78E-05	3.78E-03	1.78E-03	1.43E-02	2.35E-03	5.1722E-01	1.3632E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9575280	0.9775940	0.9792580	0.9919720	0.9831320	1.8456E+02	4.2301E+00
$\alpha_2$	3.00E-03	1.31E-02	1.14E-02	2.90E-02	8.88E-03	2.4781E+00	1.8631E+02
$\alpha_3$	7.84E-04	7.44E-03	5.79E-03	1.97E-02	7.10E-03	1.4043E+00	1.8739E+02
$\alpha_4$	6.92E-07	1.84E-03	5.62E-04	8.02E-03	8.88E-04	3.4767E-01	1.8844E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9883390	0.9811660	0.9831320
$\alpha_2$	1.17E-02	1.65E-02	8.88E-03
$\alpha_3$		2.35E-03	7.10E-03
$\alpha_4$			8.88E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.88E-01	9.81E-01	9.83E-01
Beta	1.17E-02	1.88E-02	1.69E-02
Gamma		1.25E-01	4.74E-01
Delta			1.11E-01

Motor Driven Pumps  
Positive Displacement Pumps

2010

POSITIVE DISPLACEMENT PUMP FAIL TO RUN

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4
Adj. Ind. Events	68.96	103.44	137.92
N <sub>1</sub>	1.6667	0.7500	0.5000
N <sub>2</sub>	0.8333	1.7500	1.2500
N <sub>3</sub>		0.2500	1.0000
N <sub>4</sub>			0.1250

## Turbine Driven Pumps

### Pooled Turbine Driven Pumps

#### TURBINE DRIVEN PUMP FAIL TO START SPAR: TDP-FS

Component : Turbine Driven Pump  
 Failure Mode : Fail to start  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 167.90

Total Number of Common-Cause Failure Events: 1

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9789610	0.9920120	0.9937470	0.9991230	0.9940790	1.7815E+02	1.4345E+00
$\alpha_2$	8.74E-04	7.99E-03	6.25E-03	2.10E-02	5.92E-03	1.4345E+00	1.7815E+02

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9827500	0.9925890	0.9937130	0.9985920	0.9960450	2.8140E+02	2.1009E+00
$\alpha_2$	4.51E-04	4.70E-03	3.60E-03	1.27E-02	1.98E-03	1.3337E+00	2.8217E+02
$\alpha_3$	6.49E-05	2.71E-03	1.66E-03	8.90E-03	1.98E-03	7.6722E-01	2.8273E+02

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9842490	0.9925800	0.9934180	0.9980610	0.9970310	3.8194E+02	2.8551E+00
$\alpha_2$	4.41E-04	3.84E-03	3.02E-03	1.00E-02	7.42E-04	1.4781E+00	3.8332E+02
$\alpha_3$	9.27E-05	2.35E-03	1.56E-03	7.29E-03	1.48E-03	9.0431E-01	3.8389E+02
$\alpha_4$	3.56E-06	1.23E-03	5.32E-04	4.81E-03	7.42E-04	4.7267E-01	3.8432E+02

#### ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9940790	0.9960450	0.9970310
$\alpha_2$	5.92E-03	1.98E-03	7.42E-04
$\alpha_3$		1.98E-03	1.48E-03
$\alpha_4$			7.42E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.94E-01	9.96E-01	9.97E-01
Beta	5.92E-03	3.95E-03	2.97E-03
Gamma		5.00E-01	7.50E-01
Delta			3.33E-01



Turbine Driven Pumps  
Pooled Turbine Driven Pumps

2010

**TURBINE DRIVEN PUMP FAIL TO START SPAR: TDP-FS**

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	167.90	251.85	335.80
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	1.0000	0.5000	0.2500
<b>N<sub>3</sub></b>		0.5000	0.5000
<b>N<sub>4</sub></b>			0.2500

Turbine Driven Pumps  
Pooled Turbine Driven Pumps  
TURBINE DRIVEN PUMP FTR LESS THAN 1H  
**TURBINE DRIVEN PUMP FTR LESS THAN 1H**

2010

Component : Turbine Driven Pump  
Failure Mode : Fail to Run less than 1 Hour  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 62.60  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9761140	0.9940700	0.9976270	0.9999880	1.0000000	7.2846E+01	4.3452E-01
$\alpha_2$	1.06E-05	5.93E-03	2.38E-03	2.39E-02	0.00E+00	4.3452E-01	7.2846E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9660150	0.9881950	0.9914590	0.9992280	1.0000000	9.2155E+01	1.1009E+00
$\alpha_2$	2.81E-04	8.94E-03	5.76E-03	2.84E-02	0.00E+00	8.3366E-01	9.2422E+01
$\alpha_3$	9.97E-08	2.87E-03	5.74E-04	1.36E-02	0.00E+00	2.6722E-01	9.2989E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9595530	0.9832260	0.9860440	0.9972690	1.0000000	1.0874E+02	1.8551E+00
$\alpha_2$	9.12E-04	1.11E-02	8.33E-03	3.08E-02	0.00E+00	1.2281E+00	1.0937E+02
$\alpha_3$	4.10E-06	3.66E-03	1.35E-03	1.51E-02	0.00E+00	4.0431E-01	1.1019E+02
$\alpha_4$	8.65E-09	2.01E-03	2.75E-04	1.01E-02	0.00E+00	2.2267E-01	1.1037E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Turbine Driven Pumps  
Pooled Turbine Driven Pumps  
TURBINE DRIVEN PUMP FTR LESS THAN 1H

2010

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	62.60	62.60	62.60
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

Turbine Driven Pumps  
Pooled Turbine Driven Pumps  
TDP FTR LESS THAN AND > 1 HOUR ALL SYSTEMS SPAR: TDP-FR  
**TDP FTR LESS THAN AND > 1 HOUR ALL SYSTEMS SPAR: TDP-FR**

2010

**Component :** Turbine Driven Pump  
**Failure Mode :** Fail to Run (Normally running equipment)  
Fail to Run >1 Hour (Standby equipment)  
Fail to Run less than 1 Hour  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 130.60  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9876020	0.9969250	0.9987700	0.9999890	1.0000000	1.4085E+02	4.3452E-01
$\alpha_2$	5.46E-06	3.08E-03	1.23E-03	1.24E-02	0.00E+00	4.3452E-01	1.4085E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9802920	0.9931730	0.9950720	0.9995550	1.0000000	1.6015E+02	1.1009E+00
$\alpha_2$	1.62E-04	5.17E-03	3.32E-03	1.65E-02	0.00E+00	8.3366E-01	1.6042E+02
$\alpha_3$	5.75E-08	1.66E-03	3.31E-04	7.86E-03	0.00E+00	2.6722E-01	1.6098E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9748790	0.9896130	0.9913740	0.9983130	1.0000000	1.7674E+02	1.8551E+00
$\alpha_2$	5.63E-04	6.88E-03	5.14E-03	1.91E-02	0.00E+00	1.2281E+00	1.7737E+02
$\alpha_3$	2.53E-06	2.26E-03	8.34E-04	9.36E-03	0.00E+00	4.0431E-01	1.7819E+02
$\alpha_4$	5.35E-09	1.25E-03	1.70E-04	6.24E-03	0.00E+00	2.2267E-01	1.7837E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9693910	0.9846360	0.9860200	0.9951690	1.0000000	2.2676E+02	3.5382E+00
$\alpha_2$	1.76E-03	9.18E-03	7.80E-03	2.13E-02	0.00E+00	2.1142E+00	2.2818E+02
$\alpha_3$	2.06E-04	4.24E-03	2.92E-03	1.28E-02	0.00E+00	9.7738E-01	2.2932E+02
$\alpha_4$	1.07E-06	1.63E-03	5.46E-04	6.91E-03	0.00E+00	3.7439E-01	2.2992E+02
$\alpha_5$	2.58E-21	3.14E-04	1.77E-07	1.81E-03	0.00E+00	7.2277E-02	2.3023E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9678230	0.9830090	0.9842690	0.9938810	1.0000000	2.4754E+02	4.2787E+00
$\alpha_2$	1.82E-03	8.89E-03	7.63E-03	2.03E-02	0.00E+00	2.2392E+00	2.4958E+02
$\alpha_3$	3.18E-04	4.53E-03	3.31E-03	1.29E-02	0.00E+00	1.1418E+00	2.5068E+02
$\alpha_4$	2.10E-05	2.35E-03	1.23E-03	8.49E-03	0.00E+00	5.9222E-01	2.5123E+02
$\alpha_5$	3.68E-09	8.82E-04	1.19E-04	4.42E-03	0.00E+00	2.2220E-01	2.5160E+02
$\alpha_6$	5.59E-19	3.31E-04	5.77E-07	1.93E-03	0.00E+00	8.3237E-02	2.5174E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	130.60	130.60	130.60	130.60	130.60
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

Turbine Driven Pumps  
Pooled Turbine Driven Pumps  
TURBINE DRIVEN PUMP FAIL TO RUN >1H  
**TURBINE DRIVEN PUMP FAIL TO RUN >1H**

2010

Component : Turbine Driven Pump  
Failure Mode : Fail to Run (Normally running equipment)  
Fail to Run >1 Hour (Standby equipment)  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 68.00  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9777550	0.9944770	0.9977910	0.9999910	1.0000000	7.8246E+01	4.3452E-01
$\alpha_2$	9.84E-06	5.52E-03	2.21E-03	2.22E-02	0.00E+00	4.3452E-01	7.8246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9678650	0.9888410	0.9919290	0.9992710	1.0000000	9.7555E+01	1.1009E+00
$\alpha_2$	2.65E-04	8.45E-03	5.44E-03	2.69E-02	0.00E+00	8.3366E-01	9.7822E+01
$\alpha_3$	9.42E-08	2.71E-03	5.42E-04	1.28E-02	0.00E+00	2.6722E-01	9.8389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9614270	0.9840070	0.9866970	0.9973970	1.0000000	1.1414E+02	1.8551E+00
$\alpha_2$	8.70E-04	1.06E-02	7.94E-03	2.94E-02	0.00E+00	1.2281E+00	1.1477E+02
$\alpha_3$	3.91E-06	3.49E-03	1.29E-03	1.44E-02	0.00E+00	4.0431E-01	1.1559E+02
$\alpha_4$	8.25E-09	1.92E-03	2.62E-04	9.61E-03	0.00E+00	2.2267E-01	1.1577E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Turbine Driven Pumps  
Pooled Turbine Driven Pumps  
**TURBINE DRIVEN PUMP FAIL TO RUN >1H**

2010

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	68.00	68.00	68.00
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

## AFW Turbine-Driven Pumps

### AFW TURBINE DRIVEN PUMP FAIL TO START SPAR: AFW-TDP-FS

System : Auxiliary feedwater  
 Component : Turbine Driven Pump  
 Failure Mode : Fail to start  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 66.90  
 Total Number of Common-Cause Failure Events: 0

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9774400	0.9943990	0.9977600	0.9999910	1.0000000	7.7146E+01	4.3452E-01
$\alpha_2$	9.98E-06	5.60E-03	2.24E-03	2.26E-02	0.00E+00	4.3452E-01	7.7146E+01

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9675050	0.9887150	0.9918380	0.9992620	1.0000000	9.6455E+01	1.1009E+00
$\alpha_2$	2.68E-04	8.55E-03	5.50E-03	2.72E-02	0.00E+00	8.3366E-01	9.6722E+01
$\alpha_3$	9.53E-08	2.74E-03	5.49E-04	1.30E-02	0.00E+00	2.6722E-01	9.7289E+01

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9610610	0.9838540	0.9865690	0.9973720	1.0000000	1.1304E+02	1.8551E+00
$\alpha_2$	8.78E-04	1.07E-02	8.01E-03	2.96E-02	0.00E+00	1.2281E+00	1.1367E+02
$\alpha_3$	3.94E-06	3.52E-03	1.30E-03	1.45E-02	0.00E+00	4.0431E-01	1.1449E+02
$\alpha_4$	8.33E-09	1.94E-03	2.64E-04	9.70E-03	0.00E+00	2.2267E-01	1.1467E+02

#### ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00



Turbine Driven Pumps  
AFW Turbine-Driven Pumps

2010

AFW TURBINE DRIVEN PUMP FAIL TO START SPAR: AFW-TDP-FS

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	66.90	66.90	66.90
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

**AFW TURBINE DRIVEN PUMP FTR LESS THAN 1H SPAR: AFW-TDP-FH**

System : Auxiliary feedwater  
 Component : Turbine Driven Pump  
 Failure Mode : Fail to Run less than 1 Hour  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 40.00

Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9655000	0.9914260	0.9965530	0.9999830	1.0000000	5.0246E+01	4.3452E-01
$\alpha_2$	1.54E-05	8.57E-03	3.45E-03	3.45E-02	0.00E+00	4.3452E-01	5.0246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9552250	0.9844190	0.9886960	0.9989790	1.0000000	6.9555E+01	1.1009E+00
$\alpha_2$	3.72E-04	1.18E-02	7.62E-03	3.75E-02	0.00E+00	8.3366E-01	6.9822E+01
$\alpha_3$	1.32E-07	3.78E-03	7.59E-04	1.79E-02	0.00E+00	2.6722E-01	7.0389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9492630	0.9789170	0.9824320	0.9965570	1.0000000	8.6136E+01	1.8551E+00
$\alpha_2$	1.15E-03	1.40E-02	1.05E-02	3.86E-02	0.00E+00	1.2281E+00	8.6763E+01
$\alpha_3$	5.16E-06	4.59E-03	1.70E-03	1.90E-02	0.00E+00	4.0431E-01	8.7587E+01
$\alpha_4$	1.09E-08	2.53E-03	3.46E-04	1.27E-02	0.00E+00	2.2267E-01	8.7768E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Turbine Driven Pumps  
AFW Turbine-Driven Pumps

2010

AFW TURBINE DRIVEN PUMP FTR LESS THAN 1H SPAR: AFW-TDP-FH

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	40.00	40.00	40.00
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

Turbine Driven Pumps  
 AFW Turbine-Driven Pumps  
 AFW TURBINE DRIVEN PUMP FAIL TO RUN SPAR: AFW-TDP-FR  
**AFW TURBINE DRIVEN PUMP FAIL TO RUN SPAR: AFW-TDP-FR**

2010

System : Auxiliary feedwater  
 Component : Turbine Driven Pump  
 Failure Mode : Fail to Run >1 Hour (Standby equipment)  
 Fail to Run less than 1 Hour  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 48.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9701940	0.9925950	0.9970290	0.9999850	1.0000000	5.8246E+01	4.3452E-01
$\alpha_2$	1.32E-05	7.40E-03	2.97E-03	2.98E-02	0.00E+00	4.3452E-01	5.8246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9597510	0.9860040	0.9898550	0.9990840	1.0000000	7.7555E+01	1.1009E+00
$\alpha_2$	3.33E-04	1.06E-02	6.84E-03	3.37E-02	0.00E+00	8.3366E-01	7.7822E+01
$\alpha_3$	1.18E-07	3.40E-03	6.81E-04	1.61E-02	0.00E+00	2.6722E-01	7.8389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9534540	0.9806740	0.9839060	0.9968480	1.0000000	9.4136E+01	1.8551E+00
$\alpha_2$	1.05E-03	1.28E-02	9.60E-03	3.54E-02	0.00E+00	1.2281E+00	9.4763E+01
$\alpha_3$	4.73E-06	4.21E-03	1.56E-03	1.74E-02	0.00E+00	4.0431E-01	9.5587E+01
$\alpha_4$	9.98E-09	2.32E-03	3.17E-04	1.16E-02	0.00E+00	2.2267E-01	9.5768E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Turbine Driven Pumps

2010

AFW Turbine-Driven Pumps

AFW TURBINE DRIVEN PUMP FAIL TO RUN SPAR: AFW-TDP-FR

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	48.00	48.00	48.00
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

Turbine Driven Pumps  
 AFW Turbine-Driven Pumps  
 AFW TURBINE DRIVEN PUMP FAIL TO RUN >1H  
**AFW TURBINE DRIVEN PUMP FAIL TO RUN >1H**

2010

System : Auxiliary feedwater  
 Component : Turbine Driven Pump  
 Failure Mode : Fail to Run >1 Hour (Standby equipment)  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 8.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9069840	0.9767390	0.9904340	0.9999540	1.0000000	1.8246E+01	4.3452E-01
$\alpha_2$	4.27E-05	2.33E-02	9.56E-03	9.30E-02	0.00E+00	4.3452E-01	1.8246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9187120	0.9715210	0.9791840	0.9981180	1.0000000	3.7555E+01	1.1009E+00
$\alpha_2$	6.87E-04	2.16E-02	1.40E-02	6.82E-02	0.00E+00	8.3366E-01	3.7822E+01
$\alpha_3$	2.43E-07	6.91E-03	1.40E-03	3.28E-02	0.00E+00	2.6722E-01	3.8389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9207150	0.9668680	0.9722640	0.9945410	1.0000000	5.4136E+01	1.8551E+00
$\alpha_2$	1.82E-03	2.19E-02	1.65E-02	6.05E-02	0.00E+00	1.2281E+00	5.4763E+01
$\alpha_3$	8.14E-06	7.22E-03	2.68E-03	2.98E-02	0.00E+00	4.0431E-01	5.5587E+01
$\alpha_4$	1.72E-08	3.98E-03	5.45E-04	1.99E-02	0.00E+00	2.2267E-01	5.5768E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Turbine Driven Pumps  
AFW Turbine-Driven Pumps

2010

AFW TURBINE DRIVEN PUMP FAIL TO RUN >1H

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	8.00	8.00	8.00
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

## BWR High Pressure Coolant Injection and Reactor Core Isolation Cooling Pumps

### COMBINED HPCI AND RCIC TDP FAIL TO START

System : High pressure coolant injection  
 Reactor core isolation  
 Component : Turbine Driven Pump  
 Failure Mode : Fail to start  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 88.00

Total Number of Common-Cause Failure Events: 1

#### ALPHA FACTOR DISTRIBUTIONS

CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9622100	0.9856090	0.9887030	0.9984190	0.9887640	9.8246E+01	1.4345E+00
$\alpha_2$	1.58E-03	1.44E-02	1.13E-02	3.78E-02	1.12E-02	1.4345E+00	9.8246E+01

#### ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2
$\alpha_1$	0.9887640
$\alpha_2$	1.12E-02

MGL Parameter	CCCG=2
1-Beta	9.89E-01
Beta	1.12E-02

Avg. Impact Vector	CCCG=2
Adj. Ind. Events	88.00
$N_1$	0.0000
$N_2$	1.0000



Turbine Driven Pumps  
 BWR High Pressure Coolant Injection and Reactor Core Isolation Cooling Pumps  
 COMBINED HPCI AND RCIC TDP FTR LESS THAN 1H  
**COMBINED HPCI AND RCIC TDP FTR LESS THAN 1H**

2010

**System :** High pressure coolant injection  
 Reactor core isolation  
**Component :** Turbine Driven Pump  
**Failure Mode :** Fail to Run less than 1 Hour  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 22.60  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9475590	0.9869440	0.9947100	0.9999740	1.0000000	3.2846E+01	4.3452E-01
$\alpha_2$	2.36E-05	1.31E-02	5.29E-03	5.24E-02	0.00E+00	4.3452E-01	3.2846E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2
$\alpha_1$	1.0000000
$\alpha_2$	0.00E+00

MGL Parameter	CCCG=2
1-Beta	1.00E+00
Beta	0.00E+00

Avg. Impact Vector	CCCG=2
Adj. Ind. Events	22.60
$N_1$	0.0000
$N_2$	0.0000

Turbine Driven Pumps  
 BWR High Pressure Coolant Injection and Reactor Core Isolation Cooling Pumps  
 COMBINED HPCI AND RCIC TDP FAIL TO RUN  
**COMBINED HPCI AND RCIC TDP FAIL TO RUN**

2010

**System :** High pressure coolant injection  
 Reactor core isolation  
**Component :** Turbine Driven Pump  
**Failure Mode :** Fail to Run >1 Hour (Standby equipment)  
 Fail to Run less than 1 Hour  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 25.60  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9518730	0.9880230	0.9951600	0.9999760	1.0000000	3.5846E+01	4.3452E-01
$\alpha_2$	2.16E-05	1.20E-02	4.84E-03	4.81E-02	0.00E+00	4.3452E-01	3.5846E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2
$\alpha_1$	1.0000000
$\alpha_2$	0.00E+00

MGL Parameter	CCCG=2
1-Beta	1.00E+00
Beta	0.00E+00

Avg. Impact Vector	CCCG=2
Adj. Ind. Events	25.60
$N_1$	0.0000
$N_2$	0.0000

Turbine Driven Pumps  
 BWR High Pressure Coolant Injection and Reactor Core Isolation Cooling Pumps  
 COMBINED HPCI AND RCIC TDP FAIL TO RUN >1H  
**COMBINED HPCI AND RCIC TDP FAIL TO RUN >1H**

2010

**System :** High pressure coolant injection  
 Reactor core isolation  
**Component :** Turbine Driven Pump  
**Failure Mode :** Fail to Run >1 Hour (Standby equipment)  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 3.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8734960	0.9682380	0.9867710	0.9999360	1.0000000	1.3246E+01	4.3452E-01
$\alpha_2$	5.92E-05	3.18E-02	1.32E-02	1.27E-01	0.00E+00	4.3452E-01	1.3246E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2
$\alpha_1$	1.0000000
$\alpha_2$	0.00E+00

MGL Parameter	CCCG=2
1-Beta	1.00E+00
Beta	0.00E+00

Avg. Impact Vector	CCCG=2
Adj. Ind. Events	3.00
$N_1$	0.0000
$N_2$	0.0000

## Motor Operated Valves

### Pooled Motor Operated Valve Distributions

#### MOV FAIL TO OPEN/CLOSE ALL SYSTEMS SPAR: MOV-FO

Component : Motor Operated Valve  
Failure Mode : Fail to close (reset) on demand  
Fail to Open/Close Mode Unspecified (demand based)  
Fail to open on demand  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 486.70

Total Number of Common-Cause Failure Events: 8

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9733330	0.9886710	0.9904450	0.9979480	0.9905450	1.7598E+02	2.0165E+00
$\alpha_2$	2.05E-03	1.13E-02	9.56E-03	2.67E-02	9.46E-03	2.0165E+00	1.7598E+02

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9738350	0.9866890	0.9878310	0.9956450	0.9894640	2.7659E+02	3.7313E+00
$\alpha_2$	2.76E-03	1.04E-02	9.23E-03	2.19E-02	8.30E-03	2.9063E+00	2.7742E+02
$\alpha_3$	8.89E-05	2.94E-03	1.88E-03	9.43E-03	2.23E-03	8.2502E-01	2.7950E+02

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9728200	0.9844870	0.9853280	0.9932690	0.9878370	3.7364E+02	5.8877E+00
$\alpha_2$	4.06E-03	1.13E-02	1.04E-02	2.14E-02	9.21E-03	4.2825E+00	3.7525E+02
$\alpha_3$	2.05E-04	2.98E-03	2.17E-03	8.54E-03	2.19E-03	1.1315E+00	3.7840E+02
$\alpha_4$	3.66E-06	1.25E-03	5.41E-04	4.88E-03	7.57E-04	4.7367E-01	3.7905E+02

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9735460	0.9836850	0.9843070	0.9916900	0.9883110	5.0454E+02	8.3683E+00
$\alpha_2$	3.96E-03	9.91E-03	9.28E-03	1.80E-02	7.18E-03	5.0829E+00	5.0783E+02
$\alpha_3$	9.71E-04	4.55E-03	3.92E-03	1.03E-02	3.28E-03	2.3331E+00	5.1058E+02
$\alpha_4$	3.34E-05	1.47E-03	8.95E-04	4.87E-03	9.21E-04	7.5479E-01	5.1215E+02
$\alpha_5$	3.28E-10	3.85E-04	3.86E-05	1.99E-03	3.03E-04	1.9748E-01	5.1271E+02

Motor Operated Valves

2010

Pooled Motor Operated Valve Distributions

MOV FAIL TO OPEN/CLOSE ALL SYSTEMS SPAR: MOV-FO

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9750180	0.9840990	0.9846180	0.9914020	0.9888510	6.0618E+02	9.7944E+00
$\alpha_2$	3.16E-03	8.05E-03	7.52E-03	1.47E-02	5.49E-03	4.9562E+00	6.1102E+02
$\alpha_3$	1.43E-03	5.05E-03	4.53E-03	1.05E-02	3.98E-03	3.1118E+00	6.1286E+02
$\alpha_4$	1.18E-04	1.80E-03	1.30E-03	5.19E-03	1.04E-03	1.1074E+00	6.1487E+02
$\alpha_5$	2.24E-06	7.68E-04	3.33E-04	3.01E-03	5.08E-04	4.7330E-01	6.1550E+02
$\alpha_6$	1.21E-12	2.37E-04	8.82E-06	1.31E-03	1.26E-04	1.4574E-01	6.1583E+02

**CCCG = 7**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9758200	0.9839290	0.9843450	0.9906090	0.9898010	7.5441E+02	1.2322E+01
$\alpha_2$	3.08E-03	7.31E-03	6.89E-03	1.30E-02	4.37E-03	5.6080E+00	7.6112E+02
$\alpha_3$	1.37E-03	4.49E-03	4.06E-03	9.04E-03	3.14E-03	3.4398E+00	7.6329E+02
$\alpha_4$	4.61E-04	2.60E-03	2.18E-03	6.17E-03	1.74E-03	1.9939E+00	7.6474E+02
$\alpha_5$	4.14E-05	1.14E-03	7.50E-04	3.59E-03	6.17E-04	8.7707E-01	7.6585E+02
$\alpha_6$	1.50E-07	4.47E-04	1.33E-04	1.96E-03	2.72E-04	3.4278E-01	7.6639E+02
$\alpha_7$	2.16E-25	7.87E-05	7.94E-09	4.42E-04	5.43E-05	6.0371E-02	7.6667E+02

**CCCG = 8**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9771010	0.9845000	0.9848610	0.9906520	0.9905140	8.7015E+02	1.3700E+01
$\alpha_2$	2.78E-03	6.51E-03	6.14E-03	1.15E-02	3.66E-03	5.7527E+00	8.7810E+02
$\alpha_3$	1.20E-03	3.90E-03	3.53E-03	7.86E-03	2.60E-03	3.4466E+00	8.8040E+02
$\alpha_4$	5.58E-04	2.63E-03	2.26E-03	5.95E-03	1.79E-03	2.3238E+00	8.8153E+02
$\alpha_5$	1.33E-04	1.47E-03	1.11E-03	4.01E-03	8.94E-04	1.2962E+00	8.8255E+02
$\alpha_6$	7.27E-06	6.96E-04	3.73E-04	2.48E-03	3.77E-04	6.1486E-01	8.8323E+02
$\alpha_7$	7.44E-10	2.45E-04	3.12E-05	1.24E-03	1.43E-04	2.1677E-01	8.8363E+02
$\alpha_8$	1.31E-30	5.51E-05	4.38E-10	2.91E-04	2.37E-05	4.8724E-02	8.8380E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9905450	0.9894640	0.9878370	0.9883110	0.9888510	0.9898010	0.9905140
$\alpha_2$	9.46E-03	8.30E-03	9.21E-03	7.18E-03	5.49E-03	4.37E-03	3.66E-03
$\alpha_3$		2.23E-03	2.19E-03	3.28E-03	3.98E-03	3.14E-03	2.60E-03
$\alpha_4$			7.57E-04	9.21E-04	1.04E-03	1.74E-03	1.79E-03
$\alpha_5$				3.03E-04	5.08E-04	6.17E-04	8.94E-04
$\alpha_6$					1.26E-04	2.72E-04	3.77E-04
$\alpha_7$						5.43E-05	1.43E-04
$\alpha_8$							2.37E-05

Motor Operated Valves

2010

Pooled Motor Operated Valve Distributions

MOV FAIL TO OPEN/CLOSE ALL SYSTEMS SPAR: MOV-FO

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.91E-01	9.89E-01	9.88E-01	9.88E-01	9.89E-01	9.90E-01	9.91E-01
Beta	9.46E-03	1.05E-02	1.22E-02	1.17E-02	1.11E-02	1.02E-02	9.49E-03
Gamma		2.12E-01	2.43E-01	3.85E-01	5.07E-01	5.71E-01	6.14E-01
Delta			2.57E-01	2.72E-01	2.96E-01	4.61E-01	5.54E-01
Epsilon				2.48E-01	3.78E-01	3.51E-01	4.45E-01
Mu					1.99E-01	3.46E-01	3.78E-01
Upsilon						1.67E-01	3.06E-01
Sigma							1.43E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	162.23	243.35	324.47	405.58	486.70	567.82	648.93
N <sub>1</sub>	3.5027	3.6814	3.0389	2.8019	2.5394	2.5414	2.4909
N <sub>2</sub>	1.5820	2.0726	3.0544	2.9687	2.7170	2.5202	2.4080
N <sub>3</sub>		0.5578	0.7272	1.3557	1.9700	1.8086	1.7082
N <sub>4</sub>			0.2510	0.3804	0.5152	1.0050	1.1773
N <sub>5</sub>				0.1252	0.2511	0.3553	0.5879
N <sub>6</sub>					0.0625	0.1565	0.2479
N <sub>7</sub>						0.0313	0.0938
N <sub>8</sub>							0.0156

Motor Operated Valves  
Pooled Motor Operated Valve Distributions  
MOV FAIL TO OPEN ALL SYSTEMS SPAR: MOV-CC  
**MOV FAIL TO OPEN ALL SYSTEMS SPAR: MOV-CC**

Component : Motor Operated Valve  
Failure Mode : Fail to open on demand  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 272.80

Total Number of Common-Cause Failure Events: 4

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9518680	0.9807780	0.9843850	0.9973570	0.9838390	8.3925E+01	1.6448E+00
$\alpha_2$	2.65E-03	1.92E-02	1.56E-02	4.81E-02	1.62E-02	1.6448E+00	8.3925E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9599550	0.9814940	0.9837050	0.9954900	0.9862770	1.3959E+02	2.6319E+00
$\alpha_2$	2.01E-03	1.28E-02	1.06E-02	3.10E-02	8.79E-03	1.8146E+00	1.4041E+02
$\alpha_3$	1.69E-04	5.75E-03	3.66E-03	1.84E-02	4.93E-03	8.1732E-01	1.4140E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9627900	0.9810490	0.9826580	0.9938060	0.9874330	1.9240E+02	3.7167E+00
$\alpha_2$	2.12E-03	1.09E-02	9.30E-03	2.52E-02	6.15E-03	2.1395E+00	1.9398E+02
$\alpha_3$	3.67E-04	5.63E-03	4.07E-03	1.62E-02	4.73E-03	1.1045E+00	1.9501E+02
$\alpha_4$	7.01E-06	2.41E-03	1.04E-03	9.44E-03	1.69E-03	4.7267E-01	1.9564E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9649400	0.9801630	0.9812760	0.9915710	0.9886140	2.7870E+02	5.6406E+00
$\alpha_2$	2.61E-03	9.99E-03	8.87E-03	2.12E-02	3.94E-03	2.8410E+00	2.8150E+02
$\alpha_3$	1.05E-03	6.52E-03	5.40E-03	1.58E-02	4.74E-03	1.8529E+00	2.8249E+02
$\alpha_4$	5.84E-05	2.64E-03	1.60E-03	8.74E-03	2.03E-03	7.4939E-01	2.8359E+02
$\alpha_5$	5.83E-10	6.94E-04	6.95E-05	3.59E-03	6.77E-04	1.9728E-01	2.8414E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9677770	0.9812130	0.9821410	0.9914700	0.9902640	3.3592E+02	6.4317E+00
$\alpha_2$	1.62E-03	7.17E-03	6.23E-03	1.59E-02	9.70E-04	2.4537E+00	3.3990E+02
$\alpha_3$	1.54E-03	6.99E-03	6.06E-03	1.56E-02	5.66E-03	2.3928E+00	3.3996E+02
$\alpha_4$	1.34E-04	2.83E-03	1.94E-03	8.55E-03	1.70E-03	9.6722E-01	3.4138E+02
$\alpha_5$	3.98E-06	1.38E-03	5.97E-04	5.40E-03	1.13E-03	4.7220E-01	3.4188E+02
$\alpha_6$	2.17E-12	4.26E-04	1.59E-05	2.36E-03	2.83E-04	1.4574E-01	3.4221E+02

Motor Operated Valves  
Pooled Motor Operated Valve Distributions  
MOV FAIL TO OPEN ALL SYSTEMS SPAR: MOV-CC  
CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9689200	0.9806800	0.9813880	0.9900170	0.9914110	4.3946E+02	8.6578E+00
$\alpha_2$	2.22E-03	7.43E-03	6.71E-03	1.51E-02	9.39E-04	3.3297E+00	4.4479E+02
$\alpha_3$	1.17E-03	5.33E-03	4.62E-03	1.19E-02	2.94E-03	2.3895E+00	4.4573E+02
$\alpha_4$	5.43E-04	3.80E-03	3.09E-03	9.47E-03	2.77E-03	1.7014E+00	4.4642E+02
$\alpha_5$	5.81E-05	1.86E-03	1.19E-03	5.94E-03	1.21E-03	8.3427E-01	4.4728E+02
$\alpha_6$	2.55E-07	7.64E-04	2.28E-04	3.35E-03	6.07E-04	3.4258E-01	4.4778E+02
$\alpha_7$	3.71E-25	1.35E-04	1.36E-08	7.57E-04	1.21E-04	6.0371E-02	4.4806E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9705700	0.9812740	0.9818850	0.9898850	0.9922410	5.1055E+02	9.7430E+00
$\alpha_2$	2.24E-03	6.99E-03	6.37E-03	1.39E-02	1.00E-03	3.6388E+00	5.1665E+02
$\alpha_3$	8.41E-04	4.22E-03	3.60E-03	9.70E-03	1.55E-03	2.1955E+00	5.1810E+02
$\alpha_4$	5.80E-04	3.58E-03	2.96E-03	8.67E-03	2.43E-03	1.8610E+00	5.1843E+02
$\alpha_5$	1.71E-04	2.27E-03	1.67E-03	6.41E-03	1.61E-03	1.1808E+00	5.1911E+02
$\alpha_6$	1.10E-05	1.16E-03	6.10E-04	4.15E-03	7.97E-04	6.0136E-01	5.1969E+02
$\alpha_7$	1.26E-09	4.17E-04	5.31E-05	2.10E-03	3.19E-04	2.1677E-01	5.2008E+02
$\alpha_8$	2.23E-30	9.36E-05	7.45E-10	4.94E-04	5.30E-05	4.8724E-02	5.2024E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9838390	0.9862770	0.9874330	0.9886140	0.9902640	0.9914110	0.9922410
$\alpha_2$	1.62E-02	8.79E-03	6.15E-03	3.94E-03	9.70E-04	9.39E-04	1.00E-03
$\alpha_3$		4.93E-03	4.73E-03	4.74E-03	5.66E-03	2.94E-03	1.55E-03
$\alpha_4$			1.69E-03	2.03E-03	1.70E-03	2.77E-03	2.43E-03
$\alpha_5$				6.77E-04	1.13E-03	1.21E-03	1.61E-03
$\alpha_6$					2.83E-04	6.07E-04	7.97E-04
$\alpha_7$						1.21E-04	3.19E-04
$\alpha_8$							5.30E-05

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.84E-01	9.86E-01	9.87E-01	9.89E-01	9.90E-01	9.91E-01	9.92E-01
Beta	1.62E-02	1.37E-02	1.26E-02	1.14E-02	9.74E-03	8.59E-03	7.76E-03
Gamma		3.59E-01	5.10E-01	6.54E-01	9.00E-01	8.91E-01	8.71E-01
Delta			2.63E-01	3.64E-01	3.55E-01	6.15E-01	7.70E-01
Epsilon				2.50E-01	4.55E-01	4.12E-01	5.33E-01
Mu					2.00E-01	3.75E-01	4.21E-01
Upsilon						1.67E-01	3.18E-01
Sigma							1.43E-01



Motor Operated Valves

2010

Pooled Motor Operated Valve Distributions

MOV FAIL TO OPEN ALL SYSTEMS SPAR: MOV-CC

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	72.75	109.12	145.49	181.87	218.24	254.61	290.99
N <sub>1</sub>	0.9293	0.9132	0.7766	0.6698	0.7430	0.7972	0.8319
N <sub>2</sub>	1.2103	0.9809	0.9114	0.7268	0.2145	0.2419	0.2941
N <sub>3</sub>		0.5501	0.7002	0.8755	1.2510	0.7583	0.4571
N <sub>4</sub>			0.2500	0.3750	0.3750	0.7125	0.7145
N <sub>5</sub>				0.1250	0.2500	0.3125	0.4725
N <sub>6</sub>					0.0625	0.1563	0.2344
N <sub>7</sub>						0.0313	0.0938
N <sub>8</sub>							0.0156

Motor Operated Valves  
Pooled Motor Operated Valve Distributions  
MOV FAIL TO CLOSE ALL SYSTEMS SPAR: MOV-OO  
**MOV FAIL TO CLOSE ALL SYSTEMS SPAR: MOV-OO**

2010

Component : Motor Operated Valve  
Failure Mode : Fail to close (reset) on demand  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 195.90  
Total Number of Common-Cause Failure Events: 4

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9742010	0.9919930	0.9949270	0.9997760	0.9958710	9.9889E+01	8.0622E-01
$\alpha_2$	2.27E-04	8.01E-03	5.07E-03	2.58E-02	4.13E-03	8.0622E-01	9.9889E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9694990	0.9866730	0.9885800	0.9973230	0.9918230	1.6292E+02	2.2005E+00
$\alpha_2$	1.99E-03	1.17E-02	9.76E-03	2.79E-02	8.12E-03	1.9255E+00	1.6320E+02
$\alpha_3$	7.76E-08	1.67E-03	3.51E-04	7.83E-03	5.80E-05	2.7502E-01	1.6485E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9658200	0.9822290	0.9836270	0.9938550	0.9878420	2.2253E+02	4.0261E+00
$\alpha_2$	4.51E-03	1.49E-02	1.35E-02	3.00E-02	1.20E-02	3.3711E+00	2.2318E+02
$\alpha_3$	3.22E-06	1.90E-03	7.53E-04	7.70E-03	1.51E-04	4.3131E-01	2.2612E+02
$\alpha_4$	4.48E-09	9.87E-04	1.36E-04	4.94E-03	5.60E-06	2.2367E-01	2.2633E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9664550	0.9805540	0.9815380	0.9912860	0.9877420	3.1596E+02	6.2660E+00
$\alpha_2$	4.92E-03	1.35E-02	1.25E-02	2.55E-02	1.01E-02	4.3561E+00	3.1787E+02
$\alpha_3$	5.07E-04	4.52E-03	3.55E-03	1.19E-02	2.16E-03	1.4576E+00	3.2077E+02
$\alpha_4$	8.55E-07	1.18E-03	4.03E-04	4.98E-03	2.43E-05	3.7979E-01	3.2185E+02
$\alpha_5$	2.07E-21	2.25E-04	1.30E-07	1.30E-03	8.99E-07	7.2477E-02	3.2215E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9674510	0.9802840	0.9811030	0.9903190	0.9873750	3.7994E+02	7.6415E+00
$\alpha_2$	4.69E-03	1.22E-02	1.14E-02	2.26E-02	9.40E-03	4.7417E+00	3.8284E+02
$\alpha_3$	7.79E-04	4.80E-03	3.98E-03	1.16E-02	2.70E-03	1.8608E+00	3.8572E+02
$\alpha_4$	3.87E-05	1.89E-03	1.13E-03	6.32E-03	5.26E-04	7.3242E-01	3.8685E+02
$\alpha_5$	2.56E-09	5.76E-04	7.88E-05	2.88E-03	4.13E-06	2.2330E-01	3.8736E+02
$\alpha_6$	3.63E-19	2.15E-04	3.75E-07	1.25E-03	0.00E+00	8.3237E-02	3.8750E+02

Motor Operated Valves  
Pooled Motor Operated Valve Distributions  
MOV FAIL TO CLOSE ALL SYSTEMS SPAR: MOV-OO  
CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9685020	0.9798070	0.9804410	0.9889430	0.9881860	4.9052E+02	1.0109E+01
$\alpha_2$	4.42E-03	1.07E-02	1.01E-02	1.92E-02	7.35E-03	5.3661E+00	4.9526E+02
$\alpha_3$	1.32E-03	5.36E-03	4.71E-03	1.16E-02	3.39E-03	2.6815E+00	4.9795E+02
$\alpha_4$	2.27E-04	2.56E-03	1.94E-03	7.02E-03	9.43E-04	1.2814E+00	4.9935E+02
$\alpha_5$	8.09E-06	1.13E-03	5.68E-04	4.15E-03	1.38E-04	5.6457E-01	5.0006E+02
$\alpha_6$	1.36E-10	3.72E-04	3.18E-05	1.95E-03	6.45E-07	1.8648E-01	5.0044E+02
$\alpha_7$	0.00E+00	5.81E-05	5.08E-14	2.18E-04	0.00E+00	2.9071E-02	5.0060E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9699900	0.9803170	0.9808650	0.9887690	0.9888200	5.6866E+02	1.1418E+01
$\alpha_2$	3.91E-03	9.41E-03	8.85E-03	1.68E-02	5.97E-03	5.4586E+00	5.7462E+02
$\alpha_3$	1.40E-03	5.15E-03	4.60E-03	1.08E-02	3.54E-03	2.9894E+00	5.7709E+02
$\alpha_4$	3.65E-04	2.77E-03	2.23E-03	7.05E-03	1.31E-03	1.6093E+00	5.7847E+02
$\alpha_5$	4.26E-05	1.42E-03	9.04E-04	4.56E-03	3.26E-04	8.2373E-01	5.7925E+02
$\alpha_6$	4.81E-07	6.56E-04	2.24E-04	2.77E-03	3.81E-05	3.8046E-01	5.7970E+02
$\alpha_7$	2.80E-14	2.12E-04	3.81E-06	1.21E-03	0.00E+00	1.2297E-01	5.7995E+02
$\alpha_8$	5.25E-43	5.71E-05	8.13E-13	2.41E-04	0.00E+00	3.3124E-02	5.8004E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9958710	0.9918230	0.9878420	0.9877420	0.9873750	0.9881860	0.9888200
$\alpha_2$	4.13E-03	8.12E-03	1.20E-02	1.01E-02	9.40E-03	7.35E-03	5.97E-03
$\alpha_3$		5.80E-05	1.51E-04	2.16E-03	2.70E-03	3.39E-03	3.54E-03
$\alpha_4$			5.60E-06	2.43E-05	5.26E-04	9.43E-04	1.31E-03
$\alpha_5$				8.99E-07	4.13E-06	1.38E-04	3.26E-04
$\alpha_6$					0.00E+00	6.45E-07	3.81E-05
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.96E-01	9.92E-01	9.88E-01	9.88E-01	9.87E-01	9.88E-01	9.89E-01
Beta	4.13E-03	8.18E-03	1.22E-02	1.23E-02	1.26E-02	1.18E-02	1.12E-02
Gamma		7.09E-03	1.29E-02	1.78E-01	2.56E-01	3.78E-01	4.66E-01
Delta			3.57E-02	1.15E-02	1.64E-01	2.42E-01	3.21E-01
Epsilon				3.57E-02	7.78E-03	1.28E-01	2.18E-01
Mu					0.00E+00	4.65E-03	1.05E-01
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Motor Operated Valves

2010

Pooled Motor Operated Valve Distributions

MOV FAIL TO CLOSE ALL SYSTEMS SPAR: MOV-OO

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	87.07	130.60	174.13	217.67	261.20	304.73	348.27
N <sub>1</sub>	2.5733	2.7683	2.2623	2.1320	1.7964	1.7442	1.6590
N <sub>2</sub>	0.3717	1.0918	2.1430	2.2419	2.5025	2.2783	2.1139
N <sub>3</sub>		0.0078	0.0270	0.4802	0.7190	1.0503	1.2510
N <sub>4</sub>			0.0010	0.0054	0.1402	0.2925	0.4628
N <sub>5</sub>				0.0002	0.0011	0.0428	0.1154
N <sub>6</sub>					0.0000	0.0002	0.0135
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Motor Operated Valves  
Pooled Motor Operated Valve Distributions  
MOV SPURIOUS OPERATION ALL SYSTEMS SPAR: MOV-CO  
**MOV SPURIOUS OPERATION ALL SYSTEMS SPAR: MOV-CO**

2010

Component : Motor Operated Valve  
Failure Mode : Spurious operation open or close  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 24.00  
Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8725230	0.9628520	0.9785950	0.9994900	0.9684190	1.6817E+01	6.4882E-01
$\alpha_2$	5.07E-04	3.71E-02	2.14E-02	1.27E-01	3.16E-02	6.4882E-01	1.6817E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9013250	0.9605540	0.9678750	0.9947070	0.9496400	3.8984E+01	1.6009E+00
$\alpha_2$	2.75E-03	3.11E-02	2.38E-02	8.46E-02	4.32E-02	1.2623E+00	3.9323E+01
$\alpha_3$	2.57E-06	8.34E-03	2.48E-03	3.66E-02	7.19E-03	3.3862E-01	4.0246E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9080180	0.9571600	0.9620750	0.9894800	0.9416900	5.8365E+01	2.6123E+00
$\alpha_2$	4.31E-03	2.86E-02	2.36E-02	6.99E-02	3.96E-02	1.7424E+00	5.9235E+01
$\alpha_3$	1.24E-04	1.04E-02	5.73E-03	3.65E-02	1.76E-02	6.3291E-01	6.0344E+01
$\alpha_4$	3.59E-08	3.89E-03	6.13E-04	1.91E-02	1.10E-03	2.3697E-01	6.0740E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9282170	0.9613920	0.9640230	0.9855610	0.9419630	1.1123E+02	4.4669E+00
$\alpha_2$	5.19E-03	2.20E-02	1.93E-02	4.80E-02	2.68E-02	2.5428E+00	1.1315E+02
$\alpha_3$	1.29E-03	1.22E-02	9.48E-03	3.22E-02	2.68E-02	1.4060E+00	1.1429E+02
$\alpha_4$	8.00E-06	3.85E-03	1.58E-03	1.54E-02	4.46E-03	4.4579E-01	1.1525E+02
$\alpha_5$	5.16E-21	6.25E-04	3.53E-07	3.62E-03	0.00E+00	7.2277E-02	1.1562E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9327880	0.9623540	0.9645330	0.9844680	0.9473680	1.3494E+02	5.2787E+00
$\alpha_2$	3.97E-03	1.75E-02	1.53E-02	3.87E-02	1.13E-02	2.4535E+00	1.3777E+02
$\alpha_3$	1.78E-03	1.22E-02	9.99E-03	3.03E-02	3.01E-02	1.7132E+00	1.3851E+02
$\alpha_4$	1.63E-04	5.75E-03	3.64E-03	1.86E-02	1.13E-02	8.0652E-01	1.3941E+02
$\alpha_5$	6.62E-09	1.58E-03	2.15E-04	7.94E-03	0.00E+00	2.2220E-01	1.4000E+02
$\alpha_6$	1.01E-18	5.94E-04	1.04E-06	3.46E-03	0.00E+00	8.3237E-02	1.4014E+02

Motor Operated Valves  
Pooled Motor Operated Valve Distributions  
MOV SPURIOUS OPERATION ALL SYSTEMS SPAR: MOV-CO  
*ALPHA FACTOR and MGL PARAMETERS*

2010

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9684190	0.9496400	0.9416900	0.9419630	0.9473680
$\alpha_2$	3.16E-02	4.32E-02	3.96E-02	2.68E-02	1.13E-02
$\alpha_3$		7.19E-03	1.76E-02	2.68E-02	3.01E-02
$\alpha_4$			1.10E-03	4.46E-03	1.13E-02
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.68E-01	9.50E-01	9.42E-01	9.42E-01	9.47E-01
Beta	3.16E-02	5.04E-02	5.83E-02	5.80E-02	5.26E-02
Gamma		1.43E-01	3.21E-01	5.38E-01	7.86E-01
Delta			5.89E-02	1.43E-01	2.73E-01
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	6.00	9.00	12.00	15.00	18.00
$N_1$	0.5714	0.4286	0.2286	0.0714	0.0000
$N_2$	0.2143	0.4286	0.5143	0.4286	0.2143
$N_3$		0.0714	0.2286	0.4286	0.5714
$N_4$			0.0143	0.0714	0.2143
$N_5$				0.0000	0.0000
$N_6$					0.0000

Motor Operated Valves  
PWR Containment Spray Motor Operated Valves  
CONTAINMENT SPRAY MOV FAIL TO OPEN/CLOSE

2010

**PWR Containment Spray Motor Operated Valves**  
**CONTAINMENT SPRAY MOV FAIL TO OPEN/CLOSE**

**System :** Containment spray recirculation  
**Component :** Motor Operated Valve  
**Failure Mode :** Fail to close (reset) on demand  
Fail to Open/Close Mode Unspecified (demand based)  
Fail to open on demand  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 23.50  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9489320	0.9872880	0.9948520	0.9999750	1.0000000	3.3746E+01	4.3452E-01
$\alpha_2$	2.29E-05	1.27E-02	5.15E-03	5.11E-02	0.00E+00	4.3452E-01	3.3746E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9417320	0.9796720	0.9852150	0.9986630	1.0000000	5.3055E+01	1.1009E+00
$\alpha_2$	4.87E-04	1.54E-02	9.97E-03	4.88E-02	0.00E+00	8.3366E-01	5.3322E+01
$\alpha_3$	1.73E-07	4.93E-03	9.93E-04	2.34E-02	0.00E+00	2.6722E-01	5.3889E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9376940	0.9740520	0.9783390	0.9957420	1.0000000	6.9636E+01	1.8551E+00
$\alpha_2$	1.42E-03	1.72E-02	1.29E-02	4.75E-02	0.00E+00	1.2281E+00	7.0263E+01
$\alpha_3$	6.36E-06	5.66E-03	2.09E-03	2.34E-02	0.00E+00	4.0431E-01	7.1087E+01
$\alpha_4$	1.34E-08	3.11E-03	4.26E-04	1.56E-02	0.00E+00	2.2267E-01	7.1268E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9430560	0.9712800	0.9737970	0.9909040	1.0000000	1.1966E+02	3.5382E+00
$\alpha_2$	3.30E-03	1.72E-02	1.46E-02	3.97E-02	0.00E+00	2.1142E+00	1.2108E+02
$\alpha_3$	3.87E-04	7.93E-03	5.48E-03	2.39E-02	0.00E+00	9.7738E-01	1.2222E+02
$\alpha_4$	2.00E-06	3.04E-03	1.02E-03	1.29E-02	0.00E+00	3.7439E-01	1.2282E+02
$\alpha_5$	4.84E-21	5.87E-04	3.32E-07	3.40E-03	0.00E+00	7.2277E-02	1.2313E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9442590	0.9704350	0.9725790	0.9892870	1.0000000	1.4044E+02	4.2787E+00
$\alpha_2$	3.18E-03	1.55E-02	1.33E-02	3.52E-02	0.00E+00	2.2392E+00	1.4248E+02
$\alpha_3$	5.55E-04	7.89E-03	5.77E-03	2.25E-02	0.00E+00	1.1418E+00	1.4358E+02
$\alpha_4$	3.66E-05	4.09E-03	2.14E-03	1.48E-02	0.00E+00	5.9222E-01	1.4413E+02
$\alpha_5$	6.42E-09	1.54E-03	2.08E-04	7.69E-03	0.00E+00	2.2220E-01	1.4450E+02
$\alpha_6$	9.74E-19	5.75E-04	1.01E-06	3.36E-03	0.00E+00	8.3237E-02	1.4464E+02

Motor Operated Valves  
PWR Containment Spray Motor Operated Valves  
CONTAINMENT SPRAY MOV FAIL TO OPEN/CLOSE  
*ALPHA FACTOR and MGL PARAMETERS*

2010

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	23.50	23.50	23.50	23.50	23.50
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000



Motor Operated Valves  
PWR Containment Spray Motor Operated Valves  
CONTAINMENT SPRAY MOV-CC  
**CONTAINMENT SPRAY MOV-CC**

2010

System : Containment spray recirculation  
Component : Motor Operated Valve  
Failure Mode : Fail to open on demand  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 16.50  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9358690	0.9840140	0.9935000	0.9999680	1.0000000	2.6746E+01	4.3452E-01
$\alpha_2$	2.90E-05	1.60E-02	6.50E-03	6.41E-02	0.00E+00	4.3452E-01	2.6746E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9331860	0.9766540	0.9829890	0.9984660	1.0000000	4.6055E+01	1.1009E+00
$\alpha_2$	5.60E-04	1.77E-02	1.15E-02	5.60E-02	0.00E+00	8.3366E-01	4.6322E+01
$\alpha_3$	1.99E-07	5.67E-03	1.14E-03	2.69E-02	0.00E+00	2.6722E-01	4.6889E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9310250	0.9712350	0.9759630	0.9952700	1.0000000	6.2636E+01	1.8551E+00
$\alpha_2$	1.58E-03	1.90E-02	1.43E-02	5.26E-02	0.00E+00	1.2281E+00	6.3263E+01
$\alpha_3$	7.06E-06	6.27E-03	2.32E-03	2.59E-02	0.00E+00	4.0431E-01	6.4087E+01
$\alpha_4$	1.49E-08	3.45E-03	4.73E-04	1.73E-02	0.00E+00	2.2267E-01	6.4268E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9396640	0.9695500	0.9722090	0.9903480	1.0000000	1.1266E+02	3.5382E+00
$\alpha_2$	3.50E-03	1.82E-02	1.55E-02	4.21E-02	0.00E+00	2.1142E+00	1.1408E+02
$\alpha_3$	4.11E-04	8.41E-03	5.81E-03	2.53E-02	0.00E+00	9.7738E-01	1.1522E+02
$\alpha_4$	2.12E-06	3.22E-03	1.08E-03	1.37E-02	0.00E+00	3.7439E-01	1.1582E+02
$\alpha_5$	5.13E-21	6.22E-04	3.52E-07	3.60E-03	0.00E+00	7.2277E-02	1.1613E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9414510	0.9689320	0.9711740	0.9887350	1.0000000	1.3344E+02	4.2787E+00
$\alpha_2$	3.34E-03	1.63E-02	1.40E-02	3.70E-02	0.00E+00	2.2392E+00	1.3548E+02
$\alpha_3$	5.84E-04	8.29E-03	6.06E-03	2.36E-02	0.00E+00	1.1418E+00	1.3658E+02
$\alpha_4$	3.84E-05	4.30E-03	2.25E-03	1.55E-02	0.00E+00	5.9222E-01	1.3713E+02
$\alpha_5$	6.74E-09	1.61E-03	2.19E-04	8.08E-03	0.00E+00	2.2220E-01	1.3750E+02
$\alpha_6$	1.02E-18	6.04E-04	1.06E-06	3.53E-03	0.00E+00	8.3237E-02	1.3764E+02

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PWR Containment Spray Motor Operated Valves  
CONTAINMENT SPRAY MOV-CC

2010

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	16.50	16.50	16.50	16.50	16.50
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

Motor Operated Valves  
PWR Containment Spray Motor Operated Valves  
CONTAINMENT SPRAY MOV-OO  
**CONTAINMENT SPRAY MOV-OO**

2010

System : Containment spray recirculation  
Component : Motor Operated Valve  
Failure Mode : Fail to close (reseal) on demand  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 7.00  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9017830	0.9754240	0.9898730	0.9999510	1.0000000	1.7246E+01	4.3452E-01
$\alpha_2$	4.52E-05	2.46E-02	1.01E-02	9.82E-02	0.00E+00	4.3452E-01	1.7246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9165860	0.9707650	0.9786210	0.9980670	1.0000000	3.6555E+01	1.1009E+00
$\alpha_2$	7.05E-04	2.21E-02	1.44E-02	7.00E-02	0.00E+00	8.3366E-01	3.6822E+01
$\alpha_3$	2.49E-07	7.10E-03	1.44E-03	3.37E-02	0.00E+00	2.6722E-01	3.7389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9192920	0.9662660	0.9717540	0.9944390	1.0000000	5.3136E+01	1.8551E+00
$\alpha_2$	1.85E-03	2.23E-02	1.68E-02	6.16E-02	0.00E+00	1.2281E+00	5.3763E+01
$\alpha_3$	8.29E-06	7.35E-03	2.73E-03	3.04E-02	0.00E+00	4.0431E-01	5.4587E+01
$\alpha_4$	1.75E-08	4.05E-03	5.55E-04	2.03E-02	0.00E+00	2.2267E-01	5.4768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9343580	0.9668390	0.9697150	0.9894740	1.0000000	1.0316E+02	3.5382E+00
$\alpha_2$	3.82E-03	1.98E-02	1.69E-02	4.58E-02	0.00E+00	2.1142E+00	1.0458E+02
$\alpha_3$	4.48E-04	9.16E-03	6.33E-03	2.75E-02	0.00E+00	9.7738E-01	1.0572E+02
$\alpha_4$	2.31E-06	3.51E-03	1.18E-03	1.49E-02	0.00E+00	3.7439E-01	1.0632E+02
$\alpha_5$	5.59E-21	6.77E-04	3.83E-07	3.92E-03	0.00E+00	7.2277E-02	1.0663E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9371630	0.9666300	0.9690330	0.9878880	1.0000000	1.2394E+02	4.2787E+00
$\alpha_2$	3.59E-03	1.75E-02	1.50E-02	3.97E-02	0.00E+00	2.2392E+00	1.2598E+02
$\alpha_3$	6.27E-04	8.91E-03	6.51E-03	2.54E-02	0.00E+00	1.1418E+00	1.2708E+02
$\alpha_4$	4.13E-05	4.62E-03	2.42E-03	1.67E-02	0.00E+00	5.9222E-01	1.2763E+02
$\alpha_5$	7.25E-09	1.73E-03	2.35E-04	8.68E-03	0.00E+00	2.2220E-01	1.2800E+02
$\alpha_6$	1.10E-18	6.49E-04	1.14E-06	3.79E-03	0.00E+00	8.3237E-02	1.2814E+02

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*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	7.00	7.00	7.00	7.00	7.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

Motor Operated Valves  
 BWR Residual Heat Removal Motor-Operated Valves  
 BWR RHR MOV FAIL TO OPEN/CLOSE

2010

**BWR Residual Heat Removal Motor-Operated Valves**

**BWR RHR MOV FAIL TO OPEN/CLOSE**

**System :** Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
**Component :** Motor Operated Valve  
**Failure Mode :** Fail to close (reset) on demand  
 Fail to Open/Close Mode Unspecified (demand based)  
 Fail to open on demand  
**Plant Type :** BWR  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 123.50  
 Total Number of Common-Cause Failure Events: 2

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9588300	0.9840110	0.9872660	0.9980620	0.9871410	9.3409E+01	1.5178E+00
$\alpha_2$	1.94E-03	1.60E-02	1.27E-02	4.12E-02	1.29E-02	1.5178E+00	9.3409E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9663090	0.9849690	0.9869850	0.9967460	0.9900600	1.5405E+02	2.3509E+00
$\alpha_2$	1.31E-03	1.01E-02	8.13E-03	2.58E-02	5.96E-03	1.5837E+00	1.5482E+02
$\alpha_3$	1.18E-04	4.91E-03	3.02E-03	1.61E-02	3.98E-03	7.6722E-01	1.5563E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9684800	0.9844070	0.9858850	0.9952960	0.9910270	2.1181E+02	3.3551E+00
$\alpha_2$	1.62E-03	9.19E-03	7.72E-03	2.18E-02	4.49E-03	1.9781E+00	2.1319E+02
$\alpha_3$	1.66E-04	4.20E-03	2.80E-03	1.30E-02	2.99E-03	9.0431E-01	2.1426E+02
$\alpha_4$	6.38E-06	2.20E-03	9.52E-04	8.60E-03	1.50E-03	4.7267E-01	2.1469E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9695490	0.9831140	0.9841460	0.9931420	0.9920080	3.0303E+02	5.2049E+00
$\alpha_2$	2.37E-03	9.16E-03	8.12E-03	1.95E-02	3.40E-03	2.8225E+00	3.0541E+02
$\alpha_3$	5.09E-04	4.66E-03	3.64E-03	1.23E-02	2.20E-03	1.4357E+00	3.0680E+02
$\alpha_4$	5.39E-05	2.43E-03	1.47E-03	8.06E-03	1.80E-03	7.4939E-01	3.0749E+02
$\alpha_5$	5.38E-10	6.40E-04	6.41E-05	3.31E-03	5.99E-04	1.9728E-01	3.0804E+02

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 BWR Residual Heat Removal Motor-Operated Valves  
 BWR RHR MOV FAIL TO OPEN/CLOSE

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**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9713760	0.9835110	0.9843700	0.9927070	0.9926350	3.6498E+02	6.1190E+00
$\alpha_2$	2.16E-03	7.98E-03	7.11E-03	1.68E-02	2.89E-03	2.9614E+00	3.6814E+02
$\alpha_3$	5.26E-04	4.20E-03	3.35E-03	1.08E-02	1.67E-03	1.5585E+00	3.6954E+02
$\alpha_4$	1.30E-04	2.64E-03	1.82E-03	7.96E-03	1.56E-03	9.8112E-01	3.7012E+02
$\alpha_5$	3.67E-06	1.27E-03	5.50E-04	4.99E-03	1.00E-03	4.7220E-01	3.7063E+02
$\alpha_6$	2.01E-12	3.93E-04	1.46E-05	2.17E-03	2.50E-04	1.4574E-01	3.7095E+02

**CCCG = 7**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9716030	0.9824390	0.9831000	0.9910140	0.9930840	4.7323E+02	8.4590E+00
$\alpha_2$	2.66E-03	7.98E-03	7.31E-03	1.56E-02	2.59E-03	3.8424E+00	4.7785E+02
$\alpha_3$	7.70E-04	4.23E-03	3.56E-03	9.95E-03	1.39E-03	2.0363E+00	4.7965E+02
$\alpha_4$	2.69E-04	2.78E-03	2.13E-03	7.52E-03	1.21E-03	1.3408E+00	4.8035E+02
$\alpha_5$	5.47E-05	1.74E-03	1.11E-03	5.54E-03	1.08E-03	8.3657E-01	4.8085E+02
$\alpha_6$	2.37E-07	7.11E-04	2.12E-04	3.11E-03	5.37E-04	3.4258E-01	4.8135E+02
$\alpha_7$	3.45E-25	1.25E-04	1.26E-08	7.04E-04	1.07E-04	6.0371E-02	4.8163E+02

**CCCG = 8**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9728060	0.9827380	0.9833080	0.9907150	0.9934350	5.4902E+02	9.6437E+00
$\alpha_2$	2.59E-03	7.40E-03	6.82E-03	1.42E-02	2.37E-03	4.1319E+00	5.5453E+02
$\alpha_3$	7.56E-04	3.87E-03	3.29E-03	8.94E-03	1.27E-03	2.1601E+00	5.5650E+02
$\alpha_4$	2.91E-04	2.60E-03	2.04E-03	6.85E-03	9.28E-04	1.4551E+00	5.5721E+02
$\alpha_5$	1.02E-04	1.84E-03	1.29E-03	5.46E-03	9.65E-04	1.0293E+00	5.5763E+02
$\alpha_6$	1.03E-05	1.08E-03	5.69E-04	3.87E-03	7.06E-04	6.0176E-01	5.5806E+02
$\alpha_7$	1.18E-09	3.88E-04	4.94E-05	1.96E-03	2.82E-04	2.1677E-01	5.5845E+02
$\alpha_8$	2.08E-30	8.72E-05	6.94E-10	4.60E-04	4.69E-05	4.8724E-02	5.5861E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9871410	0.9900600	0.9910270	0.9920080	0.9926350	0.9930840	0.9934350
$\alpha_2$	1.29E-02	5.96E-03	4.49E-03	3.40E-03	2.89E-03	2.59E-03	2.37E-03
$\alpha_3$		3.98E-03	2.99E-03	2.20E-03	1.67E-03	1.39E-03	1.27E-03
$\alpha_4$			1.50E-03	1.80E-03	1.56E-03	1.21E-03	9.28E-04
$\alpha_5$				5.99E-04	1.00E-03	1.08E-03	9.65E-04
$\alpha_6$					2.50E-04	5.37E-04	7.06E-04
$\alpha_7$						1.07E-04	2.82E-04
$\alpha_8$							4.69E-05

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 BWR RHR MOV FAIL TO OPEN/CLOSE

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MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.87E-01	9.90E-01	9.91E-01	9.92E-01	9.93E-01	9.93E-01	9.93E-01
Beta	1.29E-02	9.94E-03	8.97E-03	7.99E-03	7.36E-03	6.92E-03	6.56E-03
Gamma		4.00E-01	5.00E-01	5.75E-01	6.08E-01	6.25E-01	6.39E-01
Delta			3.33E-01	5.22E-01	6.27E-01	6.78E-01	6.98E-01
Epsilon				2.50E-01	4.46E-01	5.88E-01	6.83E-01
Mu					2.00E-01	3.73E-01	5.17E-01
Upsilon						1.67E-01	3.18E-01
Sigma							1.43E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	82.33	123.50	164.67	205.83	247.00	288.17	329.33
N <sub>1</sub>	0.8333	1.0000	1.0000	1.0417	1.0417	1.0127	0.9645
N <sub>2</sub>	1.0833	0.7500	0.7500	0.7083	0.7222	0.7546	0.7872
N <sub>3</sub>		0.5000	0.5000	0.4583	0.4167	0.4051	0.4217
N <sub>4</sub>			0.2500	0.3750	0.3889	0.3519	0.3086
N <sub>5</sub>				0.1250	0.2500	0.3148	0.3210
N <sub>6</sub>					0.0625	0.1563	0.2348
N <sub>7</sub>						0.0313	0.0938
N <sub>8</sub>							0.0156

Motor Operated Valves  
 BWR Residual Heat Removal Motor-Operated Valves  
 BWR RHR MOV FAIL TO OPEN  
**BWR RHR MOV FAIL TO OPEN**

2010

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
 Component : Motor Operated Valve  
 Failure Mode : Fail to open on demand  
 Plant Type : BWR  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 74.20  
 Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9561880	0.9832970	0.9868790	0.9981570	0.9867020	8.4446E+01	1.4345E+00
$\alpha_2$	1.84E-03	1.67E-02	1.31E-02	4.38E-02	1.33E-02	1.4345E+00	8.4446E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9658970	0.9853030	0.9875020	0.9972020	0.9910950	1.4085E+02	2.1009E+00
$\alpha_2$	8.98E-04	9.33E-03	7.16E-03	2.52E-02	4.45E-03	1.3337E+00	1.4162E+02
$\alpha_3$	1.29E-04	5.37E-03	3.31E-03	1.76E-02	4.45E-03	7.6722E-01	1.4218E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9693850	0.9855360	0.9871450	0.9962020	0.9933070	1.9454E+02	2.8551E+00
$\alpha_2$	8.62E-04	7.49E-03	5.90E-03	1.95E-02	1.67E-03	1.4781E+00	1.9592E+02
$\alpha_3$	1.81E-04	4.58E-03	3.05E-03	1.42E-02	3.35E-03	9.0431E-01	1.9649E+02
$\alpha_4$	6.96E-06	2.39E-03	1.04E-03	9.37E-03	1.67E-03	4.7267E-01	1.9692E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9704120	0.9841430	0.9852550	0.9940720	0.9946380	2.8166E+02	4.5383E+00
$\alpha_2$	1.60E-03	7.82E-03	6.71E-03	1.79E-02	6.70E-04	2.2392E+00	2.8396E+02
$\alpha_3$	4.65E-04	4.73E-03	3.63E-03	1.27E-02	2.01E-03	1.3524E+00	2.8485E+02
$\alpha_4$	5.80E-05	2.62E-03	1.59E-03	8.68E-03	2.01E-03	7.4939E-01	2.8545E+02
$\alpha_5$	5.80E-10	6.89E-04	6.91E-05	3.57E-03	6.70E-04	1.9728E-01	2.8600E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9724730	0.9846920	0.9856170	0.9937420	0.9955280	3.3954E+02	5.2787E+00
$\alpha_2$	1.41E-03	6.68E-03	5.75E-03	1.51E-02	2.80E-04	2.3017E+00	3.4252E+02
$\alpha_3$	4.18E-04	4.04E-03	3.13E-03	1.08E-02	1.12E-03	1.3918E+00	3.4343E+02
$\alpha_4$	1.33E-04	2.81E-03	1.92E-03	8.49E-03	1.68E-03	9.6722E-01	3.4385E+02
$\alpha_5$	3.95E-06	1.37E-03	5.92E-04	5.37E-03	1.12E-03	4.7220E-01	3.4435E+02
$\alpha_6$	2.16E-12	4.23E-04	1.58E-05	2.34E-03	2.80E-04	1.4574E-01	3.4467E+02



Motor Operated Valves  
 BWR Residual Heat Removal Motor-Operated Valves  
 BWR RHR MOV FAIL TO OPEN  
 CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9725780	0.9834990	0.9842060	0.9919930	0.9961630	4.4375E+02	7.4452E+00
$\alpha_2$	1.96E-03	6.91E-03	6.20E-03	1.43E-02	1.20E-04	3.1191E+00	4.4808E+02
$\alpha_3$	6.08E-04	3.96E-03	3.26E-03	9.72E-03	6.00E-04	1.7875E+00	4.4941E+02
$\alpha_4$	2.64E-04	2.88E-03	2.19E-03	7.87E-03	1.20E-03	1.3014E+00	4.4989E+02
$\alpha_5$	5.77E-05	1.85E-03	1.19E-03	5.90E-03	1.20E-03	8.3427E-01	4.5036E+02
$\alpha_6$	2.53E-07	7.59E-04	2.26E-04	3.32E-03	6.00E-04	3.4258E-01	4.5085E+02
$\alpha_7$	3.68E-25	1.34E-04	1.35E-08	7.52E-04	1.20E-04	6.0371E-02	4.5113E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9738770	0.9838530	0.9844620	0.9917400	0.9966420	5.1553E+02	8.4611E+00
$\alpha_2$	1.93E-03	6.41E-03	5.80E-03	1.30E-02	5.24E-05	3.3603E+00	5.2063E+02
$\alpha_3$	5.55E-04	3.50E-03	2.89E-03	8.52E-03	3.15E-04	1.8322E+00	5.2216E+02
$\alpha_4$	2.69E-04	2.64E-03	2.04E-03	7.05E-03	7.87E-04	1.3809E+00	5.2261E+02
$\alpha_5$	1.05E-04	1.95E-03	1.36E-03	5.79E-03	1.05E-03	1.0208E+00	5.2297E+02
$\alpha_6$	1.09E-05	1.15E-03	6.06E-04	4.12E-03	7.87E-04	6.0136E-01	5.2339E+02
$\alpha_7$	1.26E-09	4.14E-04	5.27E-05	2.09E-03	3.15E-04	2.1677E-01	5.2377E+02
$\alpha_8$	2.22E-30	9.30E-05	7.40E-10	4.90E-04	5.24E-05	4.8724E-02	5.2394E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9867020	0.9910950	0.9933070	0.9946380	0.9955280	0.9961630	0.9966420
$\alpha_2$	1.33E-02	4.45E-03	1.67E-03	6.70E-04	2.80E-04	1.20E-04	5.24E-05
$\alpha_3$		4.45E-03	3.35E-03	2.01E-03	1.12E-03	6.00E-04	3.15E-04
$\alpha_4$			1.67E-03	2.01E-03	1.68E-03	1.20E-03	7.87E-04
$\alpha_5$				6.70E-04	1.12E-03	1.20E-03	1.05E-03
$\alpha_6$					2.80E-04	6.00E-04	7.87E-04
$\alpha_7$						1.20E-04	3.15E-04
$\alpha_8$							5.24E-05

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.87E-01	9.91E-01	9.93E-01	9.95E-01	9.96E-01	9.96E-01	9.97E-01
Beta	1.33E-02	8.90E-03	6.69E-03	5.36E-03	4.47E-03	3.84E-03	3.36E-03
Gamma		5.00E-01	7.50E-01	8.75E-01	9.38E-01	9.69E-01	9.84E-01
Delta			3.33E-01	5.71E-01	7.33E-01	8.39E-01	9.05E-01
Epsilon				2.50E-01	4.55E-01	6.15E-01	7.37E-01
Mu					2.00E-01	3.75E-01	5.24E-01
Upsilon						1.67E-01	3.18E-01
Sigma							1.43E-01

Motor Operated Valves  
 BWR Residual Heat Removal Motor-Operated Valves  
 BWR RHR MOV FAIL TO OPEN

2010

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	74.20	111.30	148.40	185.50	222.60	259.70	296.80
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	1.0000	0.5000	0.2500	0.1250	0.0625	0.0313	0.0156
N <sub>3</sub>		0.5000	0.5000	0.3750	0.2500	0.1563	0.0938
N <sub>4</sub>			0.2500	0.3750	0.3750	0.3125	0.2344
N <sub>5</sub>				0.1250	0.2500	0.3125	0.3125
N <sub>6</sub>					0.0625	0.1563	0.2344
N <sub>7</sub>						0.0313	0.0938
N <sub>8</sub>							0.0156

Motor Operated Valves  
 BWR Residual Heat Removal Motor-Operated Valves  
 BWR RHR MOV FAIL TO CLOSE  
**BWR RHR MOV FAIL TO CLOSE**

2010

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
 Component : Motor Operated Valve  
 Failure Mode : Fail to close (reseal) on demand  
 Plant Type : BWR  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 47.30  
 Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9446310	0.9853090	0.9929860	0.9999270	0.9966090	3.4729E+01	5.1782E-01
$\alpha_2$	7.08E-05	1.47E-02	7.02E-03	5.54E-02	3.39E-03	5.1782E-01	3.4729E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9464220	0.9799500	0.9844730	0.9980050	0.9931920	6.6025E+01	1.3509E+00
$\alpha_2$	1.02E-03	1.61E-02	1.16E-02	4.65E-02	6.81E-03	1.0837E+00	6.6292E+01
$\alpha_3$	1.38E-07	3.97E-03	7.96E-04	1.88E-02	0.00E+00	2.6722E-01	6.7109E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9457010	0.9756680	0.9788700	0.9946910	0.9897540	9.4436E+01	2.3551E+00
$\alpha_2$	2.64E-03	1.79E-02	1.47E-02	4.40E-02	1.02E-02	1.7281E+00	9.5063E+01
$\alpha_3$	4.69E-06	4.18E-03	1.54E-03	1.73E-02	0.00E+00	4.0431E-01	9.6387E+01
$\alpha_4$	9.89E-09	2.30E-03	3.14E-04	1.15E-02	0.00E+00	2.2267E-01	9.6568E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9503380	0.9738070	0.9757540	0.9906320	0.9890430	1.5633E+02	4.2049E+00
$\alpha_2$	4.19E-03	1.68E-02	1.48E-02	3.61E-02	9.59E-03	2.6975E+00	1.5784E+02
$\alpha_3$	3.93E-04	6.61E-03	4.70E-03	1.93E-02	1.37E-03	1.0607E+00	1.5947E+02
$\alpha_4$	1.53E-06	2.33E-03	7.84E-04	9.91E-03	0.00E+00	3.7439E-01	1.6016E+02
$\alpha_5$	3.71E-21	4.50E-04	2.54E-07	2.60E-03	0.00E+00	7.2277E-02	1.6046E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9523810	0.9736200	0.9752340	0.9893540	0.9884620	1.8893E+02	5.1190E+00
$\alpha_2$	3.98E-03	1.49E-02	1.33E-02	3.15E-02	9.06E-03	2.8989E+00	1.9115E+02
$\alpha_3$	6.25E-04	6.74E-03	5.14E-03	1.83E-02	2.29E-03	1.3085E+00	1.9274E+02
$\alpha_4$	3.08E-05	3.12E-03	1.66E-03	1.12E-02	1.91E-04	6.0612E-01	1.9344E+02
$\alpha_5$	4.78E-09	1.15E-03	1.55E-04	5.74E-03	0.00E+00	2.2220E-01	1.9383E+02
$\alpha_6$	7.26E-19	4.29E-04	7.49E-07	2.50E-03	0.00E+00	8.3237E-02	1.9397E+02

Motor Operated Valves  
 BWR Residual Heat Removal Motor-Operated Valves  
 BWR RHR MOV FAIL TO CLOSE

2010

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9551240	0.9729060	0.9740460	0.9868020	0.9880450	2.6784E+02	7.4589E+00
$\alpha_2$	4.60E-03	1.38E-02	1.27E-02	2.71E-02	8.53E-03	3.8112E+00	2.7149E+02
$\alpha_3$	1.13E-03	6.83E-03	5.68E-03	1.65E-02	2.93E-03	1.8800E+00	2.7342E+02
$\alpha_4$	2.06E-04	3.74E-03	2.62E-03	1.11E-02	4.65E-04	1.0283E+00	2.7427E+02
$\alpha_5$	9.56E-06	1.90E-03	9.04E-04	7.19E-03	2.71E-05	5.2407E-01	2.7477E+02
$\alpha_6$	2.44E-10	6.77E-04	5.77E-05	3.55E-03	0.00E+00	1.8628E-01	2.7511E+02
$\alpha_7$	0.00E+00	1.06E-04	9.24E-14	3.97E-04	0.00E+00	2.9071E-02	2.7527E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9570090	0.9732340	0.9742030	0.9861400	0.9877750	3.1429E+02	8.6437E+00
$\alpha_2$	4.47E-03	1.27E-02	1.18E-02	2.44E-02	7.98E-03	4.1163E+00	3.1882E+02
$\alpha_3$	1.19E-03	6.40E-03	5.41E-03	1.50E-02	3.39E-03	2.0663E+00	3.2087E+02
$\alpha_4$	3.05E-04	3.78E-03	2.82E-03	1.05E-02	7.68E-04	1.2208E+00	3.2171E+02
$\alpha_5$	4.21E-05	2.22E-03	1.31E-03	7.48E-03	8.79E-05	7.1683E-01	3.2222E+02
$\alpha_6$	6.49E-07	1.14E-03	3.73E-04	4.86E-03	4.13E-06	3.6736E-01	3.2257E+02
$\alpha_7$	5.04E-14	3.81E-04	6.84E-06	2.17E-03	0.00E+00	1.2297E-01	3.2281E+02
$\alpha_8$	9.44E-43	1.03E-04	1.46E-12	4.33E-04	0.00E+00	3.3124E-02	3.2290E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9966090	0.9931920	0.9897540	0.9890430	0.9884620	0.9880450	0.9877750
$\alpha_2$	3.39E-03	6.81E-03	1.02E-02	9.59E-03	9.06E-03	8.53E-03	7.98E-03
$\alpha_3$		0.00E+00	0.00E+00	1.37E-03	2.29E-03	2.93E-03	3.39E-03
$\alpha_4$			0.00E+00	0.00E+00	1.91E-04	4.65E-04	7.68E-04
$\alpha_5$				0.00E+00	0.00E+00	2.71E-05	8.79E-05
$\alpha_6$					0.00E+00	0.00E+00	4.13E-06
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.97E-01	9.93E-01	9.90E-01	9.89E-01	9.88E-01	9.88E-01	9.88E-01
Beta	3.39E-03	6.81E-03	1.02E-02	1.10E-02	1.15E-02	1.20E-02	1.22E-02
Gamma		0.00E+00	0.00E+00	1.25E-01	2.15E-01	2.87E-01	3.48E-01
Delta			0.00E+00	0.00E+00	7.70E-02	1.44E-01	2.02E-01
Epsilon				0.00E+00	0.00E+00	5.52E-02	1.07E-01
Mu					0.00E+00	0.00E+00	4.49E-02
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Motor Operated Valves  
 BWR Residual Heat Removal Motor-Operated Valves  
 BWR RHR MOV FAIL TO CLOSE

2010

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	23.65	35.47	47.30	59.13	70.95	82.78	94.60
N <sub>1</sub>	0.8333	1.0000	1.0000	1.0417	1.0417	1.0127	0.9645
N <sub>2</sub>	0.0833	0.2500	0.5000	0.5833	0.6597	0.7234	0.7716
N <sub>3</sub>		0.0000	0.0000	0.0833	0.1667	0.2488	0.3279
N <sub>4</sub>			0.0000	0.0000	0.0139	0.0394	0.0743
N <sub>5</sub>				0.0000	0.0000	0.0023	0.0085
N <sub>6</sub>					0.0000	0.0000	0.0004
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Motor Operated Valves  
 BWR Isolation Condenser Motor-Operated Valves  
 ISO CONDENSER MOV FAIL TO OPEN/CLOSE

2010

**BWR Isolation Condenser Motor-Operated Valves**  
**ISO CONDENSER MOV FAIL TO OPEN/CLOSE**

System : Isolation condenser  
 Component : Motor Operated Valve  
 Failure Mode : Fail to close (reset) on demand  
 Fail to Open/Close Mode Unspecified (demand based)  
 Fail to open on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 8.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9069840	0.9767390	0.9904340	0.9999540	1.0000000	1.8246E+01	4.3452E-01
$\alpha_2$	4.27E-05	2.33E-02	9.56E-03	9.30E-02	0.00E+00	4.3452E-01	1.8246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9187120	0.9715210	0.9791840	0.9981180	1.0000000	3.7555E+01	1.1009E+00
$\alpha_2$	6.87E-04	2.16E-02	1.40E-02	6.82E-02	0.00E+00	8.3366E-01	3.7822E+01
$\alpha_3$	2.43E-07	6.91E-03	1.40E-03	3.28E-02	0.00E+00	2.6722E-01	3.8389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9207150	0.9668680	0.9722640	0.9945410	1.0000000	5.4136E+01	1.8551E+00
$\alpha_2$	1.82E-03	2.19E-02	1.65E-02	6.05E-02	0.00E+00	1.2281E+00	5.4763E+01
$\alpha_3$	8.14E-06	7.22E-03	2.68E-03	2.98E-02	0.00E+00	4.0431E-01	5.5587E+01
$\alpha_4$	1.72E-08	3.98E-03	5.45E-04	1.99E-02	0.00E+00	2.2267E-01	5.5768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9349600	0.9671470	0.9699980	0.9895730	1.0000000	1.0416E+02	3.5382E+00
$\alpha_2$	3.78E-03	1.96E-02	1.67E-02	4.54E-02	0.00E+00	2.1142E+00	1.0558E+02
$\alpha_3$	4.43E-04	9.08E-03	6.27E-03	2.73E-02	0.00E+00	9.7738E-01	1.0672E+02
$\alpha_4$	2.29E-06	3.48E-03	1.17E-03	1.48E-02	0.00E+00	3.7439E-01	1.0732E+02
$\alpha_5$	5.54E-21	6.71E-04	3.80E-07	3.89E-03	0.00E+00	7.2277E-02	1.0763E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9376440	0.9668880	0.9692700	0.9879830	1.0000000	1.2494E+02	4.2787E+00
$\alpha_2$	3.56E-03	1.73E-02	1.49E-02	3.94E-02	0.00E+00	2.2392E+00	1.2698E+02
$\alpha_3$	6.22E-04	8.84E-03	6.46E-03	2.52E-02	0.00E+00	1.1418E+00	1.2808E+02
$\alpha_4$	4.10E-05	4.58E-03	2.40E-03	1.65E-02	0.00E+00	5.9222E-01	1.2863E+02
$\alpha_5$	7.19E-09	1.72E-03	2.33E-04	8.62E-03	0.00E+00	2.2220E-01	1.2900E+02
$\alpha_6$	1.09E-18	6.44E-04	1.13E-06	3.76E-03	0.00E+00	8.3237E-02	1.2914E+02

Motor Operated Valves  
 BWR Isolation Condenser Motor-Operated Valves  
 ISO CONDENSER MOV FAIL TO OPEN/CLOSE  
*ALPHA FACTOR and MGL PARAMETERS*

2010

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	8.00	8.00	8.00	8.00	8.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

Motor Operated Valves  
 BWR Isolation Condenser Motor-Operated Valves  
 ISO CONDENSER MOV FAIL TO OPEN  
**ISO CONDENSER MOV FAIL TO OPEN**

2010

System : Isolation condenser  
 Component : Motor Operated Valve  
 Failure Mode : Fail to open on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 6.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8959650	0.9739500	0.9892430	0.9999480	1.0000000	1.6246E+01	4.3452E-01
$\alpha_2$	4.81E-05	2.60E-02	1.08E-02	1.04E-01	0.00E+00	4.3452E-01	1.6246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9143470	0.9699670	0.9780280	0.9980130	1.0000000	3.5555E+01	1.1009E+00
$\alpha_2$	7.25E-04	2.27E-02	1.48E-02	7.18E-02	0.00E+00	8.3366E-01	3.5822E+01
$\alpha_3$	2.56E-07	7.29E-03	1.48E-03	3.46E-02	0.00E+00	2.6722E-01	3.6389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9178250	0.9665410	0.9712250	0.9943340	1.0000000	5.2136E+01	1.8551E+00
$\alpha_2$	1.89E-03	2.27E-02	1.72E-02	6.27E-02	0.00E+00	1.2281E+00	5.2763E+01
$\alpha_3$	8.45E-06	7.49E-03	2.78E-03	3.09E-02	0.00E+00	4.0431E-01	5.3587E+01
$\alpha_4$	1.78E-08	4.12E-03	5.66E-04	2.07E-02	0.00E+00	2.2267E-01	5.3768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9337450	0.9665250	0.9694270	0.9893730	1.0000000	1.0216E+02	3.5382E+00
$\alpha_2$	3.85E-03	2.00E-02	1.71E-02	4.62E-02	0.00E+00	2.1142E+00	1.0358E+02
$\alpha_3$	4.52E-04	9.25E-03	6.39E-03	2.78E-02	0.00E+00	9.7738E-01	1.0472E+02
$\alpha_4$	2.33E-06	3.54E-03	1.19E-03	1.50E-02	0.00E+00	3.7439E-01	1.0532E+02
$\alpha_5$	5.65E-21	6.84E-04	3.87E-07	3.96E-03	0.00E+00	7.2277E-02	1.0563E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9366750	0.9663680	0.9687880	0.9877920	1.0000000	1.2294E+02	4.2787E+00
$\alpha_2$	3.62E-03	1.76E-02	1.51E-02	4.00E-02	0.00E+00	2.2392E+00	1.2498E+02
$\alpha_3$	6.32E-04	8.98E-03	6.57E-03	2.55E-02	0.00E+00	1.1418E+00	1.2608E+02
$\alpha_4$	4.16E-05	4.66E-03	2.44E-03	1.68E-02	0.00E+00	5.9222E-01	1.2663E+02
$\alpha_5$	7.30E-09	1.75E-03	2.37E-04	8.75E-03	0.00E+00	2.2220E-01	1.2700E+02
$\alpha_6$	1.11E-18	6.54E-04	1.14E-06	3.82E-03	0.00E+00	8.3237E-02	1.2714E+02



Motor Operated Valves  
 BWR Isolation Condenser Motor-Operated Valves  
 ISO CONDENSER MOV FAIL TO OPEN

2010

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	6.00	6.00	6.00	6.00	6.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

Motor Operated Valves  
 BWR Isolation Condenser Motor-Operated Valves  
 ISO CONDENSER MOV FAIL TO CLOSE  
**ISO CONDENSER MOV FAIL TO CLOSE**

2010

System : Isolation condenser  
 Component : Motor Operated Valve  
 Failure Mode : Fail to close (reseal) on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 2.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8636860	0.9657330	0.9856730	0.9999380	1.0000000	1.2246E+01	4.3452E-01
$\alpha_2$	6.41E-05	3.43E-02	1.43E-02	1.36E-01	0.00E+00	4.3452E-01	1.2246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9040420	0.9662880	0.9752810	0.9977560	1.0000000	3.1555E+01	1.1009E+00
$\alpha_2$	8.16E-04	2.55E-02	1.67E-02	8.05E-02	0.00E+00	8.3366E-01	3.1822E+01
$\alpha_3$	2.88E-07	8.18E-03	1.66E-03	3.88E-02	0.00E+00	2.6722E-01	3.2389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9113590	0.9628920	0.9688970	0.9938680	1.0000000	4.8136E+01	1.8551E+00
$\alpha_2$	2.04E-03	2.46E-02	1.86E-02	6.77E-02	0.00E+00	1.2281E+00	4.8763E+01
$\alpha_3$	9.14E-06	8.09E-03	3.01E-03	3.34E-02	0.00E+00	4.0431E-01	4.9587E+01
$\alpha_4$	1.93E-08	4.45E-03	6.12E-04	2.23E-02	0.00E+00	2.2267E-01	4.9768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9311740	0.9652090	0.9682200	0.9889480	1.0000000	9.8161E+01	3.5382E+00
$\alpha_2$	4.01E-03	2.08E-02	1.77E-02	4.80E-02	0.00E+00	2.1142E+00	9.9585E+01
$\alpha_3$	4.70E-04	9.61E-03	6.64E-03	2.89E-02	0.00E+00	9.7738E-01	1.0072E+02
$\alpha_4$	2.42E-06	3.68E-03	1.24E-03	1.56E-02	0.00E+00	3.7439E-01	1.0132E+02
$\alpha_5$	5.87E-21	7.11E-04	4.02E-07	4.12E-03	0.00E+00	7.2277E-02	1.0163E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9346440	0.9652760	0.9677640	0.9873890	1.0000000	1.1894E+02	4.2787E+00
$\alpha_2$	3.74E-03	1.82E-02	1.56E-02	4.13E-02	0.00E+00	2.2392E+00	1.2098E+02
$\alpha_3$	6.53E-04	9.27E-03	6.78E-03	2.64E-02	0.00E+00	1.1418E+00	1.2208E+02
$\alpha_4$	4.30E-05	4.81E-03	2.52E-03	1.73E-02	0.00E+00	5.9222E-01	1.2263E+02
$\alpha_5$	7.54E-09	1.80E-03	2.45E-04	9.04E-03	0.00E+00	2.2220E-01	1.2300E+02
$\alpha_6$	1.14E-18	6.76E-04	1.18E-06	3.94E-03	0.00E+00	8.3237E-02	1.2314E+02

Motor Operated Valves  
 BWR Isolation Condenser Motor-Operated Valves  
 ISO CONDENSER MOV FAIL TO CLOSE  
*ALPHA FACTOR and MGL PARAMETERS*

2010

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	2.00	2.00	2.00	2.00	2.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

**PWR Auxiliary Feedwater Motor-Operated Valves**

**AFW MOV FAIL TO OPEN/CLOSE SPAR: AFW-MOV-FO**

System : Auxiliary feedwater  
Component : Motor Operated Valve  
Failure Mode : Fail to close (reset) on demand  
Fail to Open/Close Mode Unspecified (demand based)  
Fail to open on demand  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 56.80

Total Number of Common-Cause Failure Events: 3

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9211530	0.9746430	0.9831460	0.9990840	0.9815960	3.3356E+01	8.6782E-01
$\alpha_2$	9.13E-04	2.54E-02	1.69E-02	7.88E-02	1.84E-02	8.6782E-01	3.3356E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9212760	0.9648050	0.9694410	0.9924600	0.9654380	6.3075E+01	2.3009E+00
$\alpha_2$	5.45E-03	3.03E-02	2.57E-02	7.12E-02	3.31E-02	1.9837E+00	6.3392E+01
$\alpha_3$	8.63E-07	4.85E-03	1.30E-03	2.18E-02	1.44E-03	3.1722E-01	6.5059E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9175380	0.9566550	0.9598800	0.9847510	0.9517160	8.9499E+01	4.0551E+00
$\alpha_2$	1.02E-02	3.45E-02	3.12E-02	7.00E-02	4.39E-02	3.2281E+00	9.0326E+01
$\alpha_3$	6.32E-05	6.46E-03	3.44E-03	2.31E-02	4.39E-03	6.0431E-01	9.2950E+01
$\alpha_4$	1.02E-08	2.38E-03	3.25E-04	1.19E-02	0.00E+00	2.2267E-01	9.3331E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9316380	0.9602190	0.9621700	0.9821240	0.9526190	1.4977E+02	6.2049E+00
$\alpha_2$	8.67E-03	2.53E-02	2.33E-02	4.88E-02	3.26E-02	3.9475E+00	1.5203E+02
$\alpha_3$	1.82E-03	1.16E-02	9.60E-03	2.83E-02	1.48E-02	1.8107E+00	1.5416E+02
$\alpha_4$	1.58E-06	2.40E-03	8.07E-04	1.02E-02	0.00E+00	3.7439E-01	1.5560E+02
$\alpha_5$	3.82E-21	4.63E-04	2.62E-07	2.68E-03	0.00E+00	7.2277E-02	1.5590E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9358030	0.9613170	0.9629440	0.9812800	0.9551850	1.8088E+02	7.2786E+00
$\alpha_2$	6.36E-03	1.96E-02	1.79E-02	3.85E-02	2.16E-02	3.6836E+00	1.8447E+02
$\alpha_3$	3.29E-03	1.37E-02	1.21E-02	3.00E-02	2.16E-02	2.5862E+00	1.8557E+02
$\alpha_4$	6.64E-05	3.74E-03	2.19E-03	1.27E-02	1.66E-03	7.0332E-01	1.8746E+02
$\alpha_5$	4.93E-09	1.18E-03	1.60E-04	5.92E-03	0.00E+00	2.2220E-01	1.8794E+02
$\alpha_6$	7.49E-19	4.42E-04	7.73E-07	2.58E-03	0.00E+00	8.3237E-02	1.8808E+02

Motor Operated Valves  
PWR Auxiliary Feedwater Motor-Operated Valves  
AFW MOV FAIL TO OPEN/CLOSE SPAR: AFW-MOV-FO  
**CCCG = 7**

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9445200	0.9647700	0.9659230	0.9810880	0.9613410	2.5865E+02	9.4449E+00
$\alpha_2$	5.54E-03	1.56E-02	1.44E-02	2.97E-02	1.41E-02	4.1841E+00	2.6391E+02
$\alpha_3$	2.83E-03	1.07E-02	9.54E-03	2.27E-02	1.60E-02	2.8756E+00	2.6522E+02
$\alpha_4$	7.93E-04	6.01E-03	4.83E-03	1.52E-02	8.02E-03	1.6111E+00	2.6648E+02
$\alpha_5$	1.43E-05	2.08E-03	1.04E-03	7.69E-03	4.77E-04	5.5877E-01	2.6754E+02
$\alpha_6$	2.51E-10	6.95E-04	5.93E-05	3.65E-03	0.00E+00	1.8628E-01	2.6791E+02
$\alpha_7$	0.00E+00	1.08E-04	9.49E-14	4.08E-04	0.00E+00	2.9071E-02	2.6807E+02

**CCCG = 8**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9486030	0.9667310	0.9677140	0.9814950	0.9660060	3.0398E+02	1.0461E+01
$\alpha_2$	4.71E-03	1.33E-02	1.23E-02	2.54E-02	9.49E-03	4.1822E+00	3.1026E+02
$\alpha_3$	2.31E-03	8.95E-03	7.93E-03	1.91E-02	1.22E-02	2.8135E+00	3.1163E+02
$\alpha_4$	1.09E-03	6.24E-03	5.23E-03	1.49E-02	9.25E-03	1.9628E+00	3.1248E+02
$\alpha_5$	1.45E-04	3.08E-03	2.11E-03	9.31E-03	2.93E-03	9.6713E-01	3.1347E+02
$\alpha_6$	8.67E-07	1.21E-03	4.11E-04	5.10E-03	1.39E-04	3.7926E-01	3.1406E+02
$\alpha_7$	5.18E-14	3.91E-04	7.03E-06	2.23E-03	0.00E+00	1.2297E-01	3.1432E+02
$\alpha_8$	9.70E-43	1.05E-04	1.50E-12	4.45E-04	0.00E+00	3.3124E-02	3.1441E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9815960	0.9654380	0.9517160	0.9526190	0.9551850	0.9613410	0.9660060
$\alpha_2$	1.84E-02	3.31E-02	4.39E-02	3.26E-02	2.16E-02	1.41E-02	9.49E-03
$\alpha_3$		1.44E-03	4.39E-03	1.48E-02	2.16E-02	1.60E-02	1.22E-02
$\alpha_4$			0.00E+00	0.00E+00	1.66E-03	8.02E-03	9.25E-03
$\alpha_5$				0.00E+00	0.00E+00	4.77E-04	2.93E-03
$\alpha_6$					0.00E+00	0.00E+00	1.39E-04
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.82E-01	9.65E-01	9.52E-01	9.53E-01	9.55E-01	9.61E-01	9.66E-01
Beta	1.84E-02	3.46E-02	4.83E-02	4.74E-02	4.48E-02	3.87E-02	3.40E-02
Gamma		4.17E-02	9.09E-02	3.12E-01	5.19E-01	6.35E-01	7.21E-01
Delta			0.00E+00	0.00E+00	7.14E-02	3.46E-01	5.03E-01
Epsilon				0.00E+00	0.00E+00	5.61E-02	2.49E-01
Mu					0.00E+00	0.00E+00	4.54E-02
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Motor Operated Valves

2010

PWR Auxiliary Feedwater Motor-Operated Valves

AFW MOV FAIL TO OPEN/CLOSE SPAR: AFW-MOV-FO

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	21.31	31.97	42.63	53.28	63.94	74.60	85.25
N <sub>1</sub>	1.8000	1.5500	0.7333	0.3333	0.0000	0.0000	0.0000
N <sub>2</sub>	0.4333	1.1500	2.0000	1.8333	1.4444	1.0963	0.8375
N <sub>3</sub>		0.0500	0.2000	0.8333	1.4444	1.2444	1.0751
N <sub>4</sub>			0.0000	0.0000	0.1111	0.6222	0.8163
N <sub>5</sub>				0.0000	0.0000	0.0370	0.2588
N <sub>6</sub>					0.0000	0.0000	0.0123
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Motor Operated Valves  
PWR Auxiliary Feedwater Motor-Operated Valves  
AFW MOV FAIL TO OPEN SPAR: AFW-MOV-CC  
**AFW MOV FAIL TO OPEN SPAR: AFW-MOV-CC**

2010

System : Auxiliary feedwater  
Component : Motor Operated Valve  
Failure Mode : Fail to open on demand  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 28.20  
Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8944810	0.9696120	0.9828540	0.9996220	0.9803920	2.0246E+01	6.3452E-01
$\alpha_2$	3.76E-04	3.04E-02	1.71E-02	1.06E-01	1.96E-02	6.3452E-01	2.0246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9121850	0.9649730	0.9715230	0.9953160	0.9667770	4.4105E+01	1.6009E+00
$\alpha_2$	2.55E-03	2.81E-02	2.15E-02	7.61E-02	2.99E-02	1.2837E+00	4.4422E+01
$\alpha_3$	1.24E-06	6.94E-03	1.87E-03	3.11E-02	3.32E-03	3.1722E-01	4.5389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9161740	0.9608340	0.9652860	0.9902550	0.9595960	6.5136E+01	2.6551E+00
$\alpha_2$	4.34E-03	2.70E-02	2.25E-02	6.50E-02	3.03E-02	1.8281E+00	6.5963E+01
$\alpha_3$	8.75E-05	8.91E-03	4.76E-03	3.19E-02	1.01E-02	6.0431E-01	6.7187E+01
$\alpha_4$	1.42E-08	3.28E-03	4.50E-04	1.65E-02	0.00E+00	2.2267E-01	6.7568E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9322830	0.9634590	0.9659250	0.9862100	0.9591840	1.1966E+02	4.5383E+00
$\alpha_2$	5.11E-03	2.10E-02	1.85E-02	4.56E-02	2.04E-02	2.6142E+00	1.2158E+02
$\alpha_3$	1.37E-03	1.19E-02	9.40E-03	3.10E-02	2.04E-02	1.4774E+00	1.2272E+02
$\alpha_4$	1.98E-06	3.01E-03	1.01E-03	1.28E-02	0.00E+00	3.7439E-01	1.2382E+02
$\alpha_5$	4.80E-21	5.82E-04	3.29E-07	3.37E-03	0.00E+00	7.2277E-02	1.2413E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9372950	0.9649070	0.9669470	0.9855370	0.9657530	1.4514E+02	5.2787E+00
$\alpha_2$	3.06E-03	1.49E-02	1.28E-02	3.39E-02	0.00E+00	2.2392E+00	1.4818E+02
$\alpha_3$	2.78E-03	1.42E-02	1.21E-02	3.29E-02	3.42E-02	2.1418E+00	1.4828E+02
$\alpha_4$	3.52E-05	3.94E-03	2.06E-03	1.42E-02	0.00E+00	5.9222E-01	1.4983E+02
$\alpha_5$	6.17E-09	1.48E-03	2.00E-04	7.40E-03	0.00E+00	2.2220E-01	1.5020E+02
$\alpha_6$	9.37E-19	5.53E-04	9.68E-07	3.23E-03	0.00E+00	8.3237E-02	1.5034E+02

Motor Operated Valves  
PWR Auxiliary Feedwater Motor-Operated Valves  
AFW MOV FAIL TO OPEN SPAR: AFW-MOV-CC  
CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9451210	0.9668220	0.9682030	0.9838180	0.9705010	2.1695E+02	7.4450E+00
$\alpha_2$	3.87E-03	1.38E-02	1.23E-02	2.85E-02	0.00E+00	3.0878E+00	2.2131E+02
$\alpha_3$	2.03E-03	9.94E-03	8.53E-03	2.27E-02	1.77E-02	2.2312E+00	2.2216E+02
$\alpha_4$	6.39E-04	6.19E-03	4.80E-03	1.65E-02	1.18E-02	1.3889E+00	2.2301E+02
$\alpha_5$	1.14E-05	2.33E-03	1.10E-03	8.79E-03	0.00E+00	5.2177E-01	2.2387E+02
$\alpha_6$	2.99E-10	8.30E-04	7.09E-05	4.36E-03	0.00E+00	1.8628E-01	2.2421E+02
$\alpha_7$	0.00E+00	1.30E-04	1.13E-13	4.88E-04	0.00E+00	2.9071E-02	2.2437E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9485180	0.9680470	0.9692220	0.9835720	0.9740930	2.5633E+02	8.4610E+00
$\alpha_2$	3.80E-03	1.26E-02	1.14E-02	2.56E-02	0.00E+00	3.3447E+00	2.6145E+02
$\alpha_3$	1.50E-03	7.92E-03	6.72E-03	1.85E-02	9.33E-03	2.0984E+00	2.6269E+02
$\alpha_4$	8.23E-04	6.14E-03	4.95E-03	1.55E-02	1.24E-02	1.6265E+00	2.6316E+02
$\alpha_5$	1.15E-04	3.28E-03	2.14E-03	1.03E-02	4.15E-03	8.6833E-01	2.6392E+02
$\alpha_6$	7.84E-07	1.39E-03	4.54E-04	5.93E-03	0.00E+00	3.6696E-01	2.6442E+02
$\alpha_7$	6.15E-14	4.64E-04	8.35E-06	2.64E-03	0.00E+00	1.2297E-01	2.6467E+02
$\alpha_8$	1.15E-42	1.25E-04	1.78E-12	5.29E-04	0.00E+00	3.3124E-02	2.6476E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9803920	0.9667770	0.9595960	0.9591840	0.9657530	0.9705010	0.9740930
$\alpha_2$	1.96E-02	2.99E-02	3.03E-02	2.04E-02	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		3.32E-03	1.01E-02	2.04E-02	3.42E-02	1.77E-02	9.33E-03
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	1.18E-02	1.24E-02
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	4.15E-03
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.80E-01	9.67E-01	9.60E-01	9.59E-01	9.66E-01	9.71E-01	9.74E-01
Beta	1.96E-02	3.32E-02	4.04E-02	4.08E-02	3.42E-02	2.95E-02	2.59E-02
Gamma		1.00E-01	2.50E-01	5.00E-01	1.00E+00	1.00E+00	1.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	4.00E-01	6.40E-01
Epsilon				0.00E+00	0.00E+00	0.00E+00	2.50E-01
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00



Motor Operated Valves  
PWR Auxiliary Feedwater Motor-Operated Valves  
AFW MOV FAIL TO OPEN SPAR: AFW-MOV-CC

2010

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	9.40	14.10	18.80	23.50	28.20	32.90	37.60
N <sub>1</sub>	0.6000	0.4500	0.2000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.2000	0.4500	0.6000	0.5000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0500	0.2000	0.5000	1.0000	0.6000	0.3600
N <sub>4</sub>			0.0000	0.0000	0.0000	0.4000	0.4800
N <sub>5</sub>				0.0000	0.0000	0.0000	0.1600
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Motor Operated Valves  
PWR Auxiliary Feedwater Motor-Operated Valves  
AFW MOV FAIL TO CLOSE SPAR: AFW-MOV-OO  
**AFW MOV FAIL TO CLOSE SPAR: AFW-MOV-OO**

2010

System : Auxiliary feedwater  
Component : Motor Operated Valve  
Failure Mode : Fail to close (reset) on demand  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 27.60  
Total Number of Common-Cause Failure Events: 2

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9016080	0.9711570	0.9832270	0.9995620	0.9812960	2.2486E+01	6.6782E-01
$\alpha_2$	4.36E-04	2.88E-02	1.68E-02	9.84E-02	1.87E-02	6.6782E-01	2.2486E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9113900	0.9632580	0.9693770	0.9941640	0.9618740	4.7215E+01	1.8009E+00
$\alpha_2$	3.90E-03	3.13E-02	2.52E-02	7.97E-02	3.81E-02	1.5337E+00	4.7482E+01
$\alpha_3$	1.91E-07	5.45E-03	1.10E-03	2.59E-02	0.00E+00	2.6722E-01	4.8749E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9088840	0.9547930	0.9589530	0.9864770	0.9416990	6.8749E+01	3.2551E+00
$\alpha_2$	8.98E-03	3.65E-02	3.23E-02	7.84E-02	5.83E-02	2.6281E+00	6.9376E+01
$\alpha_3$	6.31E-06	5.62E-03	2.08E-03	2.32E-02	0.00E+00	4.0431E-01	7.1600E+01
$\alpha_4$	1.33E-08	3.09E-03	4.23E-04	1.55E-02	0.00E+00	2.2267E-01	7.1781E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9279470	0.9597440	0.9620950	0.9834990	0.9436960	1.2409E+02	5.2049E+00
$\alpha_2$	8.27E-03	2.67E-02	2.43E-02	5.33E-02	4.50E-02	3.4475E+00	1.2585E+02
$\alpha_3$	9.45E-04	1.01E-02	7.75E-03	2.75E-02	1.13E-02	1.3107E+00	1.2798E+02
$\alpha_4$	1.90E-06	2.90E-03	9.75E-04	1.23E-02	0.00E+00	3.7439E-01	1.2892E+02
$\alpha_5$	4.61E-21	5.59E-04	3.16E-07	3.23E-03	0.00E+00	7.2277E-02	1.2922E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9311780	0.9598400	0.9617910	0.9818460	0.9430550	1.5006E+02	6.2786E+00
$\alpha_2$	7.67E-03	2.36E-02	2.16E-02	4.63E-02	4.11E-02	3.6836E+00	1.5265E+02
$\alpha_3$	1.31E-03	1.01E-02	8.15E-03	2.58E-02	1.27E-02	1.5862E+00	1.5475E+02
$\alpha_4$	8.00E-05	4.50E-03	2.64E-03	1.53E-02	3.16E-03	7.0332E-01	1.5564E+02
$\alpha_5$	5.94E-09	1.42E-03	1.93E-04	7.12E-03	0.00E+00	2.2220E-01	1.5612E+02
$\alpha_6$	9.01E-19	5.32E-04	9.31E-07	3.11E-03	0.00E+00	8.3237E-02	1.5626E+02

Motor Operated Valves  
PWR Auxiliary Feedwater Motor-Operated Valves  
AFW MOV FAIL TO CLOSE SPAR: AFW-MOV-OO  
CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9411850	0.9634630	0.9647910	0.9812030	0.9507900	2.2269E+02	8.4449E+00
$\alpha_2$	6.43E-03	1.81E-02	1.67E-02	3.45E-02	2.70E-02	4.1841E+00	2.2695E+02
$\alpha_3$	2.05E-03	9.85E-03	8.47E-03	2.23E-02	1.59E-02	2.2756E+00	2.2886E+02
$\alpha_4$	4.16E-04	5.24E-03	3.90E-03	1.46E-02	5.47E-03	1.2111E+00	2.2992E+02
$\alpha_5$	1.66E-05	2.42E-03	1.21E-03	8.91E-03	9.10E-04	5.5877E-01	2.3058E+02
$\alpha_6$	2.91E-10	8.06E-04	6.88E-05	4.23E-03	0.00E+00	1.8628E-01	2.3095E+02
$\alpha_7$	0.00E+00	1.26E-04	1.10E-13	4.73E-04	0.00E+00	2.9071E-02	2.3111E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9453060	0.9652620	0.9663990	0.9813480	0.9566720	2.6289E+02	9.4610E+00
$\alpha_2$	5.44E-03	1.54E-02	1.42E-02	2.93E-02	1.81E-02	4.1822E+00	2.6817E+02
$\alpha_3$	2.03E-03	9.01E-03	7.84E-03	2.00E-02	1.55E-02	2.4535E+00	2.6990E+02
$\alpha_4$	6.29E-04	5.44E-03	4.29E-03	1.42E-02	7.29E-03	1.4828E+00	2.7087E+02
$\alpha_5$	8.37E-05	2.96E-03	1.87E-03	9.57E-03	2.14E-03	8.0713E-01	2.7154E+02
$\alpha_6$	1.00E-06	1.39E-03	4.75E-04	5.89E-03	2.66E-04	3.7926E-01	2.7197E+02
$\alpha_7$	5.98E-14	4.52E-04	8.12E-06	2.57E-03	0.00E+00	1.2297E-01	2.7223E+02
$\alpha_8$	1.12E-42	1.22E-04	1.73E-12	5.14E-04	0.00E+00	3.3124E-02	2.7232E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9812960	0.9618740	0.9416990	0.9436960	0.9430550	0.9507900	0.9566720
$\alpha_2$	1.87E-02	3.81E-02	5.83E-02	4.50E-02	4.11E-02	2.70E-02	1.81E-02
$\alpha_3$		0.00E+00	0.00E+00	1.13E-02	1.27E-02	1.59E-02	1.55E-02
$\alpha_4$			0.00E+00	0.00E+00	3.16E-03	5.47E-03	7.29E-03
$\alpha_5$				0.00E+00	0.00E+00	9.10E-04	2.14E-03
$\alpha_6$					0.00E+00	0.00E+00	2.66E-04
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.81E-01	9.62E-01	9.42E-01	9.44E-01	9.43E-01	9.51E-01	9.57E-01
Beta	1.87E-02	3.81E-02	5.83E-02	5.63E-02	5.69E-02	4.92E-02	4.33E-02
Gamma		0.00E+00	0.00E+00	2.00E-01	2.78E-01	4.52E-01	5.81E-01
Delta			0.00E+00	0.00E+00	2.00E-01	2.87E-01	3.85E-01
Epsilon				0.00E+00	0.00E+00	1.43E-01	2.48E-01
Mu					0.00E+00	0.00E+00	1.11E-01
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Motor Operated Valves

2010

PWR Auxiliary Feedwater Motor-Operated Valves

AFW MOV FAIL TO CLOSE SPAR: AFW-MOV-OO

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	11.04	16.56	22.08	27.60	33.12	38.64	44.16
N <sub>1</sub>	1.2000	1.1000	0.5333	0.3333	0.0000	0.0000	0.0000
N <sub>2</sub>	0.2333	0.7000	1.4000	1.3333	1.4444	1.0963	0.8375
N <sub>3</sub>		0.0000	0.0000	0.3333	0.4444	0.6444	0.7151
N <sub>4</sub>			0.0000	0.0000	0.1111	0.2222	0.3363
N <sub>5</sub>				0.0000	0.0000	0.0370	0.0988
N <sub>6</sub>					0.0000	0.0000	0.0123
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Motor Operated Valves  
PWR High Pressure Safety Injection Motor-Operated Valves  
HIGH PRESSURE INJECTION MOV FAIL TO OPEN/CLOSE

2010

**PWR High Pressure Safety Injection Motor-Operated Valves**  
**HIGH PRESSURE INJECTION MOV FAIL TO OPEN/CLOSE**

**System :** Chemical and volume control  
High pressure injection  
**Component :** Motor Operated Valve  
**Failure Mode :** Fail to close (reset) on demand  
Fail to Open/Close Mode Unspecified (demand based)  
Fail to open on demand  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 60.60  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9754510	0.9939040	0.9975550	0.9999880	1.0000000	7.0846E+01	4.3452E-01
$\alpha_2$	1.09E-05	6.10E-03	2.44E-03	2.46E-02	0.00E+00	4.3452E-01	7.0846E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9652740	0.9879360	0.9912710	0.9992110	1.0000000	9.0155E+01	1.1009E+00
$\alpha_2$	2.87E-04	9.14E-03	5.89E-03	2.91E-02	0.00E+00	8.3366E-01	9.0422E+01
$\alpha_3$	1.02E-07	2.93E-03	5.87E-04	1.39E-02	0.00E+00	2.6722E-01	9.0989E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9588140	0.9829170	0.9857860	0.9972180	1.0000000	1.0674E+02	1.8551E+00
$\alpha_2$	9.29E-04	1.13E-02	8.48E-03	3.14E-02	0.00E+00	1.2281E+00	1.0737E+02
$\alpha_3$	4.17E-06	3.72E-03	1.38E-03	1.54E-02	0.00E+00	4.0431E-01	1.0819E+02
$\alpha_4$	8.81E-09	2.05E-03	2.80E-04	1.03E-02	0.00E+00	2.2267E-01	1.0837E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9561320	0.9779270	0.9798830	0.9930350	1.0000000	1.5676E+02	3.5382E+00
$\alpha_2$	2.53E-03	1.32E-02	1.12E-02	3.06E-02	0.00E+00	2.1142E+00	1.5818E+02
$\alpha_3$	2.97E-04	6.10E-03	4.20E-03	1.84E-02	0.00E+00	9.7738E-01	1.5932E+02
$\alpha_4$	1.53E-06	2.34E-03	7.85E-04	9.92E-03	0.00E+00	3.7439E-01	1.5992E+02
$\alpha_5$	3.72E-21	4.51E-04	2.55E-07	2.61E-03	0.00E+00	7.2277E-02	1.6023E+02

Motor Operated Valves  
PWR High Pressure Safety Injection Motor-Operated Valves  
HIGH PRESSURE INJECTION MOV FAIL TO OPEN/CLOSE  
CCCG = 6

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9555360	0.9764670	0.9781970	0.9915010	1.0000000	1.7754E+02	4.2787E+00
$\alpha_2$	2.52E-03	1.23E-02	1.06E-02	2.81E-02	0.00E+00	2.2392E+00	1.7958E+02
$\alpha_3$	4.41E-04	6.28E-03	4.59E-03	1.79E-02	0.00E+00	1.1418E+00	1.8068E+02
$\alpha_4$	2.91E-05	3.26E-03	1.70E-03	1.18E-02	0.00E+00	5.9222E-01	1.8123E+02
$\alpha_5$	5.10E-09	1.22E-03	1.66E-04	6.12E-03	0.00E+00	2.2220E-01	1.8160E+02
$\alpha_6$	7.75E-19	4.58E-04	8.00E-07	2.67E-03	0.00E+00	8.3237E-02	1.8174E+02

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9560850	0.9743320	0.9755850	0.9883120	1.0000000	2.4465E+02	6.4450E+00
$\alpha_2$	3.46E-03	1.23E-02	1.10E-02	2.55E-02	0.00E+00	3.0878E+00	2.4801E+02
$\alpha_3$	8.75E-04	6.50E-03	5.24E-03	1.64E-02	0.00E+00	1.6312E+00	2.4946E+02
$\alpha_4$	1.97E-04	3.94E-03	2.72E-03	1.18E-02	0.00E+00	9.8887E-01	2.5011E+02
$\alpha_5$	1.02E-05	2.08E-03	9.83E-04	7.85E-03	0.00E+00	5.2177E-01	2.5057E+02
$\alpha_6$	2.68E-10	7.42E-04	6.33E-05	3.89E-03	0.00E+00	1.8628E-01	2.5091E+02
$\alpha_7$	0.00E+00	1.16E-04	1.01E-13	4.36E-04	0.00E+00	2.9071E-02	2.5107E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9569050	0.9739850	0.9750810	0.9873310	1.0000000	2.7933E+02	7.4610E+00
$\alpha_2$	3.50E-03	1.17E-02	1.05E-02	2.36E-02	0.00E+00	3.3447E+00	2.8345E+02
$\alpha_3$	8.96E-04	6.06E-03	4.96E-03	1.50E-02	0.00E+00	1.7384E+00	2.8505E+02
$\alpha_4$	2.83E-04	4.00E-03	2.92E-03	1.14E-02	0.00E+00	1.1465E+00	2.8564E+02
$\alpha_5$	4.49E-05	2.47E-03	1.45E-03	8.36E-03	0.00E+00	7.0833E-01	2.8608E+02
$\alpha_6$	7.24E-07	1.28E-03	4.19E-04	5.47E-03	0.00E+00	3.6696E-01	2.8642E+02
$\alpha_7$	5.68E-14	4.29E-04	7.71E-06	2.44E-03	0.00E+00	1.2297E-01	2.8667E+02
$\alpha_8$	1.06E-42	1.15E-04	1.65E-12	4.88E-04	0.00E+00	3.3124E-02	2.8676E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

PWR High Pressure Safety Injection Motor-Operated Valves  
 HIGH PRESSURE INJECTION MOV FAIL TO OPEN/CLOSE

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	60.60	60.60	60.60	60.60	60.60	60.60	60.60
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Motor Operated Valves  
PWR High Pressure Safety Injection Motor-Operated Valves  
HIGH PRESSURE INJECTION MOTOR OPERATED VALVE FAIL TO OPEN  
**HIGH PRESSURE INJECTION MOTOR OPERATED VALVE FAIL TO OPEN**

2010

**System :** Chemical and volume control  
High pressure injection  
**Component :** Motor Operated Valve  
**Failure Mode :** Fail to open on demand  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 29.60  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9566310	0.9892130	0.9956470	0.9999790	1.0000000	3.9846E+01	4.3452E-01
$\alpha_2$	1.94E-05	1.08E-02	4.35E-03	4.34E-02	0.00E+00	4.3452E-01	3.9846E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9475700	0.9817300	0.9867280	0.9980850	1.0000000	5.9155E+01	1.1009E+00
$\alpha_2$	4.37E-04	1.38E-02	8.95E-03	4.39E-02	0.00E+00	8.3366E-01	5.9422E+01
$\alpha_3$	1.55E-07	4.43E-03	8.92E-04	2.10E-02	0.00E+00	2.6722E-01	5.9989E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9425380	0.9760920	0.9800560	0.9960870	1.0000000	7.5736E+01	1.8551E+00
$\alpha_2$	1.31E-03	1.58E-02	1.19E-02	4.38E-02	0.00E+00	1.2281E+00	7.6363E+01
$\alpha_3$	5.86E-06	5.21E-03	1.93E-03	2.15E-02	0.00E+00	4.0431E-01	7.7187E+01
$\alpha_4$	1.24E-08	2.87E-03	3.92E-04	1.44E-02	0.00E+00	2.2267E-01	7.7368E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9457150	0.9726350	0.9750400	0.9913390	1.0000000	1.2576E+02	3.5382E+00
$\alpha_2$	3.14E-03	1.64E-02	1.39E-02	3.78E-02	0.00E+00	2.1142E+00	1.2718E+02
$\alpha_3$	3.69E-04	7.56E-03	5.22E-03	2.27E-02	0.00E+00	9.7738E-01	1.2832E+02
$\alpha_4$	1.90E-06	2.90E-03	9.75E-04	1.23E-02	0.00E+00	3.7439E-01	1.2892E+02
$\alpha_5$	4.61E-21	5.59E-04	3.16E-07	3.23E-03	0.00E+00	7.2277E-02	1.2923E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9464910	0.9716300	0.9736940	0.9897260	1.0000000	1.4654E+02	4.2787E+00
$\alpha_2$	3.05E-03	1.48E-02	1.28E-02	3.38E-02	0.00E+00	2.2392E+00	1.4858E+02
$\alpha_3$	5.33E-04	7.57E-03	5.53E-03	2.16E-02	0.00E+00	1.1418E+00	1.4968E+02
$\alpha_4$	3.51E-05	3.93E-03	2.06E-03	1.42E-02	0.00E+00	5.9222E-01	1.5023E+02
$\alpha_5$	6.16E-09	1.47E-03	2.00E-04	7.38E-03	0.00E+00	2.2220E-01	1.5060E+02
$\alpha_6$	9.35E-19	5.52E-04	9.65E-07	3.22E-03	0.00E+00	8.3237E-02	1.5074E+02



PWR High Pressure Safety Injection Motor-Operated Valves

HIGH PRESSURE INJECTION MOTOR OPERATED VALVE FAIL TO OPEN

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9499560	0.9707170	0.9721300	0.9866470	1.0000000	2.1365E+02	6.4450E+00
$\alpha_2$	3.95E-03	1.40E-02	1.26E-02	2.90E-02	0.00E+00	3.0878E+00	2.1701E+02
$\alpha_3$	9.98E-04	7.41E-03	5.98E-03	1.87E-02	0.00E+00	1.6312E+00	2.1846E+02
$\alpha_4$	2.25E-04	4.49E-03	3.11E-03	1.35E-02	0.00E+00	9.8887E-01	2.1911E+02
$\alpha_5$	1.17E-05	2.37E-03	1.12E-03	8.96E-03	0.00E+00	5.2177E-01	2.1957E+02
$\alpha_6$	3.05E-10	8.46E-04	7.22E-05	4.44E-03	0.00E+00	1.8628E-01	2.1991E+02
$\alpha_7$	0.00E+00	1.32E-04	1.16E-13	4.97E-04	0.00E+00	2.9071E-02	2.2007E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9517180	0.9708320	0.9720490	0.9857800	1.0000000	2.4833E+02	7.4610E+00
$\alpha_2$	3.93E-03	1.31E-02	1.18E-02	2.65E-02	0.00E+00	3.3447E+00	2.5245E+02
$\alpha_3$	1.01E-03	6.80E-03	5.56E-03	1.68E-02	0.00E+00	1.7384E+00	2.5405E+02
$\alpha_4$	3.17E-04	4.48E-03	3.28E-03	1.28E-02	0.00E+00	1.1465E+00	2.5464E+02
$\alpha_5$	5.04E-05	2.77E-03	1.63E-03	9.37E-03	0.00E+00	7.0833E-01	2.5508E+02
$\alpha_6$	8.12E-07	1.43E-03	4.70E-04	6.14E-03	0.00E+00	3.6696E-01	2.5542E+02
$\alpha_7$	6.37E-14	4.81E-04	8.64E-06	2.74E-03	0.00E+00	1.2297E-01	2.5567E+02
$\alpha_8$	1.19E-42	1.29E-04	1.84E-12	5.47E-04	0.00E+00	3.3124E-02	2.5576E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

PWR High Pressure Safety Injection Motor-Operated Valves

HIGH PRESSURE INJECTION MOTOR OPERATED VALVE FAIL TO OPEN

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	29.60	29.60	29.60	29.60	29.60	29.60	29.60
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Motor Operated Valves  
PWR High Pressure Safety Injection Motor-Operated Valves  
HIGH PRESSURE INJECTION MOTOR OPERATED VALVE FAIL TO CLOSE  
**HIGH PRESSURE INJECTION MOTOR OPERATED VALVE FAIL TO CLOSE**

2010

**System :** Chemical and volume control  
High pressure injection  
**Component :** Motor Operated Valve  
**Failure Mode :** Fail to close (reseal) on demand  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 27.00  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9536530	0.9884680	0.9953420	0.9999770	1.0000000	3.7246E+01	4.3452E-01
$\alpha_2$	2.08E-05	1.15E-02	4.66E-03	4.63E-02	0.00E+00	4.3452E-01	3.7246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9452290	0.9809060	0.9861230	0.9987500	1.0000000	5.6555E+01	1.1009E+00
$\alpha_2$	4.57E-04	1.45E-02	9.36E-03	4.59E-02	0.00E+00	8.3366E-01	5.6822E+01
$\alpha_3$	1.62E-07	4.63E-03	9.32E-04	2.20E-02	0.00E+00	2.6722E-01	5.7389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9405680	0.9752630	0.9793590	0.9959440	1.0000000	7.3136E+01	1.8551E+00
$\alpha_2$	1.35E-03	1.64E-02	1.23E-02	4.53E-02	0.00E+00	1.2281E+00	7.3763E+01
$\alpha_3$	6.06E-06	5.39E-03	2.00E-03	2.23E-02	0.00E+00	4.0431E-01	7.4587E+01
$\alpha_4$	1.28E-08	2.97E-03	4.06E-04	1.49E-02	0.00E+00	2.2267E-01	7.4768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9446120	0.9720730	0.9745250	0.9911590	1.0000000	1.2316E+02	3.5382E+00
$\alpha_2$	3.21E-03	1.67E-02	1.42E-02	3.86E-02	0.00E+00	2.1142E+00	1.2458E+02
$\alpha_3$	3.76E-04	7.71E-03	5.33E-03	2.32E-02	0.00E+00	9.7738E-01	1.2572E+02
$\alpha_4$	1.94E-06	2.95E-03	9.95E-04	1.25E-02	0.00E+00	3.7439E-01	1.2632E+02
$\alpha_5$	4.71E-21	5.70E-04	3.22E-07	3.30E-03	0.00E+00	7.2277E-02	1.2663E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9455620	0.9711330	0.9732300	0.9895430	1.0000000	1.4394E+02	4.2787E+00
$\alpha_2$	3.10E-03	1.51E-02	1.30E-02	3.44E-02	0.00E+00	2.2392E+00	1.4598E+02
$\alpha_3$	5.42E-04	7.70E-03	5.63E-03	2.19E-02	0.00E+00	1.1418E+00	1.4708E+02
$\alpha_4$	3.57E-05	4.00E-03	2.09E-03	1.44E-02	0.00E+00	5.9222E-01	1.4763E+02
$\alpha_5$	6.26E-09	1.50E-03	2.03E-04	7.51E-03	0.00E+00	2.2220E-01	1.4800E+02
$\alpha_6$	9.51E-19	5.62E-04	9.82E-07	3.28E-03	0.00E+00	8.3237E-02	1.4814E+02

PWR High Pressure Safety Injection Motor-Operated Valves

HIGH PRESSURE INJECTION MOTOR OPERATED VALVE FAIL TO CLOSE

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9493630	0.9703670	0.9717960	0.9864860	1.0000000	2.1105E+02	6.4450E+00
$\alpha_2$	4.00E-03	1.42E-02	1.27E-02	2.94E-02	0.00E+00	3.0878E+00	2.1441E+02
$\alpha_3$	1.01E-03	7.50E-03	6.05E-03	1.89E-02	0.00E+00	1.6312E+00	2.1586E+02
$\alpha_4$	2.28E-04	4.55E-03	3.15E-03	1.36E-02	0.00E+00	9.8887E-01	2.1651E+02
$\alpha_5$	1.18E-05	2.40E-03	1.14E-03	9.07E-03	0.00E+00	5.2177E-01	2.1697E+02
$\alpha_6$	3.09E-10	8.56E-04	7.31E-05	4.50E-03	0.00E+00	1.8628E-01	2.1731E+02
$\alpha_7$	0.00E+00	1.34E-04	1.17E-13	5.03E-04	0.00E+00	2.9071E-02	2.1747E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9512310	0.9705320	0.9717610	0.9856330	1.0000000	2.4573E+02	7.4610E+00
$\alpha_2$	3.97E-03	1.32E-02	1.20E-02	2.68E-02	0.00E+00	3.3447E+00	2.4985E+02
$\alpha_3$	1.02E-03	6.87E-03	5.62E-03	1.70E-02	0.00E+00	1.7384E+00	2.5145E+02
$\alpha_4$	3.20E-04	4.53E-03	3.31E-03	1.29E-02	0.00E+00	1.1465E+00	2.5204E+02
$\alpha_5$	5.09E-05	2.80E-03	1.64E-03	9.47E-03	0.00E+00	7.0833E-01	2.5248E+02
$\alpha_6$	8.20E-07	1.45E-03	4.74E-04	6.20E-03	0.00E+00	3.6696E-01	2.5282E+02
$\alpha_7$	6.43E-14	4.86E-04	8.73E-06	2.76E-03	0.00E+00	1.2297E-01	2.5307E+02
$\alpha_8$	1.21E-42	1.31E-04	1.86E-12	5.53E-04	0.00E+00	3.3124E-02	2.5316E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Motor Operated Valves

2010

PWR High Pressure Safety Injection Motor-Operated Valves

HIGH PRESSURE INJECTION MOTOR OPERATED VALVE FAIL TO CLOSE

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	27.00	27.00	27.00	27.00	27.00	27.00	27.00
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Motor Operated Valves  
PWR Residual Heat Removal Motor-Operated Valves  
PWR RHR MOV FAIL TO OPEN/CLOSE

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**PWR Residual Heat Removal Motor-Operated Valves**

**PWR RHR MOV FAIL TO OPEN/CLOSE**

**System :** Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
**Component :** Motor Operated Valve  
**Failure Mode :** Fail to close (reset) on demand  
Fail to Open/Close Mode Unspecified (demand based)  
Fail to open on demand  
**Plant Type :** PWR  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 81.80  
Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9167640	0.9790650	0.9912550	0.9999540	0.9992070	2.0709E+01	4.4282E-01
$\alpha_2$	4.29E-05	2.09E-02	8.74E-03	8.32E-02	7.93E-04	4.4282E-01	2.0709E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9310450	0.9757070	0.9821540	0.9983190	0.9984070	4.5220E+01	1.1259E+00
$\alpha_2$	6.42E-04	1.85E-02	1.22E-02	5.80E-02	1.59E-03	8.5866E-01	4.5487E+01
$\alpha_3$	2.02E-07	5.77E-03	1.16E-03	2.73E-02	0.00E+00	2.6722E-01	4.6079E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9342130	0.9723460	0.9767860	0.9952940	0.9976080	6.6986E+01	1.9051E+00
$\alpha_2$	1.66E-03	1.86E-02	1.41E-02	5.06E-02	2.39E-03	1.2781E+00	6.7613E+01
$\alpha_3$	6.60E-06	5.87E-03	2.17E-03	2.42E-02	0.00E+00	4.0431E-01	6.8487E+01
$\alpha_4$	1.39E-08	3.23E-03	4.42E-04	1.62E-02	0.00E+00	2.2267E-01	6.8668E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9432790	0.9712120	0.9736770	0.9907210	0.9968090	1.2218E+02	3.6215E+00
$\alpha_2$	3.52E-03	1.75E-02	1.50E-02	3.99E-02	3.19E-03	2.1975E+00	1.2360E+02
$\alpha_3$	3.79E-04	7.77E-03	5.36E-03	2.34E-02	0.00E+00	9.7738E-01	1.2482E+02
$\alpha_4$	1.96E-06	2.98E-03	1.00E-03	1.26E-02	0.00E+00	3.7439E-01	1.2543E+02
$\alpha_5$	4.74E-21	5.75E-04	3.25E-07	3.32E-03	0.00E+00	7.2277E-02	1.2573E+02

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**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9459470	0.9711260	0.9731650	0.9893440	0.9960060	1.4811E+02	4.4037E+00
$\alpha_2$	3.38E-03	1.55E-02	1.34E-02	3.47E-02	3.99E-03	2.3642E+00	1.5015E+02
$\alpha_3$	5.27E-04	7.49E-03	5.47E-03	2.13E-02	0.00E+00	1.1418E+00	1.5137E+02
$\alpha_4$	3.47E-05	3.88E-03	2.03E-03	1.40E-02	0.00E+00	5.9222E-01	1.5192E+02
$\alpha_5$	6.09E-09	1.46E-03	1.97E-04	7.30E-03	0.00E+00	2.2220E-01	1.5229E+02
$\alpha_6$	9.24E-19	5.46E-04	9.54E-07	3.18E-03	0.00E+00	8.3237E-02	1.5243E+02

**CCCG = 7**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9504540	0.9708360	0.9722060	0.9865310	0.9952040	2.2037E+02	6.6200E+00
$\alpha_2$	4.24E-03	1.44E-02	1.30E-02	2.93E-02	4.80E-03	3.2628E+00	2.2373E+02
$\alpha_3$	9.68E-04	7.19E-03	5.80E-03	1.81E-02	0.00E+00	1.6312E+00	2.2536E+02
$\alpha_4$	2.18E-04	4.36E-03	3.01E-03	1.31E-02	0.00E+00	9.8887E-01	2.2600E+02
$\alpha_5$	1.13E-05	2.30E-03	1.09E-03	8.69E-03	0.00E+00	5.2177E-01	2.2647E+02
$\alpha_6$	2.96E-10	8.21E-04	7.00E-05	4.31E-03	0.00E+00	1.8628E-01	2.2680E+02
$\alpha_7$	0.00E+00	1.28E-04	1.12E-13	4.82E-04	0.00E+00	2.9071E-02	2.2696E+02

**CCCG = 8**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9527560	0.9712740	0.9724380	0.9858120	0.9944010	2.6016E+02	7.6943E+00
$\alpha_2$	4.23E-03	1.34E-02	1.22E-02	2.66E-02	5.60E-03	3.5780E+00	2.6428E+02
$\alpha_3$	9.60E-04	6.49E-03	5.31E-03	1.61E-02	0.00E+00	1.7384E+00	2.6612E+02
$\alpha_4$	3.03E-04	4.28E-03	3.13E-03	1.22E-02	0.00E+00	1.1465E+00	2.6671E+02
$\alpha_5$	4.81E-05	2.64E-03	1.55E-03	8.95E-03	0.00E+00	7.0833E-01	2.6715E+02
$\alpha_6$	7.75E-07	1.37E-03	4.48E-04	5.86E-03	0.00E+00	3.6696E-01	2.6749E+02
$\alpha_7$	6.08E-14	4.59E-04	8.25E-06	2.61E-03	0.00E+00	1.2297E-01	2.6773E+02
$\alpha_8$	1.14E-42	1.24E-04	1.76E-12	5.23E-04	0.00E+00	3.3124E-02	2.6782E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9992070	0.9984070	0.9976080	0.9968090	0.9960060	0.9952040	0.9944010
$\alpha_2$	7.93E-04	1.59E-03	2.39E-03	3.19E-03	3.99E-03	4.80E-03	5.60E-03
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

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PWR RHR MOV FAIL TO OPEN/CLOSE

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.99E-01	9.98E-01	9.98E-01	9.97E-01	9.96E-01	9.95E-01	9.94E-01
Beta	7.93E-04	1.59E-03	2.39E-03	3.19E-03	3.99E-03	4.80E-03	5.60E-03
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	10.23	15.34	20.45	25.56	30.67	35.79	40.90
N <sub>1</sub>	0.2333	0.3250	0.4000	0.4583	0.5000	0.5250	0.5333
N <sub>2</sub>	0.0083	0.0250	0.0500	0.0833	0.1250	0.1750	0.2333
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000



Motor Operated Valves  
PWR Residual Heat Removal Motor-Operated Valves  
PWR RHR MOV FAIL TO OPEN  
**PWR RHR MOV FAIL TO OPEN**

2010

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
Component : Motor Operated Valve  
Failure Mode : Fail to open on demand  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 54.10  
Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9006160	0.9749560	0.9894760	0.9999440	0.9988150	1.7239E+01	4.4282E-01
$\alpha_2$	5.17E-05	2.50E-02	1.05E-02	9.94E-02	1.19E-03	4.4282E-01	1.7239E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9224590	0.9726370	0.9798620	0.9981020	0.9976170	4.0020E+01	1.1259E+00
$\alpha_2$	7.25E-04	2.09E-02	1.38E-02	6.53E-02	2.38E-03	8.5866E-01	4.0287E+01
$\alpha_3$	2.28E-07	6.49E-03	1.31E-03	3.08E-02	0.00E+00	2.6722E-01	4.0879E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9269650	0.9692590	0.9741650	0.9947630	0.9964230	6.0066E+01	1.9051E+00
$\alpha_2$	1.85E-03	2.06E-02	1.57E-02	5.61E-02	3.58E-03	1.2781E+00	6.0693E+01
$\alpha_3$	7.35E-06	6.52E-03	2.42E-03	2.69E-02	0.00E+00	4.0431E-01	6.1567E+01
$\alpha_4$	1.55E-08	3.59E-03	4.92E-04	1.80E-02	0.00E+00	2.2267E-01	6.1748E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9391390	0.9690870	0.9717170	0.9900250	0.9952270	1.1353E+02	3.6215E+00
$\alpha_2$	3.78E-03	1.88E-02	1.61E-02	4.29E-02	4.77E-03	2.1975E+00	1.1495E+02
$\alpha_3$	4.07E-04	8.34E-03	5.76E-03	2.51E-02	0.00E+00	9.7738E-01	1.1617E+02
$\alpha_4$	2.10E-06	3.20E-03	1.08E-03	1.36E-02	0.00E+00	3.7439E-01	1.1678E+02
$\alpha_5$	5.09E-21	6.17E-04	3.49E-07	3.57E-03	0.00E+00	7.2277E-02	1.1708E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9420420	0.9690180	0.9711910	0.9885560	0.9940230	1.3773E+02	4.4037E+00
$\alpha_2$	3.63E-03	1.66E-02	1.44E-02	3.72E-02	5.98E-03	2.3642E+00	1.3977E+02
$\alpha_3$	5.65E-04	8.03E-03	5.87E-03	2.29E-02	0.00E+00	1.1418E+00	1.4099E+02
$\alpha_4$	3.72E-05	4.17E-03	2.18E-03	1.50E-02	0.00E+00	5.9222E-01	1.4154E+02
$\alpha_5$	6.53E-09	1.56E-03	2.12E-04	7.83E-03	0.00E+00	2.2220E-01	1.4191E+02
$\alpha_6$	9.92E-19	5.86E-04	1.02E-06	3.42E-03	0.00E+00	8.3237E-02	1.4205E+02

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PWR Residual Heat Removal Motor-Operated Valves  
PWR RHR MOV FAIL TO OPEN

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**CCCG = 7**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9476820	0.9691890	0.9706330	0.9857620	0.9928190	2.0824E+02	6.6200E+00
$\alpha_2$	4.48E-03	1.52E-02	1.37E-02	3.09E-02	7.18E-03	3.2628E+00	2.1160E+02
$\alpha_3$	1.02E-03	7.59E-03	6.13E-03	1.92E-02	0.00E+00	1.6312E+00	2.1323E+02
$\alpha_4$	2.31E-04	4.60E-03	3.19E-03	1.38E-02	0.00E+00	9.8887E-01	2.1387E+02
$\alpha_5$	1.19E-05	2.43E-03	1.15E-03	9.18E-03	0.00E+00	5.2177E-01	2.1434E+02
$\alpha_6$	3.13E-10	8.67E-04	7.40E-05	4.55E-03	0.00E+00	1.8628E-01	2.1467E+02
$\alpha_7$	0.00E+00	1.35E-04	1.18E-13	5.09E-04	0.00E+00	2.9071E-02	2.1483E+02

**CCCG = 8**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9502050	0.9697080	0.9709320	0.9850290	0.9916130	2.4631E+02	7.6943E+00
$\alpha_2$	4.47E-03	1.41E-02	1.28E-02	2.80E-02	8.39E-03	3.5780E+00	2.5043E+02
$\alpha_3$	1.01E-03	6.84E-03	5.60E-03	1.69E-02	0.00E+00	1.7384E+00	2.5227E+02
$\alpha_4$	3.19E-04	4.51E-03	3.30E-03	1.29E-02	0.00E+00	1.1465E+00	2.5286E+02
$\alpha_5$	5.08E-05	2.79E-03	1.64E-03	9.44E-03	0.00E+00	7.0833E-01	2.5330E+02
$\alpha_6$	8.17E-07	1.44E-03	4.73E-04	6.18E-03	0.00E+00	3.6696E-01	2.5364E+02
$\alpha_7$	6.41E-14	4.84E-04	8.71E-06	2.76E-03	0.00E+00	1.2297E-01	2.5388E+02
$\alpha_8$	1.20E-42	1.30E-04	1.86E-12	5.51E-04	0.00E+00	3.3124E-02	2.5397E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9988150	0.9976170	0.9964230	0.9952270	0.9940230	0.9928190	0.9916130
$\alpha_2$	1.19E-03	2.38E-03	3.58E-03	4.77E-03	5.98E-03	7.18E-03	8.39E-03
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.99E-01	9.98E-01	9.96E-01	9.95E-01	9.94E-01	9.93E-01	9.92E-01
Beta	1.19E-03	2.38E-03	3.58E-03	4.77E-03	5.98E-03	7.18E-03	8.39E-03
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Motor Operated Valves  
PWR Residual Heat Removal Motor-Operated Valves  
PWR RHR MOV FAIL TO OPEN

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Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	6.76	10.14	13.53	16.91	20.29	23.67	27.05
N <sub>1</sub>	0.2333	0.3250	0.4000	0.4583	0.5000	0.5250	0.5333
N <sub>2</sub>	0.0083	0.0250	0.0500	0.0833	0.1250	0.1750	0.2333
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Motor Operated Valves  
PWR Residual Heat Removal Motor-Operated Valves  
PWR RHR MOV FAIL TO CLOSE  
**PWR RHR MOV FAIL TO CLOSE**

2010

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
Component : Motor Operated Valve  
Failure Mode : Fail to close (reseal) on demand  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 25.70  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9520050	0.9880560	0.9951740	0.9999760	1.0000000	3.5946E+01	4.3452E-01
$\alpha_2$	2.15E-05	1.19E-02	4.83E-03	4.80E-02	0.00E+00	4.3452E-01	3.5946E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9439790	0.9804660	0.9857990	0.9987200	1.0000000	5.5255E+01	1.1009E+00
$\alpha_2$	4.67E-04	1.48E-02	9.57E-03	4.69E-02	0.00E+00	8.3366E-01	5.5522E+01
$\alpha_3$	1.66E-07	4.74E-03	9.54E-04	2.25E-02	0.00E+00	2.6722E-01	5.6089E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9395320	0.9748260	0.9789910	0.9958710	1.0000000	7.1836E+01	1.8551E+00
$\alpha_2$	1.38E-03	1.67E-02	1.25E-02	4.61E-02	0.00E+00	1.2281E+00	7.2463E+01
$\alpha_3$	6.17E-06	5.49E-03	2.03E-03	2.27E-02	0.00E+00	4.0431E-01	7.3287E+01
$\alpha_4$	1.30E-08	3.02E-03	4.13E-04	1.51E-02	0.00E+00	2.2267E-01	7.3468E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9440440	0.9717840	0.9742590	0.9910660	1.0000000	1.2186E+02	3.5382E+00
$\alpha_2$	3.24E-03	1.69E-02	1.44E-02	3.90E-02	0.00E+00	2.1142E+00	1.2328E+02
$\alpha_3$	3.80E-04	7.79E-03	5.38E-03	2.34E-02	0.00E+00	9.7738E-01	1.2442E+02
$\alpha_4$	1.96E-06	2.99E-03	1.00E-03	1.27E-02	0.00E+00	3.7439E-01	1.2502E+02
$\alpha_5$	4.76E-21	5.76E-04	3.26E-07	3.34E-03	0.00E+00	7.2277E-02	1.2533E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9450850	0.9708770	0.9729920	0.9894500	1.0000000	1.4264E+02	4.2787E+00
$\alpha_2$	3.13E-03	1.52E-02	1.31E-02	3.47E-02	0.00E+00	2.2392E+00	1.4468E+02
$\alpha_3$	5.47E-04	7.77E-03	5.68E-03	2.21E-02	0.00E+00	1.1418E+00	1.4578E+02
$\alpha_4$	3.60E-05	4.03E-03	2.11E-03	1.45E-02	0.00E+00	5.9222E-01	1.4633E+02
$\alpha_5$	6.32E-09	1.51E-03	2.05E-04	7.58E-03	0.00E+00	2.2220E-01	1.4670E+02
$\alpha_6$	9.59E-19	5.67E-04	9.91E-07	3.31E-03	0.00E+00	8.3237E-02	1.4684E+02

Motor Operated Valves  
PWR Residual Heat Removal Motor-Operated Valves  
PWR RHR MOV FAIL TO CLOSE

2010

**CCCG = 7**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9490610	0.9701890	0.9716260	0.9864030	1.0000000	2.0975E+02	6.4450E+00
$\alpha_2$	4.02E-03	1.43E-02	1.28E-02	2.96E-02	0.00E+00	3.0878E+00	2.1311E+02
$\alpha_3$	1.02E-03	7.55E-03	6.09E-03	1.90E-02	0.00E+00	1.6312E+00	2.1456E+02
$\alpha_4$	2.29E-04	4.57E-03	3.17E-03	1.37E-02	0.00E+00	9.8887E-01	2.1521E+02
$\alpha_5$	1.19E-05	2.41E-03	1.14E-03	9.12E-03	0.00E+00	5.2177E-01	2.1567E+02
$\alpha_6$	3.11E-10	8.62E-04	7.36E-05	4.52E-03	0.00E+00	1.8628E-01	2.1601E+02
$\alpha_7$	0.00E+00	1.34E-04	1.18E-13	5.06E-04	0.00E+00	2.9071E-02	2.1617E+02

**CCCG = 8**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9509820	0.9703800	0.9716150	0.9855530	1.0000000	2.4443E+02	7.4610E+00
$\alpha_2$	3.99E-03	1.33E-02	1.20E-02	2.69E-02	0.00E+00	3.3447E+00	2.4855E+02
$\alpha_3$	1.02E-03	6.90E-03	5.65E-03	1.71E-02	0.00E+00	1.7384E+00	2.5015E+02
$\alpha_4$	3.22E-04	4.55E-03	3.33E-03	1.30E-02	0.00E+00	1.1465E+00	2.5074E+02
$\alpha_5$	5.12E-05	2.81E-03	1.65E-03	9.52E-03	0.00E+00	7.0833E-01	2.5118E+02
$\alpha_6$	8.24E-07	1.46E-03	4.77E-04	6.23E-03	0.00E+00	3.6696E-01	2.5152E+02
$\alpha_7$	6.46E-14	4.88E-04	8.78E-06	2.78E-03	0.00E+00	1.2297E-01	2.5177E+02
$\alpha_8$	1.21E-42	1.32E-04	1.87E-12	5.56E-04	0.00E+00	3.3124E-02	2.5186E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Motor Operated Valves  
PWR Residual Heat Removal Motor-Operated Valves  
PWR RHR MOV FAIL TO CLOSE

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Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	25.70	25.70	25.70	25.70	25.70	25.70	25.70
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Motor Operated Valves  
 BWR High Pressure Coolant Injection and Reactor Core Isolation Cooling Motor-Operated Valves  
 COMBINED HPCI/RCIC MOTOR OPERATED VALVE FAIL TO OPEN/CLOSE  
**BWR High Pressure Coolant Injection and Reactor Core Isolation Cooling Motor-Operated Valves**  
**COMBINED HPCI/RCIC MOTOR OPERATED VALVE FAIL TO OPEN/CLOSE**

**System :** High pressure coolant injection  
 Reactor core isolation  
**Component :** Motor Operated Valve  
**Failure Mode :** Fail to close (reset) on demand  
 Fail to Open/Close Mode Unspecified (demand based)  
 Fail to open on demand  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 71.90  
 Total Number of Common-Cause Failure Events: 2

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9529140	0.9877530	0.9944270	0.9999520	0.9980650	3.9642E+01	4.9152E-01
$\alpha_2$	4.48E-05	1.22E-02	5.58E-03	4.71E-02	1.94E-03	4.9152E-01	3.9642E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9538960	0.9831950	0.9872700	0.9985460	0.9964760	7.3501E+01	1.2563E+00
$\alpha_2$	6.50E-04	1.31E-02	9.11E-03	3.93E-02	3.35E-03	9.8126E-01	7.3776E+01
$\alpha_3$	1.72E-07	3.68E-03	7.78E-04	1.73E-02	1.77E-04	2.7502E-01	7.4482E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9538620	0.9799650	0.9828840	0.9960920	0.9951860	1.0456E+02	2.1377E+00
$\alpha_2$	1.62E-03	1.39E-02	1.10E-02	3.61E-02	4.33E-03	1.4825E+00	1.0522E+02
$\alpha_3$	6.89E-06	4.04E-03	1.60E-03	1.63E-02	4.63E-04	4.3151E-01	1.0627E+02
$\alpha_4$	9.53E-09	2.10E-03	2.89E-04	1.05E-02	1.70E-05	2.2367E-01	1.0647E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9559310	0.9771560	0.9789690	0.9921840	0.9943590	1.6903E+02	3.9517E+00
$\alpha_2$	3.23E-03	1.42E-02	1.24E-02	3.14E-02	4.69E-03	2.4579E+00	1.7052E+02
$\alpha_3$	3.43E-04	6.02E-03	4.26E-03	1.77E-02	8.75E-04	1.0415E+00	1.7194E+02
$\alpha_4$	1.60E-06	2.20E-03	7.51E-04	9.28E-03	7.37E-05	3.7979E-01	1.7260E+02
$\alpha_5$	3.86E-21	4.19E-04	2.42E-07	2.42E-03	2.73E-06	7.2477E-02	1.7291E+02

BWR High Pressure Coolant Injection and Reactor Core Isolation Cooling Motor-Operated Valves

COMBINED HPCI/RCIC MOTOR OPERATED VALVE FAIL TO OPEN/CLOSE

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9576620	0.9769000	0.9784080	0.9910010	0.9937330	2.0422E+02	4.8291E+00
$\alpha_2$	3.14E-03	1.27E-02	1.12E-02	2.75E-02	4.84E-03	2.6645E+00	2.0638E+02
$\alpha_3$	5.07E-04	5.98E-03	4.50E-03	1.65E-02	1.24E-03	1.2506E+00	2.0780E+02
$\alpha_4$	2.89E-05	2.91E-03	1.55E-03	1.04E-02	1.73E-04	6.0742E-01	2.0844E+02
$\alpha_5$	4.74E-09	1.07E-03	1.46E-04	5.34E-03	1.25E-05	2.2330E-01	2.0883E+02
$\alpha_6$	6.74E-19	3.98E-04	6.96E-07	2.32E-03	0.00E+00	8.3237E-02	2.0897E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9980650	0.9964760	0.9951860	0.9943590	0.9937330
$\alpha_2$	1.94E-03	3.35E-03	4.33E-03	4.69E-03	4.84E-03
$\alpha_3$		1.77E-04	4.63E-04	8.75E-04	1.24E-03
$\alpha_4$			1.70E-05	7.37E-05	1.73E-04
$\alpha_5$				2.73E-06	1.25E-05
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.98E-01	9.96E-01	9.95E-01	9.94E-01	9.94E-01
Beta	1.94E-03	3.52E-03	4.81E-03	5.64E-03	6.27E-03
Gamma		5.02E-02	9.98E-02	1.69E-01	2.27E-01
Delta			3.55E-02	8.03E-02	1.30E-01
Epsilon				3.57E-02	6.75E-02
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	28.76	43.14	57.52	71.90	86.28
$N_1$	0.6360	0.8064	0.9056	0.9685	0.9977
$N_2$	0.0570	0.1476	0.2544	0.3437	0.4253
$N_3$		0.0078	0.0272	0.0641	0.1088
$N_4$			0.0010	0.0054	0.0152
$N_5$				0.0002	0.0011
$N_6$					0.0000



Motor Operated Valves  
 BWR High Pressure Coolant Injection and Reactor Core Isolation Cooling Motor-  
 Operated Valves  
 COMBINED HPCI AND RCIC MOTOR OPERATED VALVE FAIL TO OPEN  
**COMBINED HPCI AND RCIC MOTOR OPERATED VALVE FAIL TO OPEN**

2010

**System :** High pressure coolant injection  
 Reactor core isolation  
**Component :** Motor Operated Valve  
**Failure Mode :** Fail to open on demand  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 34.10  
 Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9211970	0.9802910	0.9919000	0.9999600	0.9998260	2.1712E+01	4.3652E-01
$\alpha_2$	3.70E-05	1.97E-02	8.10E-03	7.88E-02	1.74E-04	4.3652E-01	2.1712E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9339130	0.9768680	0.9831150	0.9984570	0.9996510	4.6743E+01	1.1069E+00
$\alpha_2$	5.68E-04	1.75E-02	1.14E-02	5.54E-02	3.43E-04	8.3956E-01	4.7010E+01
$\alpha_3$	1.96E-07	5.59E-03	1.13E-03	2.65E-02	5.82E-06	2.6732E-01	4.7583E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9369260	0.9736750	0.9779950	0.9956430	0.9994940	6.9043E+01	1.8667E+00
$\alpha_2$	1.47E-03	1.75E-02	1.32E-02	4.82E-02	4.97E-04	1.2395E+00	6.9670E+01
$\alpha_3$	6.44E-06	5.70E-03	2.11E-03	2.36E-02	8.73E-06	4.0451E-01	7.0505E+01
$\alpha_4$	1.35E-08	3.14E-03	4.30E-04	1.57E-02	0.00E+00	2.2267E-01	7.0687E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9451060	0.9722840	0.9747050	0.9911900	0.9993370	1.2479E+02	3.5572E+00
$\alpha_2$	3.23E-03	1.66E-02	1.42E-02	3.83E-02	6.46E-04	2.1327E+00	1.2621E+02
$\alpha_3$	3.72E-04	7.62E-03	5.26E-03	2.29E-02	1.75E-05	9.7788E-01	1.2737E+02
$\alpha_4$	1.92E-06	2.92E-03	9.82E-04	1.24E-02	0.00E+00	3.7439E-01	1.2797E+02
$\alpha_5$	4.65E-21	5.63E-04	3.18E-07	3.26E-03	0.00E+00	7.2277E-02	1.2827E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9478660	0.9723200	0.9743230	0.9899360	0.9991850	1.5128E+02	4.3067E+00
$\alpha_2$	3.03E-03	1.46E-02	1.25E-02	3.30E-02	7.86E-04	2.2662E+00	1.5332E+02
$\alpha_3$	5.18E-04	7.35E-03	5.37E-03	2.09E-02	2.91E-05	1.1428E+00	1.5444E+02
$\alpha_4$	3.40E-05	3.81E-03	1.99E-03	1.37E-02	0.00E+00	5.9222E-01	1.5499E+02
$\alpha_5$	5.97E-09	1.43E-03	1.94E-04	7.15E-03	0.00E+00	2.2220E-01	1.5536E+02
$\alpha_6$	9.06E-19	5.35E-04	9.35E-07	3.12E-03	0.00E+00	8.3237E-02	1.5550E+02

BWR High Pressure Coolant Injection and Reactor Core Isolation Cooling Motor-Operated Valves

COMBINED HPCI AND RCIC MOTOR OPERATED VALVE FAIL TO OPEN

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9998260	0.9996510	0.9994940	0.9993370	0.9991850
$\alpha_2$	1.74E-04	3.43E-04	4.97E-04	6.46E-04	7.86E-04
$\alpha_3$		5.82E-06	8.73E-06	1.75E-05	2.91E-05
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	9.99E-01	9.99E-01	9.99E-01
Beta	1.74E-04	3.49E-04	5.06E-04	6.63E-04	8.15E-04
Gamma		1.67E-02	1.72E-02	2.63E-02	3.57E-02
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	11.37	17.05	22.73	28.42	34.10
$N_1$	0.0960	0.1382	0.1766	0.2115	0.2430
$N_2$	0.0020	0.0059	0.0114	0.0185	0.0270
$N_3$		0.0001	0.0002	0.0005	0.0010
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

Motor Operated Valves  
 BWR High Pressure Coolant Injection and Reactor Core Isolation Cooling Motor-  
 Operated Valves  
 COMBINED HPCI AND RCIC MOTOR OPERATED VALVE FAIL TO CLOSE  
**COMBINED HPCI AND RCIC MOTOR OPERATED VALVE FAIL TO CLOSE**

**System :** High pressure coolant injection  
 Reactor core isolation  
**Component :** Motor Operated Valve  
**Failure Mode :** Fail to close (reset) on demand  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 33.80

Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9332640	0.9826260	0.9920650	0.9999340	0.9968560	2.7686E+01	4.8952E-01
$\alpha_2$	6.27E-05	1.74E-02	7.93E-03	6.67E-02	3.14E-03	4.8952E-01	2.7686E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9396830	0.9779940	0.9833130	0.9981060	0.9942830	5.5573E+01	1.2505E+00
$\alpha_2$	8.41E-04	1.72E-02	1.19E-02	5.14E-02	5.42E-03	9.7546E-01	5.5848E+01
$\alpha_3$	2.27E-07	4.84E-03	1.03E-03	2.28E-02	2.98E-04	2.7502E-01	5.6548E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9409100	0.9743200	0.9780420	0.9950040	0.9922130	8.0665E+01	2.1261E+00
$\alpha_2$	2.05E-03	1.78E-02	1.41E-02	4.62E-02	6.98E-03	1.4711E+00	8.1320E+01
$\alpha_3$	8.86E-06	5.21E-03	2.07E-03	2.10E-02	7.76E-04	4.3131E-01	8.2360E+01
$\alpha_4$	1.23E-08	2.70E-03	3.73E-04	1.35E-02	2.87E-05	2.2367E-01	8.2567E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9470050	0.9725190	0.9746940	0.9906040	0.9909130	1.3917E+02	3.9327E+00
$\alpha_2$	3.85E-03	1.70E-02	1.49E-02	3.78E-02	7.49E-03	2.4394E+00	1.4066E+02
$\alpha_3$	4.14E-04	7.27E-03	5.14E-03	2.14E-02	1.47E-03	1.0410E+00	1.4206E+02
$\alpha_4$	1.93E-06	2.65E-03	9.09E-04	1.12E-02	1.24E-04	3.7979E-01	1.4272E+02
$\alpha_5$	4.67E-21	5.06E-04	2.93E-07	2.93E-03	4.61E-06	7.2477E-02	1.4303E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9491920	0.9722790	0.9740810	0.9892130	0.9899490	1.6839E+02	4.8011E+00
$\alpha_2$	3.71E-03	1.52E-02	1.34E-02	3.30E-02	7.66E-03	2.6375E+00	1.7055E+02
$\alpha_3$	6.12E-04	7.22E-03	5.43E-03	1.99E-02	2.07E-03	1.2496E+00	1.7194E+02
$\alpha_4$	3.49E-05	3.51E-03	1.87E-03	1.25E-02	2.92E-04	6.0742E-01	1.7258E+02
$\alpha_5$	5.73E-09	1.29E-03	1.77E-04	6.45E-03	2.12E-05	2.2330E-01	1.7297E+02
$\alpha_6$	8.13E-19	4.81E-04	8.40E-07	2.80E-03	0.00E+00	8.3237E-02	1.7311E+02

BWR High Pressure Coolant Injection and Reactor Core Isolation Cooling Motor-Operated Valves

COMBINED HPCI AND RCIC MOTOR OPERATED VALVE FAIL TO CLOSE

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9968560	0.9942830	0.9922130	0.9909130	0.9899490
$\alpha_2$	3.14E-03	5.42E-03	6.98E-03	7.49E-03	7.66E-03
$\alpha_3$		2.98E-04	7.76E-04	1.47E-03	2.07E-03
$\alpha_4$			2.87E-05	1.24E-04	2.92E-04
$\alpha_5$				4.61E-06	2.12E-05
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.97E-01	9.94E-01	9.92E-01	9.91E-01	9.90E-01
Beta	3.14E-03	5.72E-03	7.79E-03	9.09E-03	1.01E-02
Gamma		5.21E-02	1.03E-01	1.75E-01	2.38E-01
Delta			3.57E-02	8.09E-02	1.31E-01
Epsilon				3.57E-02	6.75E-02
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	16.90	25.35	33.80	42.25	50.70
$N_1$	0.5400	0.6683	0.7290	0.7570	0.7547
$N_2$	0.0550	0.1418	0.2430	0.3252	0.3983
$N_3$		0.0078	0.0270	0.0636	0.1078
$N_4$			0.0010	0.0054	0.0152
$N_5$				0.0002	0.0011
$N_6$					0.0000

Motor Operated Valves  
 Pressurizer PORV Motor-Operated Block Valves  
 PRESSURIZER PORV BLOCK MOVES FAIL TO OPEN

2010

**Pressurizer PORV Motor-Operated Block Valves**

**PRESSURIZER PORV BLOCK MOVES FAIL TO OPEN**

System : Reactor coolant  
 Component : Motor Operated Valve  
 Failure Mode : Fail to open on demand  
 Plant Type : PWR  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 4.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8819910	0.9704020	0.9877120	0.9999410	1.0000000	1.4246E+01	4.3452E-01
$\alpha_2$	5.49E-05	2.96E-02	1.23E-02	1.18E-01	0.00E+00	4.3452E-01	1.4246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9094830	0.9682340	0.9767350	0.9978890	1.0000000	3.3555E+01	1.1009E+00
$\alpha_2$	7.68E-04	2.41E-02	1.57E-02	7.59E-02	0.00E+00	8.3366E-01	3.3822E+01
$\alpha_3$	2.71E-07	7.71E-03	1.56E-03	3.66E-02	0.00E+00	2.6722E-01	3.4389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9147120	0.9643190	0.9701040	0.9941100	1.0000000	5.0136E+01	1.8551E+00
$\alpha_2$	1.96E-03	2.36E-02	1.78E-02	6.51E-02	0.00E+00	1.2281E+00	5.0763E+01
$\alpha_3$	8.78E-06	7.78E-03	2.89E-03	3.21E-02	0.00E+00	4.0431E-01	5.1587E+01
$\alpha_4$	1.85E-08	4.28E-03	5.88E-04	2.15E-02	0.00E+00	2.2267E-01	5.1768E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Motor Operated Valves  
Pressurizer PORV Motor-Operated Block Valves  
PRESSURIZER PORV BLOCK MOVES FAIL TO OPEN

2010

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	4.00	4.00	4.00
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

Motor Operated Valves  
 Pressurizer PORV Motor-Operated Block Valves  
 PRESSURIZER PORV BLOCK MOVES FAIL TO CLOSE  
**PRESSURIZER PORV BLOCK MOVES FAIL TO CLOSE**

2010

System : Reactor coolant  
 Component : Motor Operated Valve  
 Failure Mode : Fail to close (reseal) on demand  
 Plant Type : PWR  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 4.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8819910	0.9704020	0.9877120	0.9999410	1.0000000	1.4246E+01	4.3452E-01
$\alpha_2$	5.49E-05	2.96E-02	1.23E-02	1.18E-01	0.00E+00	4.3452E-01	1.4246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9094830	0.9682340	0.9767350	0.9978890	1.0000000	3.3555E+01	1.1009E+00
$\alpha_2$	7.68E-04	2.41E-02	1.57E-02	7.59E-02	0.00E+00	8.3366E-01	3.3822E+01
$\alpha_3$	2.71E-07	7.71E-03	1.56E-03	3.66E-02	0.00E+00	2.6722E-01	3.4389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9147120	0.9643190	0.9701040	0.9941100	1.0000000	5.0136E+01	1.8551E+00
$\alpha_2$	1.96E-03	2.36E-02	1.78E-02	6.51E-02	0.00E+00	1.2281E+00	5.0763E+01
$\alpha_3$	8.78E-06	7.78E-03	2.89E-03	3.21E-02	0.00E+00	4.0431E-01	5.1587E+01
$\alpha_4$	1.85E-08	4.28E-03	5.88E-04	2.15E-02	0.00E+00	2.2267E-01	5.1768E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Motor Operated Valves

2010

Pressurizer PORV Motor-Operated Block Valves

PRESSURIZER PORV BLOCK MOVES FAIL TO CLOSE

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	4.00	4.00	4.00
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000



## Air Operated Valves

### Pooled Air Operated Valves

#### AOV FAIL TO OPEN/CLOSE ALL SYSTEMS SPAR: AOV-FO

Component : Air Operated Valve  
 Failure Mode : Fail to close (reseal) on demand  
 Fail to Open/Close Mode Unspecified (demand based)  
 Fail to open on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 213.10

Total Number of Common-Cause Failure Events: 11

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9331610	0.9644210	0.9669510	0.9870220	0.9649150	1.1670E+02	4.3052E+00
$\alpha_2$	1.30E-02	3.56E-02	3.30E-02	6.68E-02	3.51E-02	4.3052E+00	1.1670E+02

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9395680	0.9639620	0.9655560	0.9829220	0.9639370	1.8625E+02	6.9630E+00
$\alpha_2$	8.13E-03	2.24E-02	2.07E-02	4.22E-02	2.15E-02	4.3208E+00	1.8889E+02
$\alpha_3$	3.34E-03	1.37E-02	1.20E-02	2.96E-02	1.46E-02	2.6422E+00	1.9057E+02

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9441460	0.9646650	0.9658430	0.9811630	0.9654090	2.5299E+02	9.2669E+00
$\alpha_2$	6.80E-03	1.78E-02	1.66E-02	3.30E-02	1.61E-02	4.6774E+00	2.5758E+02
$\alpha_3$	2.48E-03	1.01E-02	8.90E-03	2.19E-02	1.05E-02	2.6543E+00	2.5960E+02
$\alpha_4$	1.26E-03	7.38E-03	6.17E-03	1.76E-02	7.99E-03	1.9352E+00	2.6032E+02

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9503400	0.9670030	0.9678490	0.9807730	0.9679380	3.5335E+02	1.2057E+01
$\alpha_2$	6.94E-03	1.60E-02	1.52E-02	2.81E-02	1.41E-02	5.8612E+00	3.5955E+02
$\alpha_3$	1.70E-03	7.10E-03	6.23E-03	1.55E-02	6.09E-03	2.5952E+00	3.6281E+02
$\alpha_4$	1.64E-03	6.98E-03	6.11E-03	1.53E-02	8.20E-03	2.5523E+00	3.6286E+02
$\alpha_5$	1.66E-04	2.87E-03	2.03E-03	8.44E-03	3.67E-03	1.0486E+00	3.6436E+02

Air Operated Valves  
Pooled Air Operated Valves  
AOV FAIL TO OPEN/CLOSE ALL SYSTEMS SPAR: AOV-FO  
CCCG = 6

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9543330	0.9690370	0.9697520	0.9813110	0.9706940	4.2465E+02	1.3568E+01
$\alpha_2$	5.92E-03	1.36E-02	1.28E-02	2.37E-02	1.17E-02	5.9523E+00	4.3227E+02
$\alpha_3$	1.56E-03	6.23E-03	5.49E-03	1.34E-02	5.01E-03	2.7294E+00	4.3549E+02
$\alpha_4$	1.06E-03	5.16E-03	4.43E-03	1.18E-02	5.26E-03	2.2610E+00	4.3596E+02
$\alpha_5$	7.75E-04	4.47E-03	3.74E-03	1.07E-02	5.48E-03	1.9584E+00	4.3626E+02
$\alpha_6$	2.22E-05	1.52E-03	8.62E-04	5.27E-03	1.84E-03	6.6734E-01	4.3755E+02

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9585020	0.9710430	0.9716070	0.9816660	0.9735660	5.4252E+02	1.6178E+01
$\alpha_2$	5.23E-03	1.15E-02	1.10E-02	1.98E-02	9.12E-03	6.4461E+00	5.5225E+02
$\alpha_3$	1.83E-03	6.05E-03	5.47E-03	1.23E-02	4.75E-03	3.3814E+00	5.5532E+02
$\alpha_4$	8.93E-04	4.18E-03	3.61E-03	9.43E-03	3.66E-03	2.3358E+00	5.5636E+02
$\alpha_5$	7.40E-04	3.83E-03	3.25E-03	8.88E-03	4.39E-03	2.1388E+00	5.5656E+02
$\alpha_6$	3.03E-04	2.65E-03	2.08E-03	6.92E-03	3.51E-03	1.4781E+00	5.5722E+02
$\alpha_7$	7.14E-07	7.12E-04	2.57E-04	2.96E-03	1.00E-03	3.9797E-01	5.5830E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9613450	0.9726590	0.9731440	0.9823110	0.9757040	6.2789E+02	1.7650E+01
$\alpha_2$	4.62E-03	1.01E-02	9.63E-03	1.74E-02	7.62E-03	6.5394E+00	6.3900E+02
$\alpha_3$	1.71E-03	5.47E-03	4.97E-03	1.10E-02	4.28E-03	3.5340E+00	6.4201E+02
$\alpha_4$	8.15E-04	3.71E-03	3.21E-03	8.31E-03	2.98E-03	2.3957E+00	6.4314E+02
$\alpha_5$	5.75E-04	3.16E-03	2.66E-03	7.43E-03	3.17E-03	2.0367E+00	6.4350E+02
$\alpha_6$	4.32E-04	2.79E-03	2.30E-03	6.83E-03	3.42E-03	1.8007E+00	6.4374E+02
$\alpha_7$	9.84E-05	1.65E-03	1.17E-03	4.83E-03	2.24E-03	1.0642E+00	6.4448E+02
$\alpha_8$	2.32E-08	4.32E-04	9.32E-05	2.02E-03	5.86E-04	2.7902E-01	6.4526E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9649150	0.9639370	0.9654090	0.9679380	0.9706940	0.9735660	0.9757040
$\alpha_2$	3.51E-02	2.15E-02	1.61E-02	1.41E-02	1.17E-02	9.12E-03	7.62E-03
$\alpha_3$		1.46E-02	1.05E-02	6.09E-03	5.01E-03	4.75E-03	4.28E-03
$\alpha_4$			7.99E-03	8.20E-03	5.26E-03	3.66E-03	2.98E-03
$\alpha_5$				3.67E-03	5.48E-03	4.39E-03	3.17E-03
$\alpha_6$					1.84E-03	3.51E-03	3.42E-03
$\alpha_7$						1.00E-03	2.24E-03
$\alpha_8$							5.86E-04

Air Operated Valves  
Pooled Air Operated Valves

2010

AOV FAIL TO OPEN/CLOSE ALL SYSTEMS SPAR: AOV-FO

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.65E-01	9.64E-01	9.65E-01	9.68E-01	9.71E-01	9.74E-01	9.76E-01
Beta	3.51E-02	3.61E-02	3.46E-02	3.21E-02	2.93E-02	2.64E-02	2.43E-02
Gamma		4.05E-01	5.35E-01	5.60E-01	6.00E-01	6.55E-01	6.86E-01
Delta			4.32E-01	6.61E-01	7.15E-01	7.25E-01	7.43E-01
Epsilon				3.10E-01	5.82E-01	7.09E-01	7.60E-01
Mu					2.52E-01	5.07E-01	6.64E-01
Upsilon						2.22E-01	4.53E-01
Sigma							2.07E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	101.96	152.94	203.92	254.90	305.89	356.87	407.85
N <sub>1</sub>	4.4919	3.7507	2.9348	2.2845	1.8163	1.6020	1.3101
N <sub>2</sub>	3.8707	3.4871	3.4493	3.7470	3.7131	3.3583	3.1947
N <sub>3</sub>		2.3750	2.2500	1.6178	1.5876	1.7502	1.7956
N <sub>4</sub>			1.7125	2.1779	1.6688	1.3469	1.2492
N <sub>5</sub>				0.9763	1.7362	1.6170	1.3284
N <sub>6</sub>					0.5841	1.2918	1.4337
N <sub>7</sub>						0.3689	0.9412
N <sub>8</sub>							0.2459

Air Operated Valves  
Pooled Air Operated Valves  
AOV FAIL TO OPEN ALL SYSTEMS SPAR: AOV-CC  
**AOV FAIL TO OPEN ALL SYSTEMS SPAR: AOV-CC**

2010

Component : Air Operated Valve  
Failure Mode : Fail to open on demand  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 126.20  
Total Number of Common-Cause Failure Events: 5

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9375960	0.9739420	0.9782130	0.9956770	0.9764990	6.9901E+01	1.8702E+00
$\alpha_2$	4.32E-03	2.61E-02	2.18E-02	6.24E-02	2.35E-02	1.8702E+00	6.9901E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9466770	0.9739610	0.9765260	0.9924820	0.9772990	1.1812E+02	3.1580E+00
$\alpha_2$	3.90E-03	1.87E-02	1.61E-02	4.23E-02	1.58E-02	2.2658E+00	1.1901E+02
$\alpha_3$	2.81E-04	7.36E-03	4.89E-03	2.29E-02	6.90E-03	8.9222E-01	1.2039E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9487750	0.9722600	0.9741180	0.9894030	0.9766300	1.6322E+02	4.6569E+00
$\alpha_2$	4.82E-03	1.77E-02	1.58E-02	3.70E-02	1.45E-02	2.9674E+00	1.6491E+02
$\alpha_3$	4.95E-04	6.88E-03	5.04E-03	1.95E-02	6.26E-03	1.1543E+00	1.6672E+02
$\alpha_4$	1.78E-05	3.19E-03	1.54E-03	1.19E-02	2.61E-03	5.3517E-01	1.6734E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9525320	0.9716860	0.9729390	0.9865490	0.9764870	2.4164E+02	7.0413E+00
$\alpha_2$	5.91E-03	1.67E-02	1.54E-02	3.19E-02	1.37E-02	4.1588E+00	2.4452E+02
$\alpha_3$	1.05E-03	7.03E-03	5.76E-03	1.74E-02	5.17E-03	1.7482E+00	2.4693E+02
$\alpha_4$	1.45E-04	3.64E-03	2.43E-03	1.13E-02	3.57E-03	9.0569E-01	2.4778E+02
$\alpha_5$	5.45E-09	9.19E-04	1.33E-04	4.57E-03	1.05E-03	2.2858E-01	2.4845E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9540270	0.9714330	0.9724760	0.9852710	0.9760190	2.9059E+02	8.5453E+00
$\alpha_2$	6.07E-03	1.58E-02	1.48E-02	2.92E-02	1.40E-02	4.7315E+00	2.9440E+02
$\alpha_3$	1.02E-03	6.25E-03	5.19E-03	1.51E-02	4.10E-03	1.8710E+00	2.9726E+02
$\alpha_4$	3.25E-04	4.06E-03	3.03E-03	1.13E-02	3.50E-03	1.2155E+00	2.9792E+02
$\alpha_5$	1.38E-05	1.89E-03	9.56E-04	6.95E-03	1.93E-03	5.6600E-01	2.9857E+02
$\alpha_6$	1.84E-11	5.39E-04	2.92E-05	2.93E-03	4.39E-04	1.6134E-01	2.9897E+02

Air Operated Valves  
Pooled Air Operated Valves  
AOV FAIL TO OPEN ALL SYSTEMS SPAR: AOV-CC  
**CCCG = 7**

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9571200	0.9719440	0.9727350	0.9840790	0.9772650	3.8614E+02	1.1146E+01
$\alpha_2$	5.88E-03	1.40E-02	1.32E-02	2.48E-02	1.19E-02	5.5565E+00	3.9173E+02
$\alpha_3$	1.46E-03	6.32E-03	5.51E-03	1.39E-02	4.25E-03	2.5097E+00	3.9478E+02
$\alpha_4$	5.37E-04	4.06E-03	3.27E-03	1.03E-02	3.02E-03	1.6142E+00	3.9567E+02
$\alpha_5$	1.30E-04	2.52E-03	1.75E-03	7.53E-03	2.32E-03	1.0007E+00	3.9629E+02
$\alpha_6$	9.90E-07	1.00E-03	3.60E-04	4.16E-03	1.02E-03	3.9718E-01	3.9689E+02
$\alpha_7$	1.23E-22	1.72E-04	5.74E-08	9.84E-04	1.89E-04	6.8171E-02	3.9722E+02

**CCCG = 8**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9591840	0.9726970	0.9733780	0.9838890	0.9781510	4.4918E+02	1.2608E+01
$\alpha_2$	5.52E-03	1.27E-02	1.20E-02	2.23E-02	1.08E-02	5.8813E+00	4.5591E+02
$\alpha_3$	1.45E-03	5.84E-03	5.15E-03	1.26E-02	4.08E-03	2.6988E+00	4.5909E+02
$\alpha_4$	5.79E-04	3.83E-03	3.14E-03	9.43E-03	2.64E-03	1.7686E+00	4.6002E+02
$\alpha_5$	2.28E-04	2.70E-03	2.03E-03	7.48E-03	2.29E-03	1.2480E+00	4.6054E+02
$\alpha_6$	2.84E-05	1.54E-03	9.06E-04	5.21E-03	1.46E-03	7.1106E-01	4.6108E+02
$\alpha_7$	8.28E-09	5.37E-04	9.24E-05	2.61E-03	5.31E-04	2.4797E-01	4.6154E+02
$\alpha_8$	2.40E-28	1.14E-04	2.42E-09	6.17E-04	8.28E-05	5.2624E-02	4.6174E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9764990	0.9772990	0.9766300	0.9764870	0.9760190	0.9772650	0.9781510
$\alpha_2$	2.35E-02	1.58E-02	1.45E-02	1.37E-02	1.40E-02	1.19E-02	1.08E-02
$\alpha_3$		6.90E-03	6.26E-03	5.17E-03	4.10E-03	4.25E-03	4.08E-03
$\alpha_4$			2.61E-03	3.57E-03	3.50E-03	3.02E-03	2.64E-03
$\alpha_5$				1.05E-03	1.93E-03	2.32E-03	2.29E-03
$\alpha_6$					4.39E-04	1.02E-03	1.46E-03
$\alpha_7$						1.89E-04	5.31E-04
$\alpha_8$							8.28E-05

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.76E-01	9.77E-01	9.77E-01	9.76E-01	9.76E-01	9.77E-01	9.78E-01
Beta	2.35E-02	2.27E-02	2.34E-02	2.35E-02	2.40E-02	2.27E-02	2.18E-02
Gamma		3.04E-01	3.79E-01	4.16E-01	4.16E-01	4.75E-01	5.07E-01
Delta			2.94E-01	4.71E-01	5.89E-01	6.07E-01	6.32E-01
Epsilon				2.27E-01	4.04E-01	5.38E-01	6.23E-01
Mu					1.85E-01	3.43E-01	4.75E-01
Upsilon						1.56E-01	2.96E-01
Sigma							1.35E-01

Air Operated Valves  
Pooled Air Operated Valves

2010

AOV FAIL TO OPEN ALL SYSTEMS SPAR: AOV-CC

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	57.36	86.05	114.73	143.41	172.09	200.77	229.45
N <sub>1</sub>	2.2952	2.5107	2.3548	2.0670	1.5640	1.3174	0.9958
N <sub>2</sub>	1.4357	1.4321	1.7393	2.0446	2.4923	2.4687	2.5366
N <sub>3</sub>		0.6250	0.7500	0.7708	0.7292	0.8785	0.9604
N <sub>4</sub>			0.3125	0.5313	0.6233	0.6253	0.6221
N <sub>5</sub>				0.1563	0.3438	0.4789	0.5397
N <sub>6</sub>					0.0781	0.2109	0.3441
N <sub>7</sub>						0.0391	0.1250
N <sub>8</sub>							0.0195

Air Operated Valves  
Pooled Air Operated Valves  
AOV FAIL TO CLOSE ALL SYSTEMS SPAR: AOV-OO  
**AOV FAIL TO CLOSE ALL SYSTEMS SPAR: AOV-OO**

2010

Component : Air Operated Valve  
Failure Mode : Fail to close (reset) on demand  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 81.40  
Total Number of Common-Cause Failure Events: 6

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8933080	0.9487700	0.9540420	0.9861950	0.9462850	5.3143E+01	2.8695E+00
$\alpha_2$	1.38E-02	5.12E-02	4.60E-02	1.07E-01	5.37E-02	2.8695E+00	5.3143E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9082580	0.9492930	0.9523650	0.9798230	0.9424310	9.1845E+01	4.9059E+00
$\alpha_2$	8.00E-03	2.99E-02	2.67E-02	6.26E-02	3.11E-02	2.8887E+00	9.3862E+01
$\alpha_3$	3.80E-03	2.08E-02	1.76E-02	4.89E-02	2.65E-02	2.0172E+00	9.4734E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9184100	0.9519630	0.9541920	0.9779140	0.9467610	1.2812E+02	6.4651E+00
$\alpha_2$	5.91E-03	2.18E-02	1.95E-02	4.57E-02	1.97E-02	2.9381E+00	1.3165E+02
$\alpha_3$	2.38E-03	1.41E-02	1.18E-02	3.39E-02	1.73E-02	1.9043E+00	1.3268E+02
$\alpha_4$	1.62E-03	1.21E-02	9.74E-03	3.04E-02	1.62E-02	1.6227E+00	1.3296E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9336340	0.9586120	0.9600870	0.9785620	0.9531140	1.9813E+02	8.5543E+00
$\alpha_2$	6.15E-03	1.85E-02	1.69E-02	3.60E-02	1.59E-02	3.8165E+00	2.0287E+02
$\alpha_3$	1.40E-03	8.83E-03	7.30E-03	2.15E-02	7.92E-03	1.8244E+00	2.0486E+02
$\alpha_4$	1.77E-03	9.78E-03	8.25E-03	2.30E-02	1.54E-02	2.0211E+00	2.0466E+02
$\alpha_5$	1.64E-04	4.32E-03	2.86E-03	1.34E-02	7.66E-03	8.9228E-01	2.0579E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9409330	0.9625820	0.9638190	0.9800120	0.9605640	2.3929E+02	9.3018E+00
$\alpha_2$	4.30E-03	1.39E-02	1.26E-02	2.79E-02	9.58E-03	3.4600E+00	2.4513E+02
$\alpha_3$	1.44E-03	8.05E-03	6.77E-03	1.90E-02	6.74E-03	2.0002E+00	2.4659E+02
$\alpha_4$	8.92E-04	6.59E-03	5.32E-03	1.66E-02	8.21E-03	1.6378E+00	2.4695E+02
$\alpha_5$	8.61E-04	6.49E-03	5.23E-03	1.65E-02	1.09E-02	1.6146E+00	2.4698E+02
$\alpha_6$	2.07E-05	2.37E-03	1.23E-03	8.58E-03	3.97E-03	5.8924E-01	2.4800E+02

Air Operated Valves  
Pooled Air Operated Valves  
AOV FAIL TO CLOSE ALL SYSTEMS SPAR: AOV-OO  
CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9484890	0.9660710	0.9669880	0.9805320	0.9659480	3.2678E+02	1.1477E+01
$\alpha_2$	4.02E-03	1.18E-02	1.08E-02	2.27E-02	6.02E-03	3.9775E+00	3.3428E+02
$\alpha_3$	1.70E-03	7.40E-03	6.45E-03	1.63E-02	5.90E-03	2.5028E+00	3.3575E+02
$\alpha_4$	7.30E-04	5.06E-03	4.12E-03	1.26E-02	4.88E-03	1.7105E+00	3.3655E+02
$\alpha_5$	6.77E-04	4.91E-03	3.97E-03	1.23E-02	7.70E-03	1.6599E+00	3.3660E+02
$\alpha_6$	3.25E-04	3.75E-03	2.83E-03	1.03E-02	7.31E-03	1.2672E+00	3.3699E+02
$\alpha_7$	5.08E-07	1.06E-03	3.37E-04	4.57E-03	2.23E-03	3.5887E-01	3.3790E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9525800	0.9682960	0.9690820	0.9813250	0.9700210	3.8184E+02	1.2502E+01
$\alpha_2$	3.49E-03	1.02E-02	9.33E-03	1.96E-02	3.91E-03	4.0028E+00	3.9034E+02
$\alpha_3$	1.55E-03	6.53E-03	5.71E-03	1.43E-02	4.97E-03	2.5736E+00	3.9177E+02
$\alpha_4$	6.83E-04	4.50E-03	3.69E-03	1.11E-02	3.73E-03	1.7736E+00	3.9257E+02
$\alpha_5$	4.45E-04	3.80E-03	3.00E-03	9.88E-03	4.69E-03	1.4970E+00	3.9285E+02
$\alpha_6$	4.14E-04	3.69E-03	2.90E-03	9.70E-03	6.48E-03	1.4566E+00	3.9289E+02
$\alpha_7$	1.04E-04	2.38E-03	1.61E-03	7.29E-03	4.85E-03	9.3917E-01	3.9340E+02
$\alpha_8$	1.67E-08	6.58E-04	1.24E-04	3.15E-03	1.35E-03	2.5942E-01	3.9408E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9462850	0.9424310	0.9467610	0.9531140	0.9605640	0.9659480	0.9700210
$\alpha_2$	5.37E-02	3.11E-02	1.97E-02	1.59E-02	9.58E-03	6.02E-03	3.91E-03
$\alpha_3$		2.65E-02	1.73E-02	7.92E-03	6.74E-03	5.90E-03	4.97E-03
$\alpha_4$			1.62E-02	1.54E-02	8.21E-03	4.88E-03	3.73E-03
$\alpha_5$				7.66E-03	1.09E-02	7.70E-03	4.69E-03
$\alpha_6$					3.97E-03	7.31E-03	6.48E-03
$\alpha_7$						2.23E-03	4.85E-03
$\alpha_8$							1.35E-03

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.46E-01	9.42E-01	9.47E-01	9.53E-01	9.61E-01	9.66E-01	9.70E-01
Beta	5.37E-02	5.76E-02	5.32E-02	4.69E-02	3.94E-02	3.41E-02	3.00E-02
Gamma		4.60E-01	6.29E-01	6.61E-01	7.57E-01	8.23E-01	8.69E-01
Delta			4.83E-01	7.44E-01	7.74E-01	7.90E-01	8.09E-01
Epsilon				3.32E-01	6.45E-01	7.79E-01	8.23E-01
Mu					2.67E-01	5.53E-01	7.30E-01
Upsilon						2.34E-01	4.89E-01
Sigma							2.17E-01



Air Operated Valves  
Pooled Air Operated Valves

2010

AOV FAIL TO CLOSE ALL SYSTEMS SPAR: AOV-OO

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	40.70	61.05	81.40	101.75	122.10	142.45	162.80
N <sub>1</sub>	2.1967	1.2400	0.5800	0.2175	0.2523	0.2845	0.3143
N <sub>2</sub>	2.4350	2.0550	1.7100	1.7023	1.2208	0.8897	0.6581
N <sub>3</sub>		1.7500	1.5000	0.8470	0.8584	0.8716	0.8352
N <sub>4</sub>			1.4000	1.6467	1.0456	0.7216	0.6271
N <sub>5</sub>				0.8200	1.3924	1.1381	0.7887
N <sub>6</sub>					0.5060	1.0809	1.0896
N <sub>7</sub>						0.3298	0.8162
N <sub>8</sub>							0.2263

Air Operated Valves  
 BWR Isolation Condenser Air-Operated Valves  
 ISO CONDENSER AOV FAIL TO OPEN/CLOSE

2010

**BWR Isolation Condenser Air-Operated Valves**  
**ISO CONDENSER AOV FAIL TO OPEN/CLOSE**

**System :** Isolation condenser  
**Component :** Air Operated Valve  
**Failure Mode :** Fail to close (reset) on demand  
 Fail to Open/Close Mode Unspecified (demand based)  
 Fail to open on demand  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 1.00  
 Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.7072910	0.8822300	0.9029730	0.9858660	0.3333330	1.0746E+01	1.4345E+00
$\alpha_2$	1.41E-02	1.18E-01	9.70E-02	2.93E-01	6.67E-01	1.4345E+00	1.0746E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8529320	0.9351700	0.9439770	0.9872260	0.4285710	3.0305E+01	2.1009E+00
$\alpha_2$	8.23E-04	2.57E-02	1.68E-02	8.11E-02	0.00E+00	8.3366E-01	3.1572E+01
$\alpha_3$	3.50E-03	3.91E-02	3.00E-02	1.06E-01	5.71E-01	1.2672E+00	3.1139E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8811760	0.9428880	0.9487180	0.9846280	0.5000000	4.7136E+01	2.8551E+00
$\alpha_2$	2.04E-03	2.46E-02	1.86E-02	6.77E-02	0.00E+00	1.2281E+00	4.8763E+01
$\alpha_3$	9.14E-06	8.09E-03	3.01E-03	3.34E-02	0.00E+00	4.0431E-01	4.9587E+01
$\alpha_4$	2.02E-03	2.45E-02	1.84E-02	6.75E-02	5.00E-01	1.2227E+00	4.8768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9177320	0.9554850	0.9584350	0.9831430	0.5555560	9.7411E+01	4.5382E+00
$\alpha_2$	4.00E-03	2.07E-02	1.77E-02	4.79E-02	0.00E+00	2.1142E+00	9.9835E+01
$\alpha_3$	4.69E-04	9.59E-03	6.63E-03	2.88E-02	0.00E+00	9.7738E-01	1.0097E+02
$\alpha_4$	3.10E-04	8.58E-03	5.65E-03	2.68E-02	2.22E-01	8.7439E-01	1.0107E+02
$\alpha_5$	4.31E-05	5.61E-03	2.87E-03	2.05E-02	2.22E-01	5.7228E-01	1.0138E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9239510	0.9573330	0.9597820	0.9823620	0.6000000	1.1844E+02	5.2787E+00
$\alpha_2$	3.72E-03	1.81E-02	1.56E-02	4.11E-02	0.00E+00	2.2392E+00	1.2148E+02
$\alpha_3$	6.50E-04	9.23E-03	6.75E-03	2.63E-02	0.00E+00	1.1418E+00	1.2258E+02
$\alpha_4$	2.20E-04	6.81E-03	4.40E-03	2.16E-02	1.00E-01	8.4222E-01	1.2288E+02
$\alpha_5$	1.14E-04	5.84E-03	3.48E-03	1.96E-02	2.00E-01	7.2220E-01	1.2300E+02
$\alpha_6$	7.22E-07	2.69E-03	7.75E-04	1.19E-02	1.00E-01	3.3324E-01	1.2339E+02

Air Operated Valves  
 BWR Isolation Condenser Air-Operated Valves  
 ISO CONDENSER AOV FAIL TO OPEN/CLOSE  
*ALPHA FACTOR and MGL PARAMETERS*

2010

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.3333330	0.4285710	0.5000000	0.5555560	0.6000000
$\alpha_2$	6.67E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		5.71E-01	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			5.00E-01	2.22E-01	1.00E-01
$\alpha_5$				2.22E-01	2.00E-01
$\alpha_6$					1.00E-01

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	3.33E-01	4.29E-01	5.00E-01	5.56E-01	6.00E-01
Beta	6.67E-01	5.71E-01	5.00E-01	4.44E-01	4.00E-01
Gamma		1.00E+00	1.00E+00	1.00E+00	1.00E+00
Delta			1.00E+00	1.00E+00	1.00E+00
Epsilon				5.00E-01	7.50E-01
Mu					3.33E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	0.50	0.75	1.00	1.25	1.50
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	1.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		1.0000	0.0000	0.0000	0.0000
$N_4$			1.0000	0.5000	0.2500
$N_5$				0.5000	0.5000
$N_6$					0.2500

Air Operated Valves  
 BWR Isolation Condenser Air-Operated Valves  
 ISO CONDENSER AOV FAIL TO OPEN  
**ISO CONDENSER AOV FAIL TO OPEN**

2010

System : Isolation condenser  
 Component : Air Operated Valve  
 Failure Mode : Fail to open on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 1.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8522320	0.9628000	0.9843830	0.9999320	1.0000000	1.1246E+01	4.3452E-01
$\alpha_2$	7.00E-05	3.72E-02	1.56E-02	1.48E-01	0.00E+00	4.3452E-01	1.1246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9010680	0.9652240	0.9744830	0.9976820	1.0000000	3.0555E+01	1.1009E+00
$\alpha_2$	8.43E-04	2.63E-02	1.72E-02	8.30E-02	0.00E+00	8.3366E-01	3.0822E+01
$\alpha_3$	2.98E-07	8.44E-03	1.71E-03	4.00E-02	0.00E+00	2.6722E-01	3.1389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9095820	0.9621340	0.9682530	0.9937390	1.0000000	4.7136E+01	1.8551E+00
$\alpha_2$	2.09E-03	2.51E-02	1.89E-02	6.90E-02	0.00E+00	1.2281E+00	4.7763E+01
$\alpha_3$	9.32E-06	8.25E-03	3.07E-03	3.41E-02	0.00E+00	4.0431E-01	4.8587E+01
$\alpha_4$	1.97E-08	4.55E-03	6.24E-04	2.28E-02	0.00E+00	2.2267E-01	4.8768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9304990	0.9648630	0.9678980	0.9888360	1.0000000	9.7161E+01	3.5382E+00
$\alpha_2$	4.05E-03	2.10E-02	1.79E-02	4.85E-02	0.00E+00	2.1142E+00	9.8585E+01
$\alpha_3$	4.74E-04	9.71E-03	6.71E-03	2.92E-02	0.00E+00	9.7738E-01	9.9722E+01
$\alpha_4$	2.45E-06	3.72E-03	1.25E-03	1.58E-02	0.00E+00	3.7439E-01	1.0032E+02
$\alpha_5$	5.93E-21	7.18E-04	4.06E-07	4.16E-03	0.00E+00	7.2277E-02	1.0063E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9341160	0.9649920	0.9674990	0.9872840	1.0000000	1.1794E+02	4.2787E+00
$\alpha_2$	3.77E-03	1.83E-02	1.58E-02	4.16E-02	0.00E+00	2.2392E+00	1.1998E+02
$\alpha_3$	6.58E-04	9.34E-03	6.84E-03	2.66E-02	0.00E+00	1.1418E+00	1.2108E+02
$\alpha_4$	4.33E-05	4.85E-03	2.54E-03	1.75E-02	0.00E+00	5.9222E-01	1.2163E+02
$\alpha_5$	7.60E-09	1.82E-03	2.47E-04	9.11E-03	0.00E+00	2.2220E-01	1.2200E+02
$\alpha_6$	1.15E-18	6.81E-04	1.19E-06	3.98E-03	0.00E+00	8.3237E-02	1.2214E+02

Air Operated Valves  
 BWR Isolation Condenser Air-Operated Valves  
 ISO CONDENSER AOV FAIL TO OPEN

2010

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	1.00	1.00	1.00	1.00	1.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

Air Operated Valves  
 BWR Isolation Condenser Air-Operated Valves  
 ISO CONDENSER AOV FAIL TO CLOSE  
**ISO CONDENSER AOV FAIL TO CLOSE**

2010

System : Isolation condenser  
 Component : Air Operated Valve  
 Failure Mode : Fail to close (reseal) on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 0.00  
 Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.6956560	0.8771890	0.8985750	0.9851950	0.0000000	1.0246E+01	1.4345E+00
$\alpha_2$	1.48E-02	1.23E-01	1.01E-01	3.04E-01	1.00E+00	1.4345E+00	1.0246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8495560	0.9336340	0.9426210	0.9869090	0.0000000	2.9555E+01	2.1009E+00
$\alpha_2$	8.43E-04	2.63E-02	1.72E-02	8.30E-02	0.00E+00	8.3366E-01	3.0822E+01
$\alpha_3$	3.59E-03	4.00E-02	3.08E-02	1.08E-01	1.00E+00	1.2672E+00	3.0389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8788090	0.9417220	0.9476570	0.9843040	0.0000000	4.6136E+01	2.8551E+00
$\alpha_2$	2.09E-03	2.51E-02	1.89E-02	6.90E-02	0.00E+00	1.2281E+00	4.7763E+01
$\alpha_3$	9.32E-06	8.25E-03	3.07E-03	3.41E-02	0.00E+00	4.0431E-01	4.8587E+01
$\alpha_4$	2.06E-03	2.50E-02	1.88E-02	6.88E-02	1.00E+00	1.2227E+00	4.7768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9167220	0.9549330	0.9579160	0.9829300	0.0000000	9.6161E+01	4.5382E+00
$\alpha_2$	4.05E-03	2.10E-02	1.79E-02	4.85E-02	0.00E+00	2.1142E+00	9.8585E+01
$\alpha_3$	4.74E-04	9.71E-03	6.71E-03	2.92E-02	0.00E+00	9.7738E-01	9.9722E+01
$\alpha_4$	3.14E-04	8.68E-03	5.72E-03	2.72E-02	5.00E-01	8.7439E-01	9.9825E+01
$\alpha_5$	4.37E-05	5.68E-03	2.91E-03	2.07E-02	5.00E-01	5.7228E-01	1.0013E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9230310	0.9568100	0.9592860	0.9821410	0.0000000	1.1694E+02	5.2787E+00
$\alpha_2$	3.77E-03	1.83E-02	1.58E-02	4.16E-02	0.00E+00	2.2392E+00	1.1998E+02
$\alpha_3$	6.58E-04	9.34E-03	6.84E-03	2.66E-02	0.00E+00	1.1418E+00	1.2108E+02
$\alpha_4$	2.23E-04	6.89E-03	4.45E-03	2.19E-02	2.50E-01	8.4222E-01	1.2138E+02
$\alpha_5$	1.16E-04	5.91E-03	3.52E-03	1.98E-02	5.00E-01	7.2220E-01	1.2150E+02
$\alpha_6$	7.30E-07	2.73E-03	7.85E-04	1.20E-02	2.50E-01	3.3324E-01	1.2189E+02

Air Operated Valves  
 BWR Isolation Condenser Air-Operated Valves  
 ISO CONDENSER AOV FAIL TO CLOSE

2010

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
$\alpha_2$	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		1.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			1.00E+00	5.00E-01	2.50E-01
$\alpha_5$				5.00E-01	5.00E-01
$\alpha_6$					2.50E-01

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Gamma		1.00E+00	1.00E+00	1.00E+00	1.00E+00
Delta			1.00E+00	1.00E+00	1.00E+00
Epsilon				5.00E-01	7.50E-01
Mu					3.33E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	0.00	0.00	0.00	0.00	0.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	1.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		1.0000	0.0000	0.0000	0.0000
$N_4$			1.0000	0.5000	0.2500
$N_5$				0.5000	0.5000
$N_6$					0.2500

**PWR Auxiliary Feedwater Air-Operated Valves**  
**AFW AOV FAIL TO OPEN/CLOSE SPAR: AOV-FO**

**Component :** Air Operated Valve  
**Failure Mode :** Fail to close (reset) on demand  
Fail to Open/Close Mode Unspecified (demand based)  
Fail to open on demand  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 213.10  
Total Number of Common-Cause Failure Events: 11

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9331610	0.9644210	0.9669510	0.9870220	0.9649150	1.1670E+02	4.3052E+00
$\alpha_2$	1.30E-02	3.56E-02	3.30E-02	6.68E-02	3.51E-02	4.3052E+00	1.1670E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9395680	0.9639620	0.9655560	0.9829220	0.9639370	1.8625E+02	6.9630E+00
$\alpha_2$	8.13E-03	2.24E-02	2.07E-02	4.22E-02	2.15E-02	4.3208E+00	1.8889E+02
$\alpha_3$	3.34E-03	1.37E-02	1.20E-02	2.96E-02	1.46E-02	2.6422E+00	1.9057E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9441460	0.9646650	0.9658430	0.9811630	0.9654090	2.5299E+02	9.2669E+00
$\alpha_2$	6.80E-03	1.78E-02	1.66E-02	3.30E-02	1.61E-02	4.6774E+00	2.5758E+02
$\alpha_3$	2.48E-03	1.01E-02	8.90E-03	2.19E-02	1.05E-02	2.6543E+00	2.5960E+02
$\alpha_4$	1.26E-03	7.38E-03	6.17E-03	1.76E-02	7.99E-03	1.9352E+00	2.6032E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9503400	0.9670030	0.9678490	0.9807730	0.9679380	3.5335E+02	1.2057E+01
$\alpha_2$	6.94E-03	1.60E-02	1.52E-02	2.81E-02	1.41E-02	5.8612E+00	3.5955E+02
$\alpha_3$	1.70E-03	7.10E-03	6.23E-03	1.55E-02	6.09E-03	2.5952E+00	3.6281E+02
$\alpha_4$	1.64E-03	6.98E-03	6.11E-03	1.53E-02	8.20E-03	2.5523E+00	3.6286E+02
$\alpha_5$	1.66E-04	2.87E-03	2.03E-03	8.44E-03	3.67E-03	1.0486E+00	3.6436E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9543330	0.9690370	0.9697520	0.9813110	0.9706940	4.2465E+02	1.3568E+01
$\alpha_2$	5.92E-03	1.36E-02	1.28E-02	2.37E-02	1.17E-02	5.9523E+00	4.3227E+02
$\alpha_3$	1.56E-03	6.23E-03	5.49E-03	1.34E-02	5.01E-03	2.7294E+00	4.3549E+02
$\alpha_4$	1.06E-03	5.16E-03	4.43E-03	1.18E-02	5.26E-03	2.2610E+00	4.3596E+02
$\alpha_5$	7.75E-04	4.47E-03	3.74E-03	1.07E-02	5.48E-03	1.9584E+00	4.3626E+02
$\alpha_6$	2.22E-05	1.52E-03	8.62E-04	5.27E-03	1.84E-03	6.6734E-01	4.3755E+02



Air Operated Valves  
PWR Auxiliary Feedwater Air-Operated Valves  
AFW AOV FAIL TO OPEN/CLOSE SPAR: AOV-FO  
CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9585020	0.9710430	0.9716070	0.9816660	0.9735660	5.4252E+02	1.6178E+01
$\alpha_2$	5.23E-03	1.15E-02	1.10E-02	1.98E-02	9.12E-03	6.4461E+00	5.5225E+02
$\alpha_3$	1.83E-03	6.05E-03	5.47E-03	1.23E-02	4.75E-03	3.3814E+00	5.5532E+02
$\alpha_4$	8.93E-04	4.18E-03	3.61E-03	9.43E-03	3.66E-03	2.3358E+00	5.5636E+02
$\alpha_5$	7.40E-04	3.83E-03	3.25E-03	8.88E-03	4.39E-03	2.1388E+00	5.5656E+02
$\alpha_6$	3.03E-04	2.65E-03	2.08E-03	6.92E-03	3.51E-03	1.4781E+00	5.5722E+02
$\alpha_7$	7.14E-07	7.12E-04	2.57E-04	2.96E-03	1.00E-03	3.9797E-01	5.5830E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9613450	0.9726590	0.9731440	0.9823110	0.9757040	6.2789E+02	1.7650E+01
$\alpha_2$	4.62E-03	1.01E-02	9.63E-03	1.74E-02	7.62E-03	6.5394E+00	6.3900E+02
$\alpha_3$	1.71E-03	5.47E-03	4.97E-03	1.10E-02	4.28E-03	3.5340E+00	6.4201E+02
$\alpha_4$	8.15E-04	3.71E-03	3.21E-03	8.31E-03	2.98E-03	2.3957E+00	6.4314E+02
$\alpha_5$	5.75E-04	3.16E-03	2.66E-03	7.43E-03	3.17E-03	2.0367E+00	6.4350E+02
$\alpha_6$	4.32E-04	2.79E-03	2.30E-03	6.83E-03	3.42E-03	1.8007E+00	6.4374E+02
$\alpha_7$	9.84E-05	1.65E-03	1.17E-03	4.83E-03	2.24E-03	1.0642E+00	6.4448E+02
$\alpha_8$	2.32E-08	4.32E-04	9.32E-05	2.02E-03	5.86E-04	2.7902E-01	6.4526E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9649150	0.9639370	0.9654090	0.9679380	0.9706940	0.9735660	0.9757040
$\alpha_2$	3.51E-02	2.15E-02	1.61E-02	1.41E-02	1.17E-02	9.12E-03	7.62E-03
$\alpha_3$		1.46E-02	1.05E-02	6.09E-03	5.01E-03	4.75E-03	4.28E-03
$\alpha_4$			7.99E-03	8.20E-03	5.26E-03	3.66E-03	2.98E-03
$\alpha_5$				3.67E-03	5.48E-03	4.39E-03	3.17E-03
$\alpha_6$					1.84E-03	3.51E-03	3.42E-03
$\alpha_7$						1.00E-03	2.24E-03
$\alpha_8$							5.86E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.65E-01	9.64E-01	9.65E-01	9.68E-01	9.71E-01	9.74E-01	9.76E-01
Beta	3.51E-02	3.61E-02	3.46E-02	3.21E-02	2.93E-02	2.64E-02	2.43E-02
Gamma		4.05E-01	5.35E-01	5.60E-01	6.00E-01	6.55E-01	6.86E-01
Delta			4.32E-01	6.61E-01	7.15E-01	7.25E-01	7.43E-01
Epsilon				3.10E-01	5.82E-01	7.09E-01	7.60E-01
Mu					2.52E-01	5.07E-01	6.64E-01
Upsilon						2.22E-01	4.53E-01
Sigma							2.07E-01

Air Operated Valves

2010

PWR Auxiliary Feedwater Air-Operated Valves

AFW AOV FAIL TO OPEN/CLOSE SPAR: AOV-FO

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	101.96	152.94	203.92	254.90	305.89	356.87	407.85
N <sub>1</sub>	4.4919	3.7507	2.9348	2.2845	1.8163	1.6020	1.3101
N <sub>2</sub>	3.8707	3.4871	3.4493	3.7470	3.7131	3.3583	3.1947
N <sub>3</sub>		2.3750	2.2500	1.6178	1.5876	1.7502	1.7956
N <sub>4</sub>			1.7125	2.1779	1.6688	1.3469	1.2492
N <sub>5</sub>				0.9763	1.7362	1.6170	1.3284
N <sub>6</sub>					0.5841	1.2918	1.4337
N <sub>7</sub>						0.3689	0.9412
N <sub>8</sub>							0.2459

Air Operated Valves  
PWR Auxiliary Feedwater Air-Operated Valves  
AFW AOV FAIL TO OPEN SPAR: AFW-AOV-CC  
**AFW AOV FAIL TO OPEN SPAR: AFW-AOV-CC**

2010

System : Auxiliary feedwater  
Component : Air Operated Valve  
Failure Mode : Fail to open on demand  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 29.10  
Total Number of Common-Cause Failure Events: 3

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8922460	0.9663920	0.9785260	0.9990900	0.9723270	2.2628E+01	7.8692E-01
$\alpha_2$	9.07E-04	3.36E-02	2.15E-02	1.08E-01	2.77E-02	7.8692E-01	2.2628E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9085350	0.9613400	0.9674070	0.9933620	0.9568340	4.7446E+01	1.9080E+00
$\alpha_2$	3.75E-03	3.07E-02	2.46E-02	7.86E-02	3.65E-02	1.5158E+00	4.7838E+01
$\alpha_3$	7.31E-06	7.95E-03	2.85E-03	3.32E-02	6.69E-03	3.9222E-01	4.8962E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9114200	0.9564500	0.9609470	0.9873070	0.9468580	6.9331E+01	3.1569E+00
$\alpha_2$	6.27E-03	3.06E-02	2.64E-02	6.93E-02	4.04E-02	2.2174E+00	7.0270E+01
$\alpha_3$	1.23E-04	9.03E-03	5.08E-03	3.13E-02	1.02E-02	6.5431E-01	7.1834E+01
$\alpha_4$	2.63E-07	3.93E-03	8.88E-04	1.83E-02	2.55E-03	2.8517E-01	7.2203E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9265130	0.9586130	0.9609470	0.9827290	0.9391150	1.2449E+02	5.3747E+00
$\alpha_2$	8.24E-03	2.66E-02	2.42E-02	5.31E-02	4.43E-02	3.4505E+00	1.2641E+02
$\alpha_3$	8.98E-04	9.93E-03	7.55E-03	2.71E-02	1.04E-02	1.2899E+00	1.2857E+02
$\alpha_4$	2.19E-05	4.09E-03	1.97E-03	1.53E-02	5.18E-03	5.3069E-01	1.2933E+02
$\alpha_5$	1.30E-15	7.98E-04	5.85E-06	4.63E-03	1.04E-03	1.0358E-01	1.2976E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9278940	0.9572720	0.9592060	0.9800480	0.9320500	1.5022E+02	6.7051E+00
$\alpha_2$	8.84E-03	2.55E-02	2.36E-02	4.91E-02	4.96E-02	4.0093E+00	1.5292E+02
$\alpha_3$	1.04E-03	9.27E-03	7.28E-03	2.43E-02	8.75E-03	1.4543E+00	1.5547E+02
$\alpha_4$	1.61E-04	5.27E-03	3.37E-03	1.68E-02	6.56E-03	8.2662E-01	1.5610E+02
$\alpha_5$	3.44E-07	2.01E-03	5.35E-04	9.05E-03	2.63E-03	3.1600E-01	1.5661E+02
$\alpha_6$	2.66E-16	6.30E-04	3.49E-06	3.66E-03	4.37E-04	9.8837E-02	1.5683E+02

Air Operated Valves  
PWR Auxiliary Feedwater Air-Operated Valves  
AFW AOV FAIL TO OPEN SPAR: AFW-AOV-CC  
CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9375820	0.9605850	0.9619010	0.9790820	0.9347890	2.2257E+02	9.1325E+00
$\alpha_2$	8.04E-03	2.07E-02	1.94E-02	3.81E-02	4.16E-02	4.8019E+00	2.2690E+02
$\alpha_3$	1.73E-03	9.08E-03	7.71E-03	2.11E-02	1.15E-02	2.1046E+00	2.2960E+02
$\alpha_4$	4.70E-04	5.45E-03	4.11E-03	1.50E-02	6.63E-03	1.2623E+00	2.3044E+02
$\alpha_5$	4.79E-05	2.96E-03	1.71E-03	1.01E-02	3.98E-03	6.8587E-01	2.3102E+02
$\alpha_6$	1.16E-08	1.04E-03	1.69E-04	5.09E-03	1.33E-03	2.4098E-01	2.3146E+02
$\alpha_7$	1.30E-38	1.59E-04	1.71E-11	7.27E-04	1.89E-04	3.6871E-02	2.3167E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9410070	0.9617910	0.9629120	0.9787410	0.9364770	2.6244E+02	1.0426E+01
$\alpha_2$	7.49E-03	1.87E-02	1.75E-02	3.38E-02	3.75E-02	5.0941E+00	2.6777E+02
$\alpha_3$	1.74E-03	8.35E-03	7.18E-03	1.89E-02	1.15E-02	2.2772E+00	2.7059E+02
$\alpha_4$	6.02E-04	5.35E-03	4.20E-03	1.40E-02	6.71E-03	1.4599E+00	2.7141E+02
$\alpha_5$	1.44E-04	3.40E-03	2.29E-03	1.04E-02	4.69E-03	9.2713E-01	2.7194E+02
$\alpha_6$	5.29E-06	1.75E-03	7.62E-04	6.82E-03	2.34E-03	4.7636E-01	2.7239E+02
$\alpha_7$	8.55E-12	5.65E-04	2.61E-05	3.10E-03	6.71E-04	1.5427E-01	2.7271E+02
$\alpha_8$	1.54E-38	1.36E-04	1.57E-11	6.22E-04	8.36E-05	3.7024E-02	2.7283E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9723270	0.9568340	0.9468580	0.9391150	0.9320500	0.9347890	0.9364770
$\alpha_2$	2.77E-02	3.65E-02	4.04E-02	4.43E-02	4.96E-02	4.16E-02	3.75E-02
$\alpha_3$		6.69E-03	1.02E-02	1.04E-02	8.75E-03	1.15E-02	1.15E-02
$\alpha_4$			2.55E-03	5.18E-03	6.56E-03	6.63E-03	6.71E-03
$\alpha_5$				1.04E-03	2.63E-03	3.98E-03	4.69E-03
$\alpha_6$					4.37E-04	1.33E-03	2.34E-03
$\alpha_7$						1.89E-04	6.71E-04
$\alpha_8$							8.36E-05

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.72E-01	9.57E-01	9.47E-01	9.39E-01	9.32E-01	9.35E-01	9.36E-01
Beta	2.77E-02	4.32E-02	5.31E-02	6.09E-02	6.79E-02	6.52E-02	6.35E-02
Gamma		1.55E-01	2.40E-01	2.72E-01	2.70E-01	3.62E-01	4.10E-01
Delta			2.00E-01	3.75E-01	5.24E-01	5.14E-01	5.57E-01
Epsilon				1.67E-01	3.18E-01	4.53E-01	5.37E-01
Mu					1.43E-01	2.76E-01	3.98E-01
Upsilon						1.25E-01	2.43E-01
Sigma							1.11E-01

Air Operated Valves  
PWR Auxiliary Feedwater Air-Operated Valves  
AFW AOV FAIL TO OPEN SPAR: AFW-AOV-CC

2010

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	10.92	16.38	21.84	27.30	32.76	38.22	43.68
N <sub>1</sub>	1.4619	1.5107	1.3548	1.0253	0.5223	0.3047	0.0313
N <sub>2</sub>	0.3524	0.6821	0.9893	1.3363	1.7701	1.7141	1.7494
N <sub>3</sub>		0.1250	0.2500	0.3125	0.3125	0.4734	0.5388
N <sub>4</sub>			0.0625	0.1563	0.2344	0.2734	0.3134
N <sub>5</sub>				0.0313	0.0938	0.1641	0.2188
N <sub>6</sub>					0.0156	0.0547	0.1094
N <sub>7</sub>						0.0078	0.0313
N <sub>8</sub>							0.0039

Air Operated Valves  
PWR Auxiliary Feedwater Air-Operated Valves  
AFW AOV FAIL TO CLOSE SPAR: AFW-AOV-OO  
**AFW AOV FAIL TO CLOSE SPAR: AFW-AOV-OO**

2010

System : Auxiliary feedwater  
Component : Air Operated Valve  
Failure Mode : Fail to close (reseat) on demand  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 20.50  
Total Number of Common-Cause Failure Events: 2

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9022980	0.9724260	0.9850050	0.9997270	0.9849480	2.1259E+01	6.0282E-01
$\alpha_2$	2.75E-04	2.76E-02	1.50E-02	9.77E-02	1.51E-02	6.0282E-01	2.1259E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9147100	0.9659630	0.9723190	0.9954300	0.9694400	4.5575E+01	1.6059E+00
$\alpha_2$	2.79E-03	2.84E-02	2.20E-02	7.57E-02	3.06E-02	1.3387E+00	4.5842E+01
$\alpha_3$	1.98E-07	5.66E-03	1.14E-03	2.69E-02	0.00E+00	2.6722E-01	4.6914E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9139780	0.9588830	0.9632070	0.9889980	0.9534350	6.6816E+01	2.8651E+00
$\alpha_2$	6.66E-03	3.21E-02	2.77E-02	7.25E-02	4.66E-02	2.2381E+00	6.7443E+01
$\alpha_3$	6.53E-06	5.80E-03	2.15E-03	2.40E-02	0.00E+00	4.0431E-01	6.9277E+01
$\alpha_4$	1.38E-08	3.20E-03	4.37E-04	1.60E-02	0.00E+00	2.2267E-01	6.9458E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9333610	0.9640160	0.9664390	0.9863940	0.9621790	1.2201E+02	4.5543E+00
$\alpha_2$	5.72E-03	2.21E-02	1.96E-02	4.69E-02	2.54E-02	2.7965E+00	1.2377E+02
$\alpha_3$	9.66E-04	1.04E-02	7.92E-03	2.81E-02	1.24E-02	1.3111E+00	1.2525E+02
$\alpha_4$	1.94E-06	2.96E-03	9.96E-04	1.26E-02	0.00E+00	3.7439E-01	1.2619E+02
$\alpha_5$	4.71E-21	5.71E-04	3.23E-07	3.30E-03	0.00E+00	7.2277E-02	1.2649E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9382390	0.9654020	0.9674080	0.9857100	0.9680500	1.4794E+02	5.3019E+00
$\alpha_2$	4.42E-03	1.77E-02	1.56E-02	3.79E-02	1.46E-02	2.7060E+00	1.5054E+02
$\alpha_3$	1.34E-03	1.04E-02	8.32E-03	2.63E-02	1.39E-02	1.5871E+00	1.5165E+02
$\alpha_4$	8.16E-05	4.59E-03	2.69E-03	1.56E-02	3.47E-03	7.0332E-01	1.5254E+02
$\alpha_5$	6.06E-09	1.45E-03	1.96E-04	7.26E-03	0.00E+00	2.2220E-01	1.5302E+02
$\alpha_6$	9.20E-19	5.43E-04	9.50E-07	3.17E-03	0.00E+00	8.3237E-02	1.5316E+02

Air Operated Valves  
PWR Auxiliary Feedwater Air-Operated Valves  
AFW AOV FAIL TO CLOSE SPAR: AFW-AOV-OO  
CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9457280	0.9671620	0.9685250	0.9839570	0.9722630	2.2021E+02	7.4767E+00
$\alpha_2$	4.59E-03	1.50E-02	1.36E-02	3.02E-02	8.78E-03	3.4142E+00	2.2427E+02
$\alpha_3$	1.71E-03	9.12E-03	7.73E-03	2.13E-02	1.20E-02	2.0772E+00	2.2561E+02
$\alpha_4$	4.23E-04	5.32E-03	3.96E-03	1.49E-02	5.98E-03	1.2112E+00	2.2648E+02
$\alpha_5$	1.68E-05	2.45E-03	1.23E-03	9.05E-03	9.95E-04	5.5877E-01	2.2713E+02
$\alpha_6$	2.95E-10	8.18E-04	6.98E-05	4.29E-03	0.00E+00	1.8628E-01	2.2750E+02
$\alpha_7$	0.00E+00	1.28E-04	1.12E-13	4.81E-04	0.00E+00	2.9071E-02	2.2766E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9490360	0.9683400	0.9694990	0.9836930	0.9754180	2.6004E+02	8.5022E+00
$\alpha_2$	4.23E-03	1.33E-02	1.21E-02	2.65E-02	5.57E-03	3.5808E+00	2.6496E+02
$\alpha_3$	1.54E-03	7.95E-03	6.77E-03	1.84E-02	9.39E-03	2.1360E+00	2.6641E+02
$\alpha_4$	5.93E-04	5.37E-03	4.21E-03	1.41E-02	7.00E-03	1.4429E+00	2.6710E+02
$\alpha_5$	8.49E-05	3.01E-03	1.90E-03	9.70E-03	2.33E-03	8.0713E-01	2.6774E+02
$\alpha_6$	1.02E-06	1.41E-03	4.82E-04	5.97E-03	2.90E-04	3.7926E-01	2.6816E+02
$\alpha_7$	6.06E-14	4.58E-04	8.23E-06	2.61E-03	0.00E+00	1.2297E-01	2.6842E+02
$\alpha_8$	1.14E-42	1.23E-04	1.76E-12	5.21E-04	0.00E+00	3.3124E-02	2.6851E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9849480	0.9694400	0.9534350	0.9621790	0.9680500	0.9722630	0.9754180
$\alpha_2$	1.51E-02	3.06E-02	4.66E-02	2.54E-02	1.46E-02	8.78E-03	5.57E-03
$\alpha_3$		0.00E+00	0.00E+00	1.24E-02	1.39E-02	1.20E-02	9.39E-03
$\alpha_4$			0.00E+00	0.00E+00	3.47E-03	5.98E-03	7.00E-03
$\alpha_5$				0.00E+00	0.00E+00	9.95E-04	2.33E-03
$\alpha_6$					0.00E+00	0.00E+00	2.90E-04
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.85E-01	9.69E-01	9.53E-01	9.62E-01	9.68E-01	9.72E-01	9.75E-01
Beta	1.51E-02	3.06E-02	4.66E-02	3.78E-02	3.19E-02	2.77E-02	2.46E-02
Gamma		0.00E+00	0.00E+00	3.28E-01	5.44E-01	6.84E-01	7.73E-01
Delta			0.00E+00	0.00E+00	2.00E-01	3.68E-01	5.06E-01
Epsilon				0.00E+00	0.00E+00	1.43E-01	2.73E-01
Mu					0.00E+00	0.00E+00	1.11E-01
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Air Operated Valves  
PWR Auxiliary Feedwater Air-Operated Valves  
AFW AOV FAIL TO CLOSE SPAR: AFW-AOV-OO

2010

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	10.25	15.38	20.50	25.63	30.75	35.88	41.00
N <sub>1</sub>	0.7633	0.6400	0.1800	0.2175	0.2523	0.2845	0.3143
N <sub>2</sub>	0.1683	0.5050	1.0100	0.6823	0.4668	0.3264	0.2361
N <sub>3</sub>		0.0000	0.0000	0.3337	0.4453	0.4460	0.3976
N <sub>4</sub>			0.0000	0.0000	0.1111	0.2223	0.2964
N <sub>5</sub>				0.0000	0.0000	0.0370	0.0988
N <sub>6</sub>					0.0000	0.0000	0.0123
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000



COMBINED HPCI AND RCIC AIR OPERATED VALVE FAIL TO OPEN/CLOSE

**High Pressure Coolant Injection and Reactor Core Isolation Cooling Air Operated Valves**

**COMBINED HPCI AND RCIC AIR OPERATED VALVE FAIL TO OPEN/CLOSE**

System : High pressure coolant injection  
 Reactor core isolation  
 Component : Air Operated Valve  
 Failure Mode : Fail to close (reset) on demand  
 Fail to Open/Close Mode Unspecified (demand based)  
 Fail to open on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 3.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8734960	0.9682380	0.9867710	0.9999360	1.0000000	1.3246E+01	4.3452E-01
$\alpha_2$	5.92E-05	3.18E-02	1.32E-02	1.27E-01	0.00E+00	4.3452E-01	1.3246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9068390	0.9672900	0.9760300	0.9978250	1.0000000	3.2555E+01	1.1009E+00
$\alpha_2$	7.91E-04	2.48E-02	1.62E-02	7.82E-02	0.00E+00	8.3366E-01	3.2822E+01
$\alpha_3$	2.80E-07	7.94E-03	1.61E-03	3.77E-02	0.00E+00	2.6722E-01	3.3389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9130680	0.9636200	0.9695110	0.9939910	1.0000000	4.9136E+01	1.8551E+00
$\alpha_2$	2.00E-03	2.41E-02	1.82E-02	6.63E-02	0.00E+00	1.2281E+00	4.9763E+01
$\alpha_3$	8.95E-06	7.93E-03	2.95E-03	3.27E-02	0.00E+00	4.0431E-01	5.0587E+01
$\alpha_4$	1.89E-08	4.37E-03	5.99E-04	2.19E-02	0.00E+00	2.2267E-01	5.0768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9318350	0.9655480	0.9685320	0.9890570	1.0000000	9.9161E+01	3.5382E+00
$\alpha_2$	3.97E-03	2.06E-02	1.76E-02	4.76E-02	0.00E+00	2.1142E+00	1.0059E+02
$\alpha_3$	4.65E-04	9.52E-03	6.58E-03	2.86E-02	0.00E+00	9.7738E-01	1.0172E+02
$\alpha_4$	2.40E-06	3.65E-03	1.23E-03	1.55E-02	0.00E+00	3.7439E-01	1.0232E+02
$\alpha_5$	5.81E-21	7.04E-04	3.98E-07	4.08E-03	0.00E+00	7.2277E-02	1.0263E+02

## High Pressure Coolant Injection and Reactor Core Isolation Cooling Air Operated Valves

## COMBINED HPCI AND RCIC AIR OPERATED VALVE FAIL TO OPEN/CLOSE

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9351640	0.9655550	0.9680290	0.9874920	1.0000000	1.1994E+02	4.2787E+00
$\alpha_2$	3.71E-03	1.80E-02	1.55E-02	4.10E-02	0.00E+00	2.2392E+00	1.2198E+02
$\alpha_3$	6.48E-04	9.19E-03	6.73E-03	2.62E-02	0.00E+00	1.1418E+00	1.2308E+02
$\alpha_4$	4.26E-05	4.77E-03	2.50E-03	1.72E-02	0.00E+00	5.9222E-01	1.2363E+02
$\alpha_5$	7.48E-09	1.79E-03	2.43E-04	8.96E-03	0.00E+00	2.2220E-01	1.2400E+02
$\alpha_6$	1.14E-18	6.70E-04	1.17E-06	3.91E-03	0.00E+00	8.3237E-02	1.2414E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	3.00	3.00	3.00	3.00	3.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

Air Operated Valves  
 High Pressure Coolant Injection and Reactor Core Isolation Cooling Air Operated Valves  
 COMBINED HPCI AND RCIC AIR OPERATED VALVE FAIL TO OPEN  
**COMBINED HPCI AND RCIC AIR OPERATED VALVE FAIL TO OPEN**

2010

**System :** High pressure coolant injection  
 Reactor core isolation  
**Component :** Air Operated Valve  
**Failure Mode :** Fail to open on demand  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 3.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8734960	0.9682380	0.9867710	0.9999360	1.0000000	1.3246E+01	4.3452E-01
$\alpha_2$	5.92E-05	3.18E-02	1.32E-02	1.27E-01	0.00E+00	4.3452E-01	1.3246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9068390	0.9672900	0.9760300	0.9978250	1.0000000	3.2555E+01	1.1009E+00
$\alpha_2$	7.91E-04	2.48E-02	1.62E-02	7.82E-02	0.00E+00	8.3366E-01	3.2822E+01
$\alpha_3$	2.80E-07	7.94E-03	1.61E-03	3.77E-02	0.00E+00	2.6722E-01	3.3389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9130680	0.9636200	0.9695110	0.9939910	1.0000000	4.9136E+01	1.8551E+00
$\alpha_2$	2.00E-03	2.41E-02	1.82E-02	6.63E-02	0.00E+00	1.2281E+00	4.9763E+01
$\alpha_3$	8.95E-06	7.93E-03	2.95E-03	3.27E-02	0.00E+00	4.0431E-01	5.0587E+01
$\alpha_4$	1.89E-08	4.37E-03	5.99E-04	2.19E-02	0.00E+00	2.2267E-01	5.0768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9318350	0.9655480	0.9685320	0.9890570	1.0000000	9.9161E+01	3.5382E+00
$\alpha_2$	3.97E-03	2.06E-02	1.76E-02	4.76E-02	0.00E+00	2.1142E+00	1.0059E+02
$\alpha_3$	4.65E-04	9.52E-03	6.58E-03	2.86E-02	0.00E+00	9.7738E-01	1.0172E+02
$\alpha_4$	2.40E-06	3.65E-03	1.23E-03	1.55E-02	0.00E+00	3.7439E-01	1.0232E+02
$\alpha_5$	5.81E-21	7.04E-04	3.98E-07	4.08E-03	0.00E+00	7.2277E-02	1.0263E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9351640	0.9655550	0.9680290	0.9874920	1.0000000	1.1994E+02	4.2787E+00
$\alpha_2$	3.71E-03	1.80E-02	1.55E-02	4.10E-02	0.00E+00	2.2392E+00	1.2198E+02
$\alpha_3$	6.48E-04	9.19E-03	6.73E-03	2.62E-02	0.00E+00	1.1418E+00	1.2308E+02
$\alpha_4$	4.26E-05	4.77E-03	2.50E-03	1.72E-02	0.00E+00	5.9222E-01	1.2363E+02
$\alpha_5$	7.48E-09	1.79E-03	2.43E-04	8.96E-03	0.00E+00	2.2220E-01	1.2400E+02
$\alpha_6$	1.14E-18	6.70E-04	1.17E-06	3.91E-03	0.00E+00	8.3237E-02	1.2414E+02

## High Pressure Coolant Injection and Reactor Core Isolation Cooling Air Operated Valves

## COMBINED HPCI AND RCIC AIR OPERATED VALVE FAIL TO OPEN

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	3.00	3.00	3.00	3.00	3.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

Air Operated Valves  
 High Pressure Coolant Injection and Reactor Core Isolation Cooling Air Operated Valves  
**COMBINED HPCI AND RCIC AIR OPERATED VALVE FAIL TO CLOSE**  
**COMBINED HPCI AND RCIC AIR OPERATED VALVE FAIL TO CLOSE**

2010

**System :** High pressure coolant injection  
 Reactor core isolation  
**Component :** Air Operated Valve  
**Failure Mode :** Fail to close (reset) on demand  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 0.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8386830	0.9593170	0.9828300	0.9999250	1.0000000	1.0246E+01	4.3452E-01
$\alpha_2$	7.70E-05	4.07E-02	1.72E-02	1.61E-01	0.00E+00	4.3452E-01	1.0246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8979020	0.9640890	0.9736330	0.9976040	1.0000000	2.9555E+01	1.1009E+00
$\alpha_2$	8.71E-04	2.72E-02	1.78E-02	8.57E-02	0.00E+00	8.3366E-01	2.9822E+01
$\alpha_3$	3.08E-07	8.72E-03	1.77E-03	4.13E-02	0.00E+00	2.6722E-01	3.0389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9077330	0.9613450	0.9675780	0.9936050	1.0000000	4.6136E+01	1.8551E+00
$\alpha_2$	2.13E-03	2.56E-02	1.93E-02	7.04E-02	0.00E+00	1.2281E+00	4.6763E+01
$\alpha_3$	9.52E-06	8.42E-03	3.13E-03	3.48E-02	0.00E+00	4.0431E-01	4.7587E+01
$\alpha_4$	2.01E-08	4.64E-03	6.37E-04	2.32E-02	0.00E+00	2.2267E-01	4.7768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9298110	0.9645110	0.9675740	0.9887220	1.0000000	9.6161E+01	3.5382E+00
$\alpha_2$	4.09E-03	2.12E-02	1.81E-02	4.90E-02	0.00E+00	2.1142E+00	9.7585E+01
$\alpha_3$	4.79E-04	9.80E-03	6.78E-03	2.95E-02	0.00E+00	9.7738E-01	9.8722E+01
$\alpha_4$	2.47E-06	3.76E-03	1.27E-03	1.59E-02	0.00E+00	3.7439E-01	9.9325E+01
$\alpha_5$	5.99E-21	7.25E-04	4.10E-07	4.20E-03	0.00E+00	7.2277E-02	9.9627E+01

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9335790	0.9647030	0.9672350	0.9871780	1.0000000	1.1694E+02	4.2787E+00
$\alpha_2$	3.80E-03	1.85E-02	1.59E-02	4.20E-02	0.00E+00	2.2392E+00	1.1898E+02
$\alpha_3$	6.64E-04	9.42E-03	6.89E-03	2.68E-02	0.00E+00	1.1418E+00	1.2008E+02
$\alpha_4$	4.37E-05	4.89E-03	2.56E-03	1.76E-02	0.00E+00	5.9222E-01	1.2063E+02
$\alpha_5$	7.67E-09	1.83E-03	2.49E-04	9.18E-03	0.00E+00	2.2220E-01	1.2100E+02
$\alpha_6$	1.16E-18	6.87E-04	1.20E-06	4.01E-03	0.00E+00	8.3237E-02	1.2114E+02

## High Pressure Coolant Injection and Reactor Core Isolation Cooling Air Operated Valves

## COMBINED HPCI AND RCIC AIR OPERATED VALVE FAIL TO CLOSE

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	0.00	0.00	0.00	0.00	0.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

## Check Valves

### Pooled Check Valves

#### CHECK VALVE FAIL TO OPEN ALL SYSTEMS SPAR: CKV-CC

Component : Check Valve  
 Failure Mode : Fail to open on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 8.00  
 Total Number of Common-Cause Failure Events: 0

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9069840	0.9767390	0.9904340	0.9999540	1.0000000	1.8246E+01	4.3452E-01
$\alpha_2$	4.27E-05	2.33E-02	9.56E-03	9.30E-02	0.00E+00	4.3452E-01	1.8246E+01

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9187120	0.9715210	0.9791840	0.9981180	1.0000000	3.7555E+01	1.1009E+00
$\alpha_2$	6.87E-04	2.16E-02	1.40E-02	6.82E-02	0.00E+00	8.3366E-01	3.7822E+01
$\alpha_3$	2.43E-07	6.91E-03	1.40E-03	3.28E-02	0.00E+00	2.6722E-01	3.8389E+01

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9207150	0.9668680	0.9722640	0.9945410	1.0000000	5.4136E+01	1.8551E+00
$\alpha_2$	1.82E-03	2.19E-02	1.65E-02	6.05E-02	0.00E+00	1.2281E+00	5.4763E+01
$\alpha_3$	8.14E-06	7.22E-03	2.68E-03	2.98E-02	0.00E+00	4.0431E-01	5.5587E+01
$\alpha_4$	1.72E-08	3.98E-03	5.45E-04	1.99E-02	0.00E+00	2.2267E-01	5.5768E+01

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9349600	0.9671470	0.9699980	0.9895730	1.0000000	1.0416E+02	3.5382E+00
$\alpha_2$	3.78E-03	1.96E-02	1.67E-02	4.54E-02	0.00E+00	2.1142E+00	1.0558E+02
$\alpha_3$	4.43E-04	9.08E-03	6.27E-03	2.73E-02	0.00E+00	9.7738E-01	1.0672E+02
$\alpha_4$	2.29E-06	3.48E-03	1.17E-03	1.48E-02	0.00E+00	3.7439E-01	1.0732E+02
$\alpha_5$	5.54E-21	6.71E-04	3.80E-07	3.89E-03	0.00E+00	7.2277E-02	1.0763E+02

##### CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9376440	0.9668880	0.9692700	0.9879830	1.0000000	1.2494E+02	4.2787E+00
$\alpha_2$	3.56E-03	1.73E-02	1.49E-02	3.94E-02	0.00E+00	2.2392E+00	1.2698E+02
$\alpha_3$	6.22E-04	8.84E-03	6.46E-03	2.52E-02	0.00E+00	1.1418E+00	1.2808E+02
$\alpha_4$	4.10E-05	4.58E-03	2.40E-03	1.65E-02	0.00E+00	5.9222E-01	1.2863E+02
$\alpha_5$	7.19E-09	1.72E-03	2.33E-04	8.62E-03	0.00E+00	2.2220E-01	1.2900E+02
$\alpha_6$	1.09E-18	6.44E-04	1.13E-06	3.76E-03	0.00E+00	8.3237E-02	1.2914E+02

Pooled Check Valves

CHECK VALVE FAIL TO OPEN ALL SYSTEMS SPAR: CKV-CC

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9445570	0.9675310	0.9690930	0.9851770	1.0000000	1.9205E+02	6.4450E+00
$\alpha_2$	4.38E-03	1.56E-02	1.40E-02	3.22E-02	0.00E+00	3.0878E+00	1.9541E+02
$\alpha_3$	1.11E-03	8.22E-03	6.64E-03	2.07E-02	0.00E+00	1.6312E+00	1.9686E+02
$\alpha_4$	2.50E-04	4.98E-03	3.45E-03	1.49E-02	0.00E+00	9.8887E-01	1.9751E+02
$\alpha_5$	1.29E-05	2.63E-03	1.24E-03	9.93E-03	0.00E+00	5.2177E-01	1.9797E+02
$\alpha_6$	3.39E-10	9.38E-04	8.01E-05	4.93E-03	0.00E+00	1.8628E-01	1.9831E+02
$\alpha_7$	0.00E+00	1.46E-04	1.28E-13	5.51E-04	0.00E+00	2.9071E-02	1.9847E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9473090	0.9681410	0.9694650	0.9844540	1.0000000	2.2673E+02	7.4610E+00
$\alpha_2$	4.30E-03	1.43E-02	1.29E-02	2.89E-02	0.00E+00	3.3447E+00	2.3085E+02
$\alpha_3$	1.10E-03	7.42E-03	6.08E-03	1.84E-02	0.00E+00	1.7384E+00	2.3245E+02
$\alpha_4$	3.47E-04	4.90E-03	3.58E-03	1.39E-02	0.00E+00	1.1465E+00	2.3304E+02
$\alpha_5$	5.51E-05	3.02E-03	1.78E-03	1.02E-02	0.00E+00	7.0833E-01	2.3348E+02
$\alpha_6$	8.87E-07	1.57E-03	5.13E-04	6.70E-03	0.00E+00	3.6696E-01	2.3382E+02
$\alpha_7$	6.95E-14	5.25E-04	9.44E-06	2.99E-03	0.00E+00	1.2297E-01	2.3407E+02
$\alpha_8$	1.30E-42	1.41E-04	2.02E-12	5.98E-04	0.00E+00	3.3124E-02	2.3416E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00



Check Valves  
Pooled Check Valves

2010

CHECK VALVE FAIL TO OPEN ALL SYSTEMS SPAR: CKV-CC

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	8.00	8.00	8.00	8.00	8.00	8.00	8.00
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

## Pooled Check Valves

## CHECK VALVE FAIL TO CLOSE ALL SYSTEMS SPAR:CKV-OO

**CHECK VALVE FAIL TO CLOSE ALL SYSTEMS SPAR:CKV-OO**

Component : Check Valve  
 Failure Mode : Fail to close (reset) on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 37.00

Total Number of Common-Cause Failure Events: 2

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8693950	0.9492330	0.9594150	0.9941760	0.9431720	2.7009E+01	1.4445E+00
$\alpha_2$	5.82E-03	5.08E-02	4.06E-02	1.31E-01	5.68E-02	1.4445E+00	2.7009E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9142230	0.9625010	0.9678000	0.9926280	0.9606420	5.4680E+01	2.1303E+00
$\alpha_2$	2.43E-03	2.40E-02	1.87E-02	6.38E-02	2.02E-02	1.3628E+00	5.5448E+01
$\alpha_3$	3.28E-04	1.35E-02	8.38E-03	4.42E-02	1.91E-02	7.6752E-01	5.6043E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9263150	0.9646970	0.9683930	0.9904440	0.9693570	7.9595E+01	2.9128E+00
$\alpha_2$	2.30E-03	1.86E-02	1.49E-02	4.77E-02	8.88E-03	1.5347E+00	8.0973E+01
$\alpha_3$	4.38E-04	1.10E-02	7.35E-03	3.39E-02	1.45E-02	9.0541E-01	8.1602E+01
$\alpha_4$	1.67E-05	5.73E-03	2.49E-03	2.24E-02	7.24E-03	4.7267E-01	8.2035E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9400120	0.9675070	0.9696700	0.9876020	0.9744740	1.3794E+02	4.6326E+00
$\alpha_2$	3.51E-03	1.63E-02	1.41E-02	3.67E-02	5.05E-03	2.3306E+00	1.4024E+02
$\alpha_3$	9.42E-04	9.51E-03	7.33E-03	2.55E-02	8.82E-03	1.3553E+00	1.4122E+02
$\alpha_4$	1.17E-04	5.26E-03	3.20E-03	1.74E-02	8.75E-03	7.4939E-01	1.4182E+02
$\alpha_5$	1.17E-09	1.38E-03	1.39E-04	7.16E-03	2.92E-03	1.9728E-01	1.4238E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9441460	0.9685840	0.9703780	0.9868810	0.9777680	1.6702E+02	5.4173E+00
$\alpha_2$	3.17E-03	1.41E-02	1.23E-02	3.13E-02	3.82E-03	2.4346E+00	1.7000E+02
$\alpha_3$	8.48E-04	8.10E-03	6.30E-03	2.15E-02	4.99E-03	1.3975E+00	1.7104E+02
$\alpha_4$	2.66E-04	5.61E-03	3.85E-03	1.70E-02	7.32E-03	9.6722E-01	1.7147E+02
$\alpha_5$	7.92E-06	2.74E-03	1.19E-03	1.07E-02	4.88E-03	4.7220E-01	1.7197E+02
$\alpha_6$	4.32E-12	8.45E-04	3.16E-05	4.68E-03	1.22E-03	1.4574E-01	1.7229E+02

Pooled Check Valves

CHECK VALVE FAIL TO CLOSE ALL SYSTEMS SPAR:CKV-OO

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9497250	0.9694660	0.9707080	0.9849580	0.9800170	2.4242E+02	7.6352E+00
$\alpha_2$	3.92E-03	1.32E-02	1.19E-02	2.68E-02	3.55E-03	3.2991E+00	2.4676E+02
$\alpha_3$	1.11E-03	7.19E-03	5.92E-03	1.76E-02	2.79E-03	1.7975E+00	2.4826E+02
$\alpha_4$	4.77E-04	5.20E-03	3.96E-03	1.42E-02	5.25E-03	1.3014E+00	2.4875E+02
$\alpha_5$	1.04E-04	3.34E-03	2.14E-03	1.06E-02	5.25E-03	8.3427E-01	2.4922E+02
$\alpha_6$	4.58E-07	1.37E-03	4.09E-04	6.00E-03	2.62E-03	3.4258E-01	2.4971E+02
$\alpha_7$	6.65E-25	2.41E-04	2.44E-08	1.36E-03	5.26E-04	6.0371E-02	2.4999E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9525820	0.9704220	0.9714810	0.9846380	0.9817730	2.8538E+02	8.6984E+00
$\alpha_2$	3.85E-03	1.22E-02	1.11E-02	2.42E-02	3.42E-03	3.5771E+00	2.9050E+02
$\alpha_3$	1.02E-03	6.30E-03	5.22E-03	1.53E-02	1.67E-03	1.8521E+00	2.9223E+02
$\alpha_4$	4.80E-04	4.70E-03	3.63E-03	1.26E-02	3.46E-03	1.3815E+00	2.9270E+02
$\alpha_5$	1.88E-04	3.47E-03	2.43E-03	1.03E-02	4.60E-03	1.0208E+00	2.9306E+02
$\alpha_6$	1.95E-05	2.04E-03	1.08E-03	7.35E-03	3.45E-03	6.0136E-01	2.9348E+02
$\alpha_7$	2.24E-09	7.37E-04	9.40E-05	3.72E-03	1.38E-03	2.1677E-01	2.9386E+02
$\alpha_8$	3.95E-30	1.66E-04	1.32E-09	8.74E-04	2.30E-04	4.8724E-02	2.9403E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9431720	0.9606420	0.9693570	0.9744740	0.9777680	0.9800170	0.9817730
$\alpha_2$	5.68E-02	2.02E-02	8.88E-03	5.05E-03	3.82E-03	3.55E-03	3.42E-03
$\alpha_3$		1.91E-02	1.45E-02	8.82E-03	4.99E-03	2.79E-03	1.67E-03
$\alpha_4$			7.24E-03	8.75E-03	7.32E-03	5.25E-03	3.46E-03
$\alpha_5$				2.92E-03	4.88E-03	5.25E-03	4.60E-03
$\alpha_6$					1.22E-03	2.62E-03	3.45E-03
$\alpha_7$						5.26E-04	1.38E-03
$\alpha_8$							2.30E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.43E-01	9.61E-01	9.69E-01	9.74E-01	9.78E-01	9.80E-01	9.82E-01
Beta	5.68E-02	3.94E-02	3.06E-02	2.55E-02	2.22E-02	2.00E-02	1.82E-02
Gamma		4.86E-01	7.10E-01	8.02E-01	8.28E-01	8.22E-01	8.12E-01
Delta			3.33E-01	5.70E-01	7.29E-01	8.30E-01	8.87E-01
Epsilon				2.50E-01	4.55E-01	6.15E-01	7.36E-01
Mu					2.00E-01	3.75E-01	5.24E-01
Upsilon						1.67E-01	3.18E-01
Sigma							1.43E-01

Check Valves  
Pooled Check Valves

2010

CHECK VALVE FAIL TO CLOSE ALL SYSTEMS SPAR:CKV-OO

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	16.44	24.67	32.89	41.11	49.33	57.56	65.78
N <sub>1</sub>	0.3229	0.4551	0.5691	0.6657	0.7457	0.8100	0.8717
N <sub>2</sub>	1.0100	0.5291	0.3066	0.2164	0.1954	0.2113	0.2324
N <sub>3</sub>		0.5003	0.5011	0.3779	0.2557	0.1663	0.1137
N <sub>4</sub>			0.2500	0.3750	0.3750	0.3125	0.2350
N <sub>5</sub>				0.1250	0.2500	0.3125	0.3125
N <sub>6</sub>					0.0625	0.1563	0.2344
N <sub>7</sub>						0.0313	0.0938
N <sub>8</sub>							0.0156

## Pooled Check Valves

CHECK VALVE FAIL TO REMAIN CLOSED ALL SYSTEMS SPAR:CKV-CO

**CHECK VALVE FAIL TO REMAIN CLOSED ALL SYSTEMS SPAR:CKV-CO**

Component : Check Valve  
 Failure Mode : Spurious operation open or close  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 0.00

Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8386830	0.9593170	0.9828300	0.9999250	1.0000000	1.0246E+01	4.3452E-01
$\alpha_2$	7.70E-05	4.07E-02	1.72E-02	1.61E-01	0.00E+00	4.3452E-01	1.0246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8979020	0.9640890	0.9736330	0.9976040	1.0000000	2.9555E+01	1.1009E+00
$\alpha_2$	8.71E-04	2.72E-02	1.78E-02	8.57E-02	0.00E+00	8.3366E-01	2.9822E+01
$\alpha_3$	3.08E-07	8.72E-03	1.77E-03	4.13E-02	0.00E+00	2.6722E-01	3.0389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9077330	0.9613450	0.9675780	0.9936050	1.0000000	4.6136E+01	1.8551E+00
$\alpha_2$	2.13E-03	2.56E-02	1.93E-02	7.04E-02	0.00E+00	1.2281E+00	4.6763E+01
$\alpha_3$	9.52E-06	8.42E-03	3.13E-03	3.48E-02	0.00E+00	4.0431E-01	4.7587E+01
$\alpha_4$	2.01E-08	4.64E-03	6.37E-04	2.32E-02	0.00E+00	2.2267E-01	4.7768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9298110	0.9645110	0.9675740	0.9887220	1.0000000	9.6161E+01	3.5382E+00
$\alpha_2$	4.09E-03	2.12E-02	1.81E-02	4.90E-02	0.00E+00	2.1142E+00	9.7585E+01
$\alpha_3$	4.79E-04	9.80E-03	6.78E-03	2.95E-02	0.00E+00	9.7738E-01	9.8722E+01
$\alpha_4$	2.47E-06	3.76E-03	1.27E-03	1.59E-02	0.00E+00	3.7439E-01	9.9325E+01
$\alpha_5$	5.99E-21	7.25E-04	4.10E-07	4.20E-03	0.00E+00	7.2277E-02	9.9627E+01

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9335790	0.9647030	0.9672350	0.9871780	1.0000000	1.1694E+02	4.2787E+00
$\alpha_2$	3.80E-03	1.85E-02	1.59E-02	4.20E-02	0.00E+00	2.2392E+00	1.1898E+02
$\alpha_3$	6.64E-04	9.42E-03	6.89E-03	2.68E-02	0.00E+00	1.1418E+00	1.2008E+02
$\alpha_4$	4.37E-05	4.89E-03	2.56E-03	1.76E-02	0.00E+00	5.9222E-01	1.2063E+02
$\alpha_5$	7.67E-09	1.83E-03	2.49E-04	9.18E-03	0.00E+00	2.2220E-01	1.2100E+02
$\alpha_6$	1.16E-18	6.87E-04	1.20E-06	4.01E-03	0.00E+00	8.3237E-02	1.2114E+02

Pooled Check Valves

CHECK VALVE FAIL TO REMAIN CLOSED ALL SYSTEMS SPAR:CKV-CO

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9422570	0.9661670	0.9677850	0.9845420	1.0000000	1.8405E+02	6.4450E+00
$\alpha_2$	4.57E-03	1.62E-02	1.45E-02	3.35E-02	0.00E+00	3.0878E+00	1.8741E+02
$\alpha_3$	1.15E-03	8.56E-03	6.91E-03	2.16E-02	0.00E+00	1.6312E+00	1.8886E+02
$\alpha_4$	2.60E-04	5.19E-03	3.59E-03	1.56E-02	0.00E+00	9.8887E-01	1.8951E+02
$\alpha_5$	1.35E-05	2.74E-03	1.30E-03	1.04E-02	0.00E+00	5.2177E-01	1.8997E+02
$\alpha_6$	3.53E-10	9.78E-04	8.35E-05	5.13E-03	0.00E+00	1.8628E-01	1.9031E+02
$\alpha_7$	0.00E+00	1.53E-04	1.34E-13	5.75E-04	0.00E+00	2.9071E-02	1.9047E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9454620	0.9670150	0.9683850	0.9838980	1.0000000	2.1873E+02	7.4610E+00
$\alpha_2$	4.45E-03	1.48E-02	1.34E-02	2.99E-02	0.00E+00	3.3447E+00	2.2285E+02
$\alpha_3$	1.14E-03	7.69E-03	6.29E-03	1.90E-02	0.00E+00	1.7384E+00	2.2445E+02
$\alpha_4$	3.59E-04	5.07E-03	3.71E-03	1.44E-02	0.00E+00	1.1465E+00	2.2504E+02
$\alpha_5$	5.70E-05	3.13E-03	1.84E-03	1.06E-02	0.00E+00	7.0833E-01	2.2548E+02
$\alpha_6$	9.18E-07	1.62E-03	5.31E-04	6.94E-03	0.00E+00	3.6696E-01	2.2582E+02
$\alpha_7$	7.20E-14	5.44E-04	9.78E-06	3.10E-03	0.00E+00	1.2297E-01	2.2607E+02
$\alpha_8$	1.35E-42	1.46E-04	2.09E-12	6.19E-04	0.00E+00	3.3124E-02	2.2616E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Check Valves  
Pooled Check Valves

2010

CHECK VALVE FAIL TO REMAIN CLOSED ALL SYSTEMS SPAR:CKV-CO

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

## Pooled Check Valves

CKV FAIL TO REMAIN CLOSED (LEAKAGE) ALL SYSTEMS SPAR:CKV-CO

**CKV FAIL TO REMAIN CLOSED (LEAKAGE) ALL SYSTEMS SPAR:CKV-CO**

Component : Check Valve  
 Failure Mode : Fail to remain closed(detectable leakage)  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 44.50

Total Number of Common-Cause Failure Events: 7

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.7881420	0.8849500	0.8920470	0.9574400	0.8537550	3.1985E+01	4.1583E+00
$\alpha_2$	4.26E-02	1.15E-01	1.08E-01	2.12E-01	1.46E-01	4.1583E+00	3.1985E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8497360	0.9125510	0.9166750	0.9612580	0.8684710	6.0683E+01	5.8152E+00
$\alpha_2$	1.52E-02	4.99E-02	4.55E-02	9.99E-02	6.94E-02	3.3194E+00	6.3179E+01
$\alpha_3$	8.78E-03	3.75E-02	3.30E-02	8.19E-02	6.22E-02	2.4958E+00	6.4002E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8686360	0.9192150	0.9221830	0.9596440	0.8751490	8.6291E+01	7.5837E+00
$\alpha_2$	1.33E-02	4.00E-02	3.68E-02	7.78E-02	5.51E-02	3.7567E+00	9.0118E+01
$\alpha_3$	6.36E-03	2.70E-02	2.37E-02	5.88E-02	4.64E-02	2.5329E+00	9.1342E+01
$\alpha_4$	1.26E-03	1.38E-02	1.05E-02	3.75E-02	2.34E-02	1.2941E+00	9.2581E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8988560	0.9343250	0.9361810	0.9634390	0.8802890	1.4518E+02	1.0205E+01
$\alpha_2$	1.17E-02	3.03E-02	2.83E-02	5.58E-02	4.66E-02	4.7094E+00	1.5068E+02
$\alpha_3$	5.36E-03	1.94E-02	1.74E-02	4.03E-02	3.66E-02	3.0131E+00	1.5237E+02
$\alpha_4$	2.03E-03	1.22E-02	1.02E-02	2.92E-02	2.73E-02	1.8923E+00	1.5349E+02
$\alpha_5$	3.34E-05	3.80E-03	1.98E-03	1.37E-02	9.30E-03	5.9018E-01	1.5479E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9085170	0.9395700	0.9411390	0.9652700	0.8930000	1.7536E+02	1.1279E+01
$\alpha_2$	7.75E-03	2.20E-02	2.04E-02	4.21E-02	2.87E-02	4.1142E+00	1.8252E+02
$\alpha_3$	5.49E-03	1.81E-02	1.64E-02	3.65E-02	3.41E-02	3.3739E+00	1.8326E+02
$\alpha_4$	2.49E-03	1.21E-02	1.04E-02	2.74E-02	2.54E-02	2.2529E+00	1.8439E+02
$\alpha_5$	5.07E-04	6.45E-03	4.80E-03	1.81E-02	1.50E-02	1.2043E+00	1.8543E+02
$\alpha_6$	4.77E-07	1.79E-03	5.13E-04	7.89E-03	3.82E-03	3.3324E-01	1.8631E+02



Pooled Check Valves

CKV FAIL TO REMAIN CLOSED (LEAKAGE) ALL SYSTEMS SPAR:CKV-CO

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9255470	0.9493890	0.9505160	0.9693910	0.9068650	2.5221E+02	1.3445E+01
$\alpha_2$	6.33E-03	1.70E-02	1.58E-02	3.17E-02	1.90E-02	4.5128E+00	2.6114E+02
$\alpha_3$	3.45E-03	1.20E-02	1.08E-02	2.46E-02	2.06E-02	3.1812E+00	2.6247E+02
$\alpha_4$	3.00E-03	1.11E-02	9.91E-03	2.33E-02	2.61E-02	2.9514E+00	2.6270E+02
$\alpha_5$	1.19E-03	7.14E-03	5.95E-03	1.72E-02	1.83E-02	1.8968E+00	2.6376E+02
$\alpha_6$	6.23E-05	2.82E-03	1.71E-03	9.35E-03	7.48E-03	7.4878E-01	2.6491E+02
$\alpha_7$	8.57E-12	5.80E-04	2.67E-05	3.18E-03	1.66E-03	1.5407E-01	2.6550E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9323950	0.9535150	0.9544860	0.9713300	0.9175500	2.9663E+02	1.4461E+01
$\alpha_2$	5.26E-03	1.43E-02	1.32E-02	2.68E-02	1.29E-02	4.4378E+00	3.0665E+02
$\alpha_3$	2.74E-03	9.83E-03	8.80E-03	2.04E-02	1.56E-02	3.0590E+00	3.0803E+02
$\alpha_4$	1.75E-03	7.82E-03	6.79E-03	1.74E-02	1.51E-02	2.4321E+00	3.0866E+02
$\alpha_5$	2.35E-03	9.07E-03	8.04E-03	1.93E-02	2.49E-02	2.8214E+00	3.0827E+02
$\alpha_6$	2.62E-04	3.69E-03	2.70E-03	1.05E-02	9.20E-03	1.1483E+00	3.0994E+02
$\alpha_7$	4.06E-06	1.50E-03	6.42E-04	5.90E-03	4.05E-03	4.6677E-01	3.1062E+02
$\alpha_8$	4.83E-17	3.07E-04	1.39E-06	1.79E-03	7.36E-04	9.5624E-02	3.1100E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.8537550	0.8684710	0.8751490	0.8802890	0.8930000	0.9068650	0.9175500
$\alpha_2$	1.46E-01	6.94E-02	5.51E-02	4.66E-02	2.87E-02	1.90E-02	1.29E-02
$\alpha_3$		6.22E-02	4.64E-02	3.66E-02	3.41E-02	2.06E-02	1.56E-02
$\alpha_4$			2.34E-02	2.73E-02	2.54E-02	2.61E-02	1.51E-02
$\alpha_5$				9.30E-03	1.50E-02	1.83E-02	2.49E-02
$\alpha_6$					3.82E-03	7.48E-03	9.20E-03
$\alpha_7$						1.66E-03	4.05E-03
$\alpha_8$							7.36E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	8.54E-01	8.68E-01	8.75E-01	8.80E-01	8.93E-01	9.07E-01	9.18E-01
Beta	1.46E-01	1.32E-01	1.25E-01	1.20E-01	1.07E-01	9.31E-02	8.24E-02
Gamma		4.73E-01	5.59E-01	6.11E-01	7.32E-01	7.96E-01	8.44E-01
Delta			3.35E-01	5.00E-01	5.64E-01	7.22E-01	7.76E-01
Epsilon				2.54E-01	4.26E-01	5.12E-01	7.20E-01
Mu					2.03E-01	3.33E-01	3.60E-01
Upsilon						1.82E-01	3.42E-01
Sigma							1.54E-01

Check Valves  
Pooled Check Valves

2010

CKV FAIL TO REMAIN CLOSED (LEAKAGE) ALL SYSTEMS SPAR:CKV-CO

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	19.47	29.21	38.95	48.69	58.42	68.16	77.90
N <sub>1</sub>	2.2690	1.9179	1.2048	0.3333	0.0000	0.0000	0.0000
N <sub>2</sub>	3.7238	2.4857	2.5286	2.5952	1.8750	1.4250	1.0931
N <sub>3</sub>		2.2286	2.1286	2.0357	2.2321	1.5500	1.3206
N <sub>4</sub>			1.0714	1.5179	1.6607	1.9625	1.2856
N <sub>5</sub>				0.5179	0.9821	1.3750	2.1131
N <sub>6</sub>					0.2500	0.5625	0.7813
N <sub>7</sub>						0.1250	0.3438
N <sub>8</sub>							0.0625

Check Valves  
 BWR Residual Heat Removal Check Valves  
 BWR RHR CHECK VALVE FAIL TO OPEN

2010

**BWR Residual Heat Removal Check Valves**

**BWR RHR CHECK VALVE FAIL TO OPEN**

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
 Component : Check Valve  
 Failure Mode : Fail to open on demand  
 Plant Type : BWR  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 2.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8636860	0.9657330	0.9856730	0.9999380	1.0000000	1.2246E+01	4.3452E-01
$\alpha_2$	6.41E-05	3.43E-02	1.43E-02	1.36E-01	0.00E+00	4.3452E-01	1.2246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9040420	0.9662880	0.9752810	0.9977560	1.0000000	3.1555E+01	1.1009E+00
$\alpha_2$	8.16E-04	2.55E-02	1.67E-02	8.05E-02	0.00E+00	8.3366E-01	3.1822E+01
$\alpha_3$	2.88E-07	8.18E-03	1.66E-03	3.88E-02	0.00E+00	2.6722E-01	3.2389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9113590	0.9628920	0.9688970	0.9938680	1.0000000	4.8136E+01	1.8551E+00
$\alpha_2$	2.04E-03	2.46E-02	1.86E-02	6.77E-02	0.00E+00	1.2281E+00	4.8763E+01
$\alpha_3$	9.14E-06	8.09E-03	3.01E-03	3.34E-02	0.00E+00	4.0431E-01	4.9587E+01
$\alpha_4$	1.93E-08	4.45E-03	6.12E-04	2.23E-02	0.00E+00	2.2267E-01	4.9768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9311740	0.9652090	0.9682200	0.9889480	1.0000000	9.8161E+01	3.5382E+00
$\alpha_2$	4.01E-03	2.08E-02	1.77E-02	4.80E-02	0.00E+00	2.1142E+00	9.9585E+01
$\alpha_3$	4.70E-04	9.61E-03	6.64E-03	2.89E-02	0.00E+00	9.7738E-01	1.0072E+02
$\alpha_4$	2.42E-06	3.68E-03	1.24E-03	1.56E-02	0.00E+00	3.7439E-01	1.0132E+02
$\alpha_5$	5.87E-21	7.11E-04	4.02E-07	4.12E-03	0.00E+00	7.2277E-02	1.0163E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9346440	0.9652760	0.9677640	0.9873890	1.0000000	1.1894E+02	4.2787E+00
$\alpha_2$	3.74E-03	1.82E-02	1.56E-02	4.13E-02	0.00E+00	2.2392E+00	1.2098E+02
$\alpha_3$	6.53E-04	9.27E-03	6.78E-03	2.64E-02	0.00E+00	1.1418E+00	1.2208E+02
$\alpha_4$	4.30E-05	4.81E-03	2.52E-03	1.73E-02	0.00E+00	5.9222E-01	1.2263E+02
$\alpha_5$	7.54E-09	1.80E-03	2.45E-04	9.04E-03	0.00E+00	2.2220E-01	1.2300E+02
$\alpha_6$	1.14E-18	6.76E-04	1.18E-06	3.94E-03	0.00E+00	8.3237E-02	1.2314E+02

Check Valves  
 BWR Residual Heat Removal Check Valves  
 BWR RHR CHECK VALVE FAIL TO OPEN  
 CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9428470	0.9665190	0.9681250	0.9847050	1.0000000	1.8605E+02	6.4450E+00
$\alpha_2$	4.52E-03	1.60E-02	1.44E-02	3.32E-02	0.00E+00	3.0878E+00	1.8941E+02
$\alpha_3$	1.14E-03	8.47E-03	6.84E-03	2.14E-02	0.00E+00	1.6312E+00	1.9086E+02
$\alpha_4$	2.57E-04	5.14E-03	3.56E-03	1.54E-02	0.00E+00	9.8887E-01	1.9151E+02
$\alpha_5$	1.33E-05	2.71E-03	1.28E-03	1.02E-02	0.00E+00	5.2177E-01	1.9197E+02
$\alpha_6$	3.49E-10	9.68E-04	8.26E-05	5.08E-03	0.00E+00	1.8628E-01	1.9231E+02
$\alpha_7$	0.00E+00	1.51E-04	1.32E-13	5.69E-04	0.00E+00	2.9071E-02	1.9247E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9459360	0.9673040	0.9686640	0.9840410	1.0000000	2.2073E+02	7.4610E+00
$\alpha_2$	4.41E-03	1.47E-02	1.33E-02	2.97E-02	0.00E+00	3.3447E+00	2.2485E+02
$\alpha_3$	1.13E-03	7.62E-03	6.24E-03	1.88E-02	0.00E+00	1.7384E+00	2.2645E+02
$\alpha_4$	3.56E-04	5.02E-03	3.67E-03	1.43E-02	0.00E+00	1.1465E+00	2.2704E+02
$\alpha_5$	5.65E-05	3.10E-03	1.82E-03	1.05E-02	0.00E+00	7.0833E-01	2.2748E+02
$\alpha_6$	9.10E-07	1.61E-03	5.27E-04	6.88E-03	0.00E+00	3.6696E-01	2.2782E+02
$\alpha_7$	7.14E-14	5.39E-04	9.69E-06	3.07E-03	0.00E+00	1.2297E-01	2.2807E+02
$\alpha_8$	1.34E-42	1.45E-04	2.07E-12	6.14E-04	0.00E+00	3.3124E-02	2.2816E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Check Valves

2010

BWR Residual Heat Removal Check Valves

BWR RHR CHECK VALVE FAIL TO OPEN

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	2.00	2.00	2.00	2.00	2.00	2.00	2.00
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

## BWR Residual Heat Removal Check Valves

## BWR RHR CHECK VALVE FAIL TO CLOSE

**BWR RHR CHECK VALVE FAIL TO CLOSE**

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
 Component : Check Valve  
 Failure Mode : Fail to close (reset) on demand  
 Plant Type : BWR  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 6.00

Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8959650	0.9739500	0.9892430	0.9999480	1.0000000	1.6246E+01	4.3452E-01
$\alpha_2$	4.81E-05	2.60E-02	1.08E-02	1.04E-01	0.00E+00	4.3452E-01	1.6246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9143470	0.9699670	0.9780280	0.9980130	1.0000000	3.5555E+01	1.1009E+00
$\alpha_2$	7.25E-04	2.27E-02	1.48E-02	7.18E-02	0.00E+00	8.3366E-01	3.5822E+01
$\alpha_3$	2.56E-07	7.29E-03	1.48E-03	3.46E-02	0.00E+00	2.6722E-01	3.6389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9178250	0.9665410	0.9712250	0.9943340	1.0000000	5.2136E+01	1.8551E+00
$\alpha_2$	1.89E-03	2.27E-02	1.72E-02	6.27E-02	0.00E+00	1.2281E+00	5.2763E+01
$\alpha_3$	8.45E-06	7.49E-03	2.78E-03	3.09E-02	0.00E+00	4.0431E-01	5.3587E+01
$\alpha_4$	1.78E-08	4.12E-03	5.66E-04	2.07E-02	0.00E+00	2.2267E-01	5.3768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9337450	0.9665250	0.9694270	0.9893730	1.0000000	1.0216E+02	3.5382E+00
$\alpha_2$	3.85E-03	2.00E-02	1.71E-02	4.62E-02	0.00E+00	2.1142E+00	1.0358E+02
$\alpha_3$	4.52E-04	9.25E-03	6.39E-03	2.78E-02	0.00E+00	9.7738E-01	1.0472E+02
$\alpha_4$	2.33E-06	3.54E-03	1.19E-03	1.50E-02	0.00E+00	3.7439E-01	1.0532E+02
$\alpha_5$	5.65E-21	6.84E-04	3.87E-07	3.96E-03	0.00E+00	7.2277E-02	1.0563E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9366750	0.9663680	0.9687880	0.9877920	1.0000000	1.2294E+02	4.2787E+00
$\alpha_2$	3.62E-03	1.76E-02	1.51E-02	4.00E-02	0.00E+00	2.2392E+00	1.2498E+02
$\alpha_3$	6.32E-04	8.98E-03	6.57E-03	2.55E-02	0.00E+00	1.1418E+00	1.2608E+02
$\alpha_4$	4.16E-05	4.66E-03	2.44E-03	1.68E-02	0.00E+00	5.9222E-01	1.2663E+02
$\alpha_5$	7.30E-09	1.75E-03	2.37E-04	8.75E-03	0.00E+00	2.2220E-01	1.2700E+02
$\alpha_6$	1.11E-18	6.54E-04	1.14E-06	3.82E-03	0.00E+00	8.3237E-02	1.2714E+02

BWR Residual Heat Removal Check Valves  
 BWR RHR CHECK VALVE FAIL TO CLOSE  
 CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9439980	0.9672000	0.9687770	0.9850250	1.0000000	1.9005E+02	6.4450E+00
$\alpha_2$	4.43E-03	1.57E-02	1.41E-02	3.25E-02	0.00E+00	3.0878E+00	1.9341E+02
$\alpha_3$	1.12E-03	8.30E-03	6.70E-03	2.10E-02	0.00E+00	1.6312E+00	1.9486E+02
$\alpha_4$	2.52E-04	5.03E-03	3.48E-03	1.51E-02	0.00E+00	9.8887E-01	1.9551E+02
$\alpha_5$	1.31E-05	2.66E-03	1.26E-03	1.00E-02	0.00E+00	5.2177E-01	1.9597E+02
$\alpha_6$	3.42E-10	9.48E-04	8.09E-05	4.98E-03	0.00E+00	1.8628E-01	1.9631E+02
$\alpha_7$	0.00E+00	1.48E-04	1.30E-13	5.57E-04	0.00E+00	2.9071E-02	1.9647E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9468590	0.9678670	0.9692050	0.9843190	1.0000000	2.2473E+02	7.4610E+00
$\alpha_2$	4.33E-03	1.44E-02	1.30E-02	2.92E-02	0.00E+00	3.3447E+00	2.2885E+02
$\alpha_3$	1.11E-03	7.49E-03	6.13E-03	1.85E-02	0.00E+00	1.7384E+00	2.3045E+02
$\alpha_4$	3.50E-04	4.94E-03	3.61E-03	1.41E-02	0.00E+00	1.1465E+00	2.3104E+02
$\alpha_5$	5.55E-05	3.05E-03	1.79E-03	1.03E-02	0.00E+00	7.0833E-01	2.3148E+02
$\alpha_6$	8.95E-07	1.58E-03	5.17E-04	6.76E-03	0.00E+00	3.6696E-01	2.3182E+02
$\alpha_7$	7.01E-14	5.30E-04	9.53E-06	3.02E-03	0.00E+00	1.2297E-01	2.3207E+02
$\alpha_8$	1.31E-42	1.43E-04	2.03E-12	6.03E-04	0.00E+00	3.3124E-02	2.3216E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Check Valves

2010

BWR Residual Heat Removal Check Valves

BWR RHR CHECK VALVE FAIL TO CLOSE

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	6.00	6.00	6.00	6.00	6.00	6.00	6.00
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000



Check Valves  
PWR Auxiliary Feedwater Check Valves  
CHECK VALVE FAIL TO OPEN SPAR: AFW-CKV-CC

2010

**PWR Auxiliary Feedwater Check Valves**  
**CHECK VALVE FAIL TO OPEN SPAR: AFW-CKV-CC**

System : Auxiliary feedwater  
Component : Check Valve  
Failure Mode : Fail to open on demand  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 2.00  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8636860	0.9657330	0.9856730	0.9999380	1.0000000	1.2246E+01	4.3452E-01
$\alpha_2$	6.41E-05	3.43E-02	1.43E-02	1.36E-01	0.00E+00	4.3452E-01	1.2246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9040420	0.9662880	0.9752810	0.9977560	1.0000000	3.1555E+01	1.1009E+00
$\alpha_2$	8.16E-04	2.55E-02	1.67E-02	8.05E-02	0.00E+00	8.3366E-01	3.1822E+01
$\alpha_3$	2.88E-07	8.18E-03	1.66E-03	3.88E-02	0.00E+00	2.6722E-01	3.2389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9113590	0.9628920	0.9688970	0.9938680	1.0000000	4.8136E+01	1.8551E+00
$\alpha_2$	2.04E-03	2.46E-02	1.86E-02	6.77E-02	0.00E+00	1.2281E+00	4.8763E+01
$\alpha_3$	9.14E-06	8.09E-03	3.01E-03	3.34E-02	0.00E+00	4.0431E-01	4.9587E+01
$\alpha_4$	1.93E-08	4.45E-03	6.12E-04	2.23E-02	0.00E+00	2.2267E-01	4.9768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9311740	0.9652090	0.9682200	0.9889480	1.0000000	9.8161E+01	3.5382E+00
$\alpha_2$	4.01E-03	2.08E-02	1.77E-02	4.80E-02	0.00E+00	2.1142E+00	9.9585E+01
$\alpha_3$	4.70E-04	9.61E-03	6.64E-03	2.89E-02	0.00E+00	9.7738E-01	1.0072E+02
$\alpha_4$	2.42E-06	3.68E-03	1.24E-03	1.56E-02	0.00E+00	3.7439E-01	1.0132E+02
$\alpha_5$	5.87E-21	7.11E-04	4.02E-07	4.12E-03	0.00E+00	7.2277E-02	1.0163E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9346440	0.9652760	0.9677640	0.9873890	1.0000000	1.1894E+02	4.2787E+00
$\alpha_2$	3.74E-03	1.82E-02	1.56E-02	4.13E-02	0.00E+00	2.2392E+00	1.2098E+02
$\alpha_3$	6.53E-04	9.27E-03	6.78E-03	2.64E-02	0.00E+00	1.1418E+00	1.2208E+02
$\alpha_4$	4.30E-05	4.81E-03	2.52E-03	1.73E-02	0.00E+00	5.9222E-01	1.2263E+02
$\alpha_5$	7.54E-09	1.80E-03	2.45E-04	9.04E-03	0.00E+00	2.2220E-01	1.2300E+02
$\alpha_6$	1.14E-18	6.76E-04	1.18E-06	3.94E-03	0.00E+00	8.3237E-02	1.2314E+02

PWR Auxiliary Feedwater Check Valves

CHECK VALVE FAIL TO OPEN SPAR: AFW-CKV-CC

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9428470	0.9665190	0.9681250	0.9847050	1.0000000	1.8605E+02	6.4450E+00
$\alpha_2$	4.52E-03	1.60E-02	1.44E-02	3.32E-02	0.00E+00	3.0878E+00	1.8941E+02
$\alpha_3$	1.14E-03	8.47E-03	6.84E-03	2.14E-02	0.00E+00	1.6312E+00	1.9086E+02
$\alpha_4$	2.57E-04	5.14E-03	3.56E-03	1.54E-02	0.00E+00	9.8887E-01	1.9151E+02
$\alpha_5$	1.33E-05	2.71E-03	1.28E-03	1.02E-02	0.00E+00	5.2177E-01	1.9197E+02
$\alpha_6$	3.49E-10	9.68E-04	8.26E-05	5.08E-03	0.00E+00	1.8628E-01	1.9231E+02
$\alpha_7$	0.00E+00	1.51E-04	1.32E-13	5.69E-04	0.00E+00	2.9071E-02	1.9247E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9459360	0.9673040	0.9686640	0.9840410	1.0000000	2.2073E+02	7.4610E+00
$\alpha_2$	4.41E-03	1.47E-02	1.33E-02	2.97E-02	0.00E+00	3.3447E+00	2.2485E+02
$\alpha_3$	1.13E-03	7.62E-03	6.24E-03	1.88E-02	0.00E+00	1.7384E+00	2.2645E+02
$\alpha_4$	3.56E-04	5.02E-03	3.67E-03	1.43E-02	0.00E+00	1.1465E+00	2.2704E+02
$\alpha_5$	5.65E-05	3.10E-03	1.82E-03	1.05E-02	0.00E+00	7.0833E-01	2.2748E+02
$\alpha_6$	9.10E-07	1.61E-03	5.27E-04	6.88E-03	0.00E+00	3.6696E-01	2.2782E+02
$\alpha_7$	7.14E-14	5.39E-04	9.69E-06	3.07E-03	0.00E+00	1.2297E-01	2.2807E+02
$\alpha_8$	1.34E-42	1.45E-04	2.07E-12	6.14E-04	0.00E+00	3.3124E-02	2.2816E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Check Valves

2010

PWR Auxiliary Feedwater Check Valves

CHECK VALVE FAIL TO OPEN SPAR: AFW-CKV-CC

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	2.00	2.00	2.00	2.00	2.00	2.00	2.00
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Check Valves

2010

PWR Auxiliary Feedwater Check Valves

CHECK VALVE FAIL TO CLOSE SPAR: AFW-CKV-OO

**CHECK VALVE FAIL TO CLOSE SPAR: AFW-CKV-OO**

System : Auxiliary feedwater  
 Component : Check Valve  
 Failure Mode : Fail to close (reseal) on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 5.00

Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8591660	0.9642770	0.9846980	0.9999250	0.9943280	1.1999E+01	4.4452E-01
$\alpha_2$	7.69E-05	3.57E-02	1.53E-02	1.41E-01	5.67E-03	4.4452E-01	1.1999E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9042200	0.9660380	0.9748750	0.9976030	0.9887980	3.2150E+01	1.1303E+00
$\alpha_2$	9.18E-04	2.59E-02	1.72E-02	8.08E-02	1.11E-02	8.6276E-01	3.2418E+01
$\alpha_3$	2.87E-07	8.04E-03	1.63E-03	3.81E-02	1.14E-04	2.6752E-01	3.3013E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9120970	0.9628430	0.9686800	0.9936070	0.9834520	4.9565E+01	1.9128E+00
$\alpha_2$	2.27E-03	2.50E-02	1.91E-02	6.77E-02	1.62E-02	1.2847E+00	5.0193E+01
$\alpha_3$	9.05E-06	7.88E-03	2.94E-03	3.25E-02	3.15E-04	4.0541E-01	5.1072E+01
$\alpha_4$	1.87E-08	4.33E-03	5.94E-04	2.17E-02	0.00E+00	2.2267E-01	5.1255E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9314140	0.9650830	0.9680270	0.9886850	0.9782220	1.0040E+02	3.6325E+00
$\alpha_2$	4.29E-03	2.12E-02	1.82E-02	4.83E-02	2.11E-02	2.2056E+00	1.0183E+02
$\alpha_3$	4.64E-04	9.42E-03	6.52E-03	2.83E-02	6.70E-04	9.8028E-01	1.0305E+02
$\alpha_4$	2.37E-06	3.60E-03	1.21E-03	1.53E-02	0.00E+00	3.7439E-01	1.0366E+02
$\alpha_5$	5.74E-21	6.95E-04	3.93E-07	4.02E-03	0.00E+00	7.2277E-02	1.0396E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9347590	0.9650530	0.9674780	0.9870430	0.9732140	1.2198E+02	4.4173E+00
$\alpha_2$	4.11E-03	1.88E-02	1.63E-02	4.19E-02	2.57E-02	2.3721E+00	1.2403E+02
$\alpha_3$	6.46E-04	9.08E-03	6.65E-03	2.58E-02	1.10E-03	1.1475E+00	1.2525E+02
$\alpha_4$	4.19E-05	4.69E-03	2.45E-03	1.69E-02	0.00E+00	5.9222E-01	1.2581E+02
$\alpha_5$	7.35E-09	1.76E-03	2.38E-04	8.81E-03	0.00E+00	2.2220E-01	1.2618E+02
$\alpha_6$	1.12E-18	6.59E-04	1.15E-06	3.84E-03	0.00E+00	8.3237E-02	1.2631E+02

PWR Auxiliary Feedwater Check Valves

CHECK VALVE FAIL TO CLOSE SPAR: AFW-CKV-OO

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9427360	0.9662330	0.9678020	0.9843570	0.9683330	1.8986E+02	6.6350E+00
$\alpha_2$	4.92E-03	1.66E-02	1.50E-02	3.39E-02	3.00E-02	3.2678E+00	1.9323E+02
$\alpha_3$	1.14E-03	8.35E-03	6.75E-03	2.10E-02	1.67E-03	1.6412E+00	1.9485E+02
$\alpha_4$	2.52E-04	5.03E-03	3.48E-03	1.51E-02	0.00E+00	9.8887E-01	1.9551E+02
$\alpha_5$	1.31E-05	2.66E-03	1.26E-03	1.00E-02	0.00E+00	5.2177E-01	1.9597E+02
$\alpha_6$	3.42E-10	9.48E-04	8.09E-05	4.98E-03	0.00E+00	1.8628E-01	1.9631E+02
$\alpha_7$	0.00E+00	1.48E-04	1.30E-13	5.57E-04	0.00E+00	2.9071E-02	1.9647E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9457360	0.9669610	0.9682920	0.9836540	0.9652000	2.2531E+02	7.6983E+00
$\alpha_2$	4.83E-03	1.53E-02	1.39E-02	3.04E-02	3.18E-02	3.5615E+00	2.2945E+02
$\alpha_3$	1.13E-03	7.55E-03	6.19E-03	1.86E-02	2.92E-03	1.7583E+00	2.3125E+02
$\alpha_4$	3.49E-04	4.92E-03	3.60E-03	1.40E-02	8.80E-05	1.1471E+00	2.3186E+02
$\alpha_5$	5.53E-05	3.04E-03	1.79E-03	1.03E-02	0.00E+00	7.0833E-01	2.3230E+02
$\alpha_6$	8.91E-07	1.57E-03	5.16E-04	6.74E-03	0.00E+00	3.6696E-01	2.3264E+02
$\alpha_7$	6.99E-14	5.28E-04	9.49E-06	3.00E-03	0.00E+00	1.2297E-01	2.3289E+02
$\alpha_8$	1.31E-42	1.42E-04	2.03E-12	6.01E-04	0.00E+00	3.3124E-02	2.3298E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9943280	0.9887980	0.9834520	0.9782220	0.9732140	0.9683330	0.9652000
$\alpha_2$	5.67E-03	1.11E-02	1.62E-02	2.11E-02	2.57E-02	3.00E-02	3.18E-02
$\alpha_3$		1.14E-04	3.15E-04	6.70E-04	1.10E-03	1.67E-03	2.92E-03
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.80E-05
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.94E-01	9.89E-01	9.83E-01	9.78E-01	9.73E-01	9.68E-01	9.65E-01
Beta	5.67E-03	1.12E-02	1.65E-02	2.18E-02	2.68E-02	3.17E-02	3.48E-02
Gamma		1.02E-02	1.91E-02	3.08E-02	4.11E-02	5.26E-02	8.64E-02
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.93E-02
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Check Valves

2010

PWR Auxiliary Feedwater Check Valves

CHECK VALVE FAIL TO CLOSE SPAR: AFW-CKV-OO

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	1.43	2.14	2.86	3.57	4.29	5.00	5.71
N <sub>1</sub>	0.3229	0.4551	0.5691	0.6657	0.7457	0.8100	0.8717
N <sub>2</sub>	0.0100	0.0291	0.0566	0.0914	0.1329	0.1800	0.2168
N <sub>3</sub>		0.0003	0.0011	0.0029	0.0057	0.0100	0.0199
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0006
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Check Valves  
PWR High Pressure Safety Injection Check Valves  
HIGH PRESSURE INJECTION CHECK VALVE FAIL TO OPEN

2010

**PWR High Pressure Safety Injection Check Valves**  
**HIGH PRESSURE INJECTION CHECK VALVE FAIL TO OPEN**

**System :** Chemical and volume control  
High pressure injection  
**Component :** Check Valve  
**Failure Mode :** Fail to open on demand  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 3.00  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8734960	0.9682380	0.9867710	0.9999360	1.0000000	1.3246E+01	4.3452E-01
$\alpha_2$	5.92E-05	3.18E-02	1.32E-02	1.27E-01	0.00E+00	4.3452E-01	1.3246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9068390	0.9672900	0.9760300	0.9978250	1.0000000	3.2555E+01	1.1009E+00
$\alpha_2$	7.91E-04	2.48E-02	1.62E-02	7.82E-02	0.00E+00	8.3366E-01	3.2822E+01
$\alpha_3$	2.80E-07	7.94E-03	1.61E-03	3.77E-02	0.00E+00	2.6722E-01	3.3389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9130680	0.9636200	0.9695110	0.9939910	1.0000000	4.9136E+01	1.8551E+00
$\alpha_2$	2.00E-03	2.41E-02	1.82E-02	6.63E-02	0.00E+00	1.2281E+00	4.9763E+01
$\alpha_3$	8.95E-06	7.93E-03	2.95E-03	3.27E-02	0.00E+00	4.0431E-01	5.0587E+01
$\alpha_4$	1.89E-08	4.37E-03	5.99E-04	2.19E-02	0.00E+00	2.2267E-01	5.0768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9318350	0.9655480	0.9685320	0.9890570	1.0000000	9.9161E+01	3.5382E+00
$\alpha_2$	3.97E-03	2.06E-02	1.76E-02	4.76E-02	0.00E+00	2.1142E+00	1.0059E+02
$\alpha_3$	4.65E-04	9.52E-03	6.58E-03	2.86E-02	0.00E+00	9.7738E-01	1.0172E+02
$\alpha_4$	2.40E-06	3.65E-03	1.23E-03	1.55E-02	0.00E+00	3.7439E-01	1.0232E+02
$\alpha_5$	5.81E-21	7.04E-04	3.98E-07	4.08E-03	0.00E+00	7.2277E-02	1.0263E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9351640	0.9655550	0.9680290	0.9874920	1.0000000	1.1994E+02	4.2787E+00
$\alpha_2$	3.71E-03	1.80E-02	1.55E-02	4.10E-02	0.00E+00	2.2392E+00	1.2198E+02
$\alpha_3$	6.48E-04	9.19E-03	6.73E-03	2.62E-02	0.00E+00	1.1418E+00	1.2308E+02
$\alpha_4$	4.26E-05	4.77E-03	2.50E-03	1.72E-02	0.00E+00	5.9222E-01	1.2363E+02
$\alpha_5$	7.48E-09	1.79E-03	2.43E-04	8.96E-03	0.00E+00	2.2220E-01	1.2400E+02
$\alpha_6$	1.14E-18	6.70E-04	1.17E-06	3.91E-03	0.00E+00	8.3237E-02	1.2414E+02

PWR High Pressure Safety Injection Check Valves

HIGH PRESSURE INJECTION CHECK VALVE FAIL TO OPEN

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	3.00	3.00	3.00	3.00	3.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000



## PWR High Pressure Safety Injection Check Valves

## HIGH PRESSURE INJECTION CHECK VALVE FAIL TO CLOSE

**HIGH PRESSURE INJECTION CHECK VALVE FAIL TO CLOSE**

System : Chemical and volume control  
 High pressure injection  
 Component : Check Valve  
 Failure Mode : Fail to close (reseal) on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 8.50

Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9093850	0.9773460	0.9906920	0.9999550	1.0000000	1.8746E+01	4.3452E-01
$\alpha_2$	4.16E-05	2.27E-02	9.31E-03	9.06E-02	0.00E+00	4.3452E-01	1.8746E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9197350	0.9718850	0.9794540	0.9981430	1.0000000	3.8055E+01	1.1009E+00
$\alpha_2$	6.78E-04	2.13E-02	1.39E-02	6.73E-02	0.00E+00	8.3366E-01	3.8322E+01
$\alpha_3$	2.40E-07	6.82E-03	1.38E-03	3.24E-02	0.00E+00	2.6722E-01	3.8889E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9214020	0.9671620	0.9725130	0.9945900	1.0000000	5.4636E+01	1.8551E+00
$\alpha_2$	1.80E-03	2.17E-02	1.64E-02	6.00E-02	0.00E+00	1.2281E+00	5.5263E+01
$\alpha_3$	8.07E-06	7.16E-03	2.66E-03	2.96E-02	0.00E+00	4.0431E-01	5.6087E+01
$\alpha_4$	1.70E-08	3.94E-03	5.40E-04	1.97E-02	0.00E+00	2.2267E-01	5.6268E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9352570	0.9672990	0.9701370	0.9896220	1.0000000	1.0466E+02	3.5382E+00
$\alpha_2$	3.76E-03	1.95E-02	1.67E-02	4.52E-02	0.00E+00	2.1142E+00	1.0608E+02
$\alpha_3$	4.41E-04	9.03E-03	6.24E-03	2.72E-02	0.00E+00	9.7738E-01	1.0722E+02
$\alpha_4$	2.28E-06	3.46E-03	1.17E-03	1.47E-02	0.00E+00	3.7439E-01	1.0782E+02
$\alpha_5$	5.52E-21	6.68E-04	3.78E-07	3.87E-03	0.00E+00	7.2277E-02	1.0813E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9378820	0.9670160	0.9693880	0.9880300	1.0000000	1.2544E+02	4.2787E+00
$\alpha_2$	3.55E-03	1.73E-02	1.48E-02	3.92E-02	0.00E+00	2.2392E+00	1.2748E+02
$\alpha_3$	6.20E-04	8.80E-03	6.44E-03	2.51E-02	0.00E+00	1.1418E+00	1.2858E+02
$\alpha_4$	4.08E-05	4.57E-03	2.39E-03	1.65E-02	0.00E+00	5.9222E-01	1.2913E+02
$\alpha_5$	7.16E-09	1.71E-03	2.32E-04	8.58E-03	0.00E+00	2.2220E-01	1.2950E+02
$\alpha_6$	1.09E-18	6.42E-04	1.12E-06	3.75E-03	0.00E+00	8.3237E-02	1.2964E+02

PWR High Pressure Safety Injection Check Valves

HIGH PRESSURE INJECTION CHECK VALVE FAIL TO CLOSE

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	8.50	8.50	8.50	8.50	8.50
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

**PWR Residual Heat Removal Check Valves**

**PWR RHR CHECK VALVE FAIL TO OPEN**

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
Component : Check Valve  
Failure Mode : Fail to open on demand  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 0.00  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8386830	0.9593170	0.9828300	0.9999250	1.0000000	1.0246E+01	4.3452E-01
$\alpha_2$	7.70E-05	4.07E-02	1.72E-02	1.61E-01	0.00E+00	4.3452E-01	1.0246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8979020	0.9640890	0.9736330	0.9976040	1.0000000	2.9555E+01	1.1009E+00
$\alpha_2$	8.71E-04	2.72E-02	1.78E-02	8.57E-02	0.00E+00	8.3366E-01	2.9822E+01
$\alpha_3$	3.08E-07	8.72E-03	1.77E-03	4.13E-02	0.00E+00	2.6722E-01	3.0389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9077330	0.9613450	0.9675780	0.9936050	1.0000000	4.6136E+01	1.8551E+00
$\alpha_2$	2.13E-03	2.56E-02	1.93E-02	7.04E-02	0.00E+00	1.2281E+00	4.6763E+01
$\alpha_3$	9.52E-06	8.42E-03	3.13E-03	3.48E-02	0.00E+00	4.0431E-01	4.7587E+01
$\alpha_4$	2.01E-08	4.64E-03	6.37E-04	2.32E-02	0.00E+00	2.2267E-01	4.7768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9298110	0.9645110	0.9675740	0.9887220	1.0000000	9.6161E+01	3.5382E+00
$\alpha_2$	4.09E-03	2.12E-02	1.81E-02	4.90E-02	0.00E+00	2.1142E+00	9.7585E+01
$\alpha_3$	4.79E-04	9.80E-03	6.78E-03	2.95E-02	0.00E+00	9.7738E-01	9.8722E+01
$\alpha_4$	2.47E-06	3.76E-03	1.27E-03	1.59E-02	0.00E+00	3.7439E-01	9.9325E+01
$\alpha_5$	5.99E-21	7.25E-04	4.10E-07	4.20E-03	0.00E+00	7.2277E-02	9.9627E+01

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9335790	0.9647030	0.9672350	0.9871780	1.0000000	1.1694E+02	4.2787E+00
$\alpha_2$	3.80E-03	1.85E-02	1.59E-02	4.20E-02	0.00E+00	2.2392E+00	1.1898E+02
$\alpha_3$	6.64E-04	9.42E-03	6.89E-03	2.68E-02	0.00E+00	1.1418E+00	1.2008E+02
$\alpha_4$	4.37E-05	4.89E-03	2.56E-03	1.76E-02	0.00E+00	5.9222E-01	1.2063E+02
$\alpha_5$	7.67E-09	1.83E-03	2.49E-04	9.18E-03	0.00E+00	2.2220E-01	1.2100E+02
$\alpha_6$	1.16E-18	6.87E-04	1.20E-06	4.01E-03	0.00E+00	8.3237E-02	1.2114E+02

Check Valves  
PWR Residual Heat Removal Check Valves  
PWR RHR CHECK VALVE FAIL TO OPEN  
CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9422570	0.9661670	0.9677850	0.9845420	1.0000000	1.8405E+02	6.4450E+00
$\alpha_2$	4.57E-03	1.62E-02	1.45E-02	3.35E-02	0.00E+00	3.0878E+00	1.8741E+02
$\alpha_3$	1.15E-03	8.56E-03	6.91E-03	2.16E-02	0.00E+00	1.6312E+00	1.8886E+02
$\alpha_4$	2.60E-04	5.19E-03	3.59E-03	1.56E-02	0.00E+00	9.8887E-01	1.8951E+02
$\alpha_5$	1.35E-05	2.74E-03	1.30E-03	1.04E-02	0.00E+00	5.2177E-01	1.8997E+02
$\alpha_6$	3.53E-10	9.78E-04	8.35E-05	5.13E-03	0.00E+00	1.8628E-01	1.9031E+02
$\alpha_7$	0.00E+00	1.53E-04	1.34E-13	5.75E-04	0.00E+00	2.9071E-02	1.9047E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9454620	0.9670150	0.9683850	0.9838980	1.0000000	2.1873E+02	7.4610E+00
$\alpha_2$	4.45E-03	1.48E-02	1.34E-02	2.99E-02	0.00E+00	3.3447E+00	2.2285E+02
$\alpha_3$	1.14E-03	7.69E-03	6.29E-03	1.90E-02	0.00E+00	1.7384E+00	2.2445E+02
$\alpha_4$	3.59E-04	5.07E-03	3.71E-03	1.44E-02	0.00E+00	1.1465E+00	2.2504E+02
$\alpha_5$	5.70E-05	3.13E-03	1.84E-03	1.06E-02	0.00E+00	7.0833E-01	2.2548E+02
$\alpha_6$	9.18E-07	1.62E-03	5.31E-04	6.94E-03	0.00E+00	3.6696E-01	2.2582E+02
$\alpha_7$	7.20E-14	5.44E-04	9.78E-06	3.10E-03	0.00E+00	1.2297E-01	2.2607E+02
$\alpha_8$	1.35E-42	1.46E-04	2.09E-12	6.19E-04	0.00E+00	3.3124E-02	2.2616E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Check Valves

2010

PWR Residual Heat Removal Check Valves

PWR RHR CHECK VALVE FAIL TO OPEN

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Check Valves  
PWR Residual Heat Removal Check Valves  
PWR RHR CHECK VALVE FAIL TO CLOSE  
**PWR RHR CHECK VALVE FAIL TO CLOSE**

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
Component : Check Valve  
Failure Mode : Fail to close (reseal) on demand  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 6.50  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8989610	0.9747090	0.9895680	0.9999500	1.0000000	1.6746E+01	4.3452E-01
$\alpha_2$	4.66E-05	2.53E-02	1.04E-02	1.01E-01	0.00E+00	4.3452E-01	1.6746E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9154810	0.9703710	0.9783290	0.9980400	1.0000000	3.6055E+01	1.1009E+00
$\alpha_2$	7.15E-04	2.24E-02	1.46E-02	7.09E-02	0.00E+00	8.3366E-01	3.6322E+01
$\alpha_3$	2.53E-07	7.19E-03	1.45E-03	3.41E-02	0.00E+00	2.6722E-01	3.6889E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9185670	0.9659560	0.9714920	0.9943870	1.0000000	5.2636E+01	1.8551E+00
$\alpha_2$	1.87E-03	2.25E-02	1.70E-02	6.21E-02	0.00E+00	1.2281E+00	5.3263E+01
$\alpha_3$	8.37E-06	7.42E-03	2.76E-03	3.06E-02	0.00E+00	4.0431E-01	5.4087E+01
$\alpha_4$	1.77E-08	4.09E-03	5.60E-04	2.05E-02	0.00E+00	2.2267E-01	5.4268E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9340530	0.9666830	0.9695720	0.9894240	1.0000000	1.0266E+02	3.5382E+00
$\alpha_2$	3.84E-03	1.99E-02	1.70E-02	4.60E-02	0.00E+00	2.1142E+00	1.0408E+02
$\alpha_3$	4.50E-04	9.20E-03	6.36E-03	2.77E-02	0.00E+00	9.7738E-01	1.0522E+02
$\alpha_4$	2.32E-06	3.53E-03	1.19E-03	1.50E-02	0.00E+00	3.7439E-01	1.0582E+02
$\alpha_5$	5.62E-21	6.81E-04	3.85E-07	3.94E-03	0.00E+00	7.2277E-02	1.0613E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9369200	0.9664990	0.9689110	0.9878400	1.0000000	1.2344E+02	4.2787E+00
$\alpha_2$	3.60E-03	1.75E-02	1.51E-02	3.98E-02	0.00E+00	2.2392E+00	1.2548E+02
$\alpha_3$	6.30E-04	8.94E-03	6.54E-03	2.55E-02	0.00E+00	1.1418E+00	1.2658E+02
$\alpha_4$	4.15E-05	4.64E-03	2.43E-03	1.67E-02	0.00E+00	5.9222E-01	1.2713E+02
$\alpha_5$	7.27E-09	1.74E-03	2.36E-04	8.72E-03	0.00E+00	2.2220E-01	1.2750E+02
$\alpha_6$	1.10E-18	6.52E-04	1.14E-06	3.80E-03	0.00E+00	8.3237E-02	1.2764E+02

PWR Residual Heat Removal Check Valves  
 PWR RHR CHECK VALVE FAIL TO CLOSE

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9441390	0.9672830	0.9688570	0.9850630	1.0000000	1.9055E+02	6.4450E+00
$\alpha_2$	4.42E-03	1.57E-02	1.41E-02	3.24E-02	0.00E+00	3.0878E+00	1.9391E+02
$\alpha_3$	1.12E-03	8.28E-03	6.69E-03	2.09E-02	0.00E+00	1.6312E+00	1.9536E+02
$\alpha_4$	2.52E-04	5.02E-03	3.48E-03	1.51E-02	0.00E+00	9.8887E-01	1.9601E+02
$\alpha_5$	1.30E-05	2.65E-03	1.25E-03	1.00E-02	0.00E+00	5.2177E-01	1.9647E+02
$\alpha_6$	3.41E-10	9.46E-04	8.07E-05	4.96E-03	0.00E+00	1.8628E-01	1.9681E+02
$\alpha_7$	0.00E+00	1.48E-04	1.29E-13	5.56E-04	0.00E+00	2.9071E-02	1.9697E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9469720	0.9679360	0.9692720	0.9843530	1.0000000	2.2523E+02	7.4610E+00
$\alpha_2$	4.32E-03	1.44E-02	1.30E-02	2.91E-02	0.00E+00	3.3447E+00	2.2935E+02
$\alpha_3$	1.11E-03	7.47E-03	6.11E-03	1.85E-02	0.00E+00	1.7384E+00	2.3095E+02
$\alpha_4$	3.49E-04	4.93E-03	3.60E-03	1.40E-02	0.00E+00	1.1465E+00	2.3154E+02
$\alpha_5$	5.54E-05	3.04E-03	1.79E-03	1.03E-02	0.00E+00	7.0833E-01	2.3198E+02
$\alpha_6$	8.93E-07	1.58E-03	5.16E-04	6.75E-03	0.00E+00	3.6696E-01	2.3232E+02
$\alpha_7$	7.00E-14	5.28E-04	9.50E-06	3.01E-03	0.00E+00	1.2297E-01	2.3257E+02
$\alpha_8$	1.31E-42	1.42E-04	2.03E-12	6.02E-04	0.00E+00	3.3124E-02	2.3266E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Check Valves

2010

PWR Residual Heat Removal Check Valves

PWR RHR CHECK VALVE FAIL TO CLOSE

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	6.50	6.50	6.50	6.50	6.50	6.50	6.50
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000



## Check Valves

## BWR High Pressure Coolant Injection/Reactor Core Isolation Cooling Check Valves

## COMBINED HPCI AND RCIC CHECK VALVE FAIL TO OPEN

**BWR High Pressure Coolant Injection/Reactor Core Isolation Cooling Check Valves****COMBINED HPCI AND RCIC CHECK VALVE FAIL TO OPEN**

System : High pressure coolant injection  
 Reactor core isolation  
 Component : Check Valve  
 Failure Mode : Fail to open on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 1.00

Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8522320	0.9628000	0.9843830	0.9999320	1.0000000	1.1246E+01	4.3452E-01
$\alpha_2$	7.00E-05	3.72E-02	1.56E-02	1.48E-01	0.00E+00	4.3452E-01	1.1246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9010680	0.9652240	0.9744830	0.9976820	1.0000000	3.0555E+01	1.1009E+00
$\alpha_2$	8.43E-04	2.63E-02	1.72E-02	8.30E-02	0.00E+00	8.3366E-01	3.0822E+01
$\alpha_3$	2.98E-07	8.44E-03	1.71E-03	4.00E-02	0.00E+00	2.6722E-01	3.1389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9095820	0.9621340	0.9682530	0.9937390	1.0000000	4.7136E+01	1.8551E+00
$\alpha_2$	2.09E-03	2.51E-02	1.89E-02	6.90E-02	0.00E+00	1.2281E+00	4.7763E+01
$\alpha_3$	9.32E-06	8.25E-03	3.07E-03	3.41E-02	0.00E+00	4.0431E-01	4.8587E+01
$\alpha_4$	1.97E-08	4.55E-03	6.24E-04	2.28E-02	0.00E+00	2.2267E-01	4.8768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9304990	0.9648630	0.9678980	0.9888360	1.0000000	9.7161E+01	3.5382E+00
$\alpha_2$	4.05E-03	2.10E-02	1.79E-02	4.85E-02	0.00E+00	2.1142E+00	9.8585E+01
$\alpha_3$	4.74E-04	9.71E-03	6.71E-03	2.92E-02	0.00E+00	9.7738E-01	9.9722E+01
$\alpha_4$	2.45E-06	3.72E-03	1.25E-03	1.58E-02	0.00E+00	3.7439E-01	1.0032E+02
$\alpha_5$	5.93E-21	7.18E-04	4.06E-07	4.16E-03	0.00E+00	7.2277E-02	1.0063E+02

BWR High Pressure Coolant Injection/Reactor Core Isolation Cooling Check Valves

COMBINED HPCI AND RCIC CHECK VALVE FAIL TO OPEN

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9341160	0.9649920	0.9674990	0.9872840	1.0000000	1.1794E+02	4.2787E+00
$\alpha_2$	3.77E-03	1.83E-02	1.58E-02	4.16E-02	0.00E+00	2.2392E+00	1.1998E+02
$\alpha_3$	6.58E-04	9.34E-03	6.84E-03	2.66E-02	0.00E+00	1.1418E+00	1.2108E+02
$\alpha_4$	4.33E-05	4.85E-03	2.54E-03	1.75E-02	0.00E+00	5.9222E-01	1.2163E+02
$\alpha_5$	7.60E-09	1.82E-03	2.47E-04	9.11E-03	0.00E+00	2.2220E-01	1.2200E+02
$\alpha_6$	1.15E-18	6.81E-04	1.19E-06	3.98E-03	0.00E+00	8.3237E-02	1.2214E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	1.00	1.00	1.00	1.00	1.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

Check Valves  
 BWR High Pressure Coolant Injection/Reactor Core Isolation Cooling Check  
 Valves  
 COMBINED HPCI AND RCIC CHECK VALVE FAIL TO CLOSE  
**COMBINED HPCI AND RCIC CHECK VALVE FAIL TO CLOSE**

**System :** High pressure coolant injection  
 Reactor core isolation  
**Component :** Check Valve  
**Failure Mode :** Fail to close (reset) on demand  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 4.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8819910	0.9704020	0.9877120	0.9999410	1.0000000	1.4246E+01	4.3452E-01
$\alpha_2$	5.49E-05	2.96E-02	1.23E-02	1.18E-01	0.00E+00	4.3452E-01	1.4246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9094830	0.9682340	0.9767350	0.9978890	1.0000000	3.3555E+01	1.1009E+00
$\alpha_2$	7.68E-04	2.41E-02	1.57E-02	7.59E-02	0.00E+00	8.3366E-01	3.3822E+01
$\alpha_3$	2.71E-07	7.71E-03	1.56E-03	3.66E-02	0.00E+00	2.6722E-01	3.4389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9147120	0.9643190	0.9701040	0.9941100	1.0000000	5.0136E+01	1.8551E+00
$\alpha_2$	1.96E-03	2.36E-02	1.78E-02	6.51E-02	0.00E+00	1.2281E+00	5.0763E+01
$\alpha_3$	8.78E-06	7.78E-03	2.89E-03	3.21E-02	0.00E+00	4.0431E-01	5.1587E+01
$\alpha_4$	1.85E-08	4.28E-03	5.88E-04	2.15E-02	0.00E+00	2.2267E-01	5.1768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9324830	0.9658790	0.9688380	0.9891640	1.0000000	1.0016E+02	3.5382E+00
$\alpha_2$	3.93E-03	2.04E-02	1.74E-02	4.71E-02	0.00E+00	2.1142E+00	1.0158E+02
$\alpha_3$	4.61E-04	9.43E-03	6.51E-03	2.83E-02	0.00E+00	9.7738E-01	1.0272E+02
$\alpha_4$	2.37E-06	3.61E-03	1.22E-03	1.53E-02	0.00E+00	3.7439E-01	1.0332E+02
$\alpha_5$	5.76E-21	6.97E-04	3.94E-07	4.04E-03	0.00E+00	7.2277E-02	1.0363E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9356760	0.9658310	0.9682860	0.9875940	1.0000000	1.2094E+02	4.2787E+00
$\alpha_2$	3.68E-03	1.79E-02	1.54E-02	4.06E-02	0.00E+00	2.2392E+00	1.2298E+02
$\alpha_3$	6.42E-04	9.12E-03	6.67E-03	2.60E-02	0.00E+00	1.1418E+00	1.2408E+02
$\alpha_4$	4.23E-05	4.73E-03	2.48E-03	1.71E-02	0.00E+00	5.9222E-01	1.2463E+02
$\alpha_5$	7.42E-09	1.77E-03	2.41E-04	8.89E-03	0.00E+00	2.2220E-01	1.2500E+02
$\alpha_6$	1.13E-18	6.65E-04	1.16E-06	3.88E-03	0.00E+00	8.3237E-02	1.2514E+02

BWR High Pressure Coolant Injection/Reactor Core Isolation Cooling Check Valves

COMBINED HPCI AND RCIC CHECK VALVE FAIL TO CLOSE

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	4.00	4.00	4.00	4.00	4.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

## Strainers, Trash Racks, and Filters

### Pooled Strainers (Non-ESW)

#### GENERIC CLEAN DISCHARGE STRAINER PLUGS

System : Chemical and volume control  
Component cooling water  
Control rod drive  
High pressure injection  
Standby liquid control  
Component : Strainer  
Failure Mode : No flow/plugged  
Component Group : Passive filter/strainer  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 0.00  
Total Number of Common-Cause Failure Events: 0

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8386830	0.9593170	0.9828300	0.9999250	0.9888200	1.0246E+01	4.3452E-01
$\alpha_2$	7.70E-05	4.07E-02	1.72E-02	1.61E-01	0.00E+00	4.3452E-01	1.0246E+01

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8979020	0.9640890	0.9736330	0.9976040	0.9888200	2.9555E+01	1.1009E+00
$\alpha_2$	8.71E-04	2.72E-02	1.78E-02	8.57E-02	0.00E+00	8.3366E-01	2.9822E+01
$\alpha_3$	3.08E-07	8.72E-03	1.77E-03	4.13E-02	0.00E+00	2.6722E-01	3.0389E+01

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9077330	0.9613450	0.9675780	0.9936050	0.9888200	4.6136E+01	1.8551E+00
$\alpha_2$	2.13E-03	2.56E-02	1.93E-02	7.04E-02	0.00E+00	1.2281E+00	4.6763E+01
$\alpha_3$	9.52E-06	8.42E-03	3.13E-03	3.48E-02	0.00E+00	4.0431E-01	4.7587E+01
$\alpha_4$	2.01E-08	4.64E-03	6.37E-04	2.32E-02	0.00E+00	2.2267E-01	4.7768E+01

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9298110	0.9645110	0.9675740	0.9887220	0.9888200	9.6161E+01	3.5382E+00
$\alpha_2$	4.09E-03	2.12E-02	1.81E-02	4.90E-02	0.00E+00	2.1142E+00	9.7585E+01
$\alpha_3$	4.79E-04	9.80E-03	6.78E-03	2.95E-02	0.00E+00	9.7738E-01	9.8722E+01
$\alpha_4$	2.47E-06	3.76E-03	1.27E-03	1.59E-02	0.00E+00	3.7439E-01	9.9325E+01
$\alpha_5$	5.99E-21	7.25E-04	4.10E-07	4.20E-03	0.00E+00	7.2277E-02	9.9627E+01

Strainers, Trash Racks, and Filters  
Pooled Strainers (Non-ESW)  
GENERIC CLEAN DISCHARGE STRAINER PLUGS  
CCCG = 6

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9335790	0.9647030	0.9672350	0.9871780	0.9888200	1.1694E+02	4.2787E+00
$\alpha_2$	3.80E-03	1.85E-02	1.59E-02	4.20E-02	0.00E+00	2.2392E+00	1.1898E+02
$\alpha_3$	6.64E-04	9.42E-03	6.89E-03	2.68E-02	0.00E+00	1.1418E+00	1.2008E+02
$\alpha_4$	4.37E-05	4.89E-03	2.56E-03	1.76E-02	0.00E+00	5.9222E-01	1.2063E+02
$\alpha_5$	7.67E-09	1.83E-03	2.49E-04	9.18E-03	0.00E+00	2.2220E-01	1.2100E+02
$\alpha_6$	1.16E-18	6.87E-04	1.20E-06	4.01E-03	0.00E+00	8.3237E-02	1.2114E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9888200	0.9888200	0.9888200	0.9888200	0.9888200
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	0.00	0.00	0.00	0.00	0.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

**Emergency Service Water Strainers**

**SERVICE WATER TSA FTO NON ENVIRONMENTAL SPAR:TSA-FO**

**System :** Normally operating service water  
 Standby service water

**Component :** Strainer

**Failure Mode :** Fail to Operate (General operation failure, rate based)

**Component Group :** Traveling Screen

**Prox. Cause :** State of other component  
 Design error or inadequacy  
 Manufacturing error or inadequacy  
 Construction/installation error or inadequacy  
 Setpoint drift  
 Ambient environmental stress  
 Inadequate procedure  
 Inadequate maintenance  
 Age/Wear  
 Accidental human action  
 Human action procedure  
 Other  
 Internal environment  
 Internal to component, piece-part

**Start Date :** 1997/01/01

**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 28.00  
 Total Number of Common-Cause Failure Events: 2

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9206260	0.9793800	0.9906270	0.9999260	0.9960990	2.3013E+01	4.8452E-01
$\alpha_2$	7.07E-05	2.06E-02	9.37E-03	7.94E-02	3.90E-03	4.8452E-01	2.3013E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9312830	0.9748850	0.9809220	0.9978300	0.9921670	4.8555E+01	1.2509E+00
$\alpha_2$	9.91E-04	1.97E-02	1.38E-02	5.89E-02	7.83E-03	9.8366E-01	4.8822E+01
$\alpha_3$	1.88E-07	5.37E-03	1.08E-03	2.54E-02	0.00E+00	2.6722E-01	4.9539E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9328590	0.9706490	0.9748180	0.9941830	0.9882040	7.1269E+01	2.1551E+00
$\alpha_2$	2.56E-03	2.08E-02	1.66E-02	5.33E-02	1.18E-02	1.5281E+00	7.1896E+01
$\alpha_3$	6.19E-06	5.51E-03	2.04E-03	2.28E-02	0.00E+00	4.0431E-01	7.3020E+01
$\alpha_4$	1.31E-08	3.03E-03	4.15E-04	1.52E-02	0.00E+00	2.2267E-01	7.3201E+01

Strainers, Trash Racks, and Filters  
 Emergency Service Water Strainers  
 SERVICE WATER TSA FTO NON ENVIRONMENTAL SPAR:TSA-FO  
 CCGG = 5

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9412660	0.9693120	0.9716620	0.9893090	0.9844230	1.2734E+02	4.0315E+00
$\alpha_2$	4.79E-03	1.98E-02	1.74E-02	4.30E-02	1.55E-02	2.6042E+00	1.2877E+02
$\alpha_3$	3.67E-04	7.46E-03	5.16E-03	2.24E-02	1.04E-04	9.8068E-01	1.3039E+02
$\alpha_4$	1.87E-06	2.85E-03	9.59E-04	1.21E-02	0.00E+00	3.7439E-01	1.3100E+02
$\alpha_5$	4.54E-21	5.50E-04	3.11E-07	3.18E-03	0.00E+00	7.2277E-02	1.3130E+02

CCGG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9429390	0.9684980	0.9704410	0.9874090	0.9806530	1.5406E+02	5.0111E+00
$\alpha_2$	5.07E-03	1.86E-02	1.66E-02	3.89E-02	1.91E-02	2.9631E+00	1.5611E+02
$\alpha_3$	5.17E-04	7.23E-03	5.30E-03	2.05E-02	2.22E-04	1.1502E+00	1.5792E+02
$\alpha_4$	3.33E-05	3.72E-03	1.95E-03	1.34E-02	2.64E-06	5.9232E-01	1.5848E+02
$\alpha_5$	5.84E-09	1.40E-03	1.89E-04	7.00E-03	0.00E+00	2.2220E-01	1.5885E+02
$\alpha_6$	8.86E-19	5.23E-04	9.15E-07	3.05E-03	0.00E+00	8.3237E-02	1.5899E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCGG=2	CCGG=3	CCGG=4	CCGG=5	CCGG=6
$\alpha_1$	0.9960990	0.9921670	0.9882040	0.9844230	0.9806530
$\alpha_2$	3.90E-03	7.83E-03	1.18E-02	1.55E-02	1.91E-02
$\alpha_3$		0.00E+00	0.00E+00	1.04E-04	2.22E-04
$\alpha_4$			0.00E+00	0.00E+00	2.64E-06
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCGG=2	CCGG=3	CCGG=4	CCGG=5	CCGG=6
1-Beta	9.96E-01	9.92E-01	9.88E-01	9.84E-01	9.81E-01
Beta	3.90E-03	7.83E-03	1.18E-02	1.56E-02	1.93E-02
Gamma		0.00E+00	0.00E+00	6.69E-03	1.16E-02
Delta			0.00E+00	0.00E+00	1.18E-02
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCGG=2	CCGG=3	CCGG=4	CCGG=5	CCGG=6
Adj. Ind. Events	11.20	16.80	22.40	28.00	33.60
$N_1$	1.5667	2.2000	2.7333	3.1750	3.5230
$N_2$	0.0500	0.1500	0.3000	0.4900	0.7239
$N_3$		0.0000	0.0000	0.0033	0.0084
$N_4$			0.0000	0.0000	0.0001
$N_5$				0.0000	0.0000
$N_6$					0.0000



Strainers, Trash Racks, and Filters  
 Emergency Service Water Strainers  
 SERVICE WATER TSA PLUG NON ENVIRONMENTAL SPAR:TSA-PG  
**SERVICE WATER TSA PLUG NON ENVIRONMENTAL SPAR:TSA-PG**

2010

**System :** Normally operating service water  
 Standby service water

**Component :** Strainer

**Failure Mode :** No flow/plugged

**Component Group :** Traveling Screen

**Prox. Cause :** State of other component  
 Design error or inadequacy  
 Manufacturing error or inadequacy  
 Construction/installation error or inadequacy  
 Setpoint drift  
 Ambient environmental stress  
 Inadequate procedure  
 Inadequate maintenance  
 Age/Wear  
 Accidental human action  
 Human action procedure  
 Other  
 Internal environment  
 Internal to component, piece-part

**Start Date :** 1997/01/01

**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 1.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8522320	0.9628000	0.9843830	0.9999320	1.0000000	1.1246E+01	4.3452E-01
$\alpha_2$	7.00E-05	3.72E-02	1.56E-02	1.48E-01	0.00E+00	4.3452E-01	1.1246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9010680	0.9652240	0.9744830	0.9976820	1.0000000	3.0555E+01	1.1009E+00
$\alpha_2$	8.43E-04	2.63E-02	1.72E-02	8.30E-02	0.00E+00	8.3366E-01	3.0822E+01
$\alpha_3$	2.98E-07	8.44E-03	1.71E-03	4.00E-02	0.00E+00	2.6722E-01	3.1389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9095820	0.9621340	0.9682530	0.9937390	1.0000000	4.7136E+01	1.8551E+00
$\alpha_2$	2.09E-03	2.51E-02	1.89E-02	6.90E-02	0.00E+00	1.2281E+00	4.7763E+01
$\alpha_3$	9.32E-06	8.25E-03	3.07E-03	3.41E-02	0.00E+00	4.0431E-01	4.8587E+01
$\alpha_4$	1.97E-08	4.55E-03	6.24E-04	2.28E-02	0.00E+00	2.2267E-01	4.8768E+01

Strainers, Trash Racks, and Filters  
 Emergency Service Water Strainers  
 SERVICE WATER TSA PLUG NON ENVIRONMENTAL SPAR:TSA-PG  
 CCCG = 5

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9304990	0.9648630	0.9678980	0.9888360	1.0000000	9.7161E+01	3.5382E+00
$\alpha_2$	4.05E-03	2.10E-02	1.79E-02	4.85E-02	0.00E+00	2.1142E+00	9.8585E+01
$\alpha_3$	4.74E-04	9.71E-03	6.71E-03	2.92E-02	0.00E+00	9.7738E-01	9.9722E+01
$\alpha_4$	2.45E-06	3.72E-03	1.25E-03	1.58E-02	0.00E+00	3.7439E-01	1.0032E+02
$\alpha_5$	5.93E-21	7.18E-04	4.06E-07	4.16E-03	0.00E+00	7.2277E-02	1.0063E+02

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9341160	0.9649920	0.9674990	0.9872840	1.0000000	1.1794E+02	4.2787E+00
$\alpha_2$	3.77E-03	1.83E-02	1.58E-02	4.16E-02	0.00E+00	2.2392E+00	1.1998E+02
$\alpha_3$	6.58E-04	9.34E-03	6.84E-03	2.66E-02	0.00E+00	1.1418E+00	1.2108E+02
$\alpha_4$	4.33E-05	4.85E-03	2.54E-03	1.75E-02	0.00E+00	5.9222E-01	1.2163E+02
$\alpha_5$	7.60E-09	1.82E-03	2.47E-04	9.11E-03	0.00E+00	2.2220E-01	1.2200E+02
$\alpha_6$	1.15E-18	6.81E-04	1.19E-06	3.98E-03	0.00E+00	8.3237E-02	1.2214E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	1.00	1.00	1.00	1.00	1.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

**SERVICE WATER STRAINER PLUG NON ENVIRONMENTAL SPAR:STR-PG**  
**SERVICE WATER STRAINER PLUG NON ENVIRONMENTAL SPAR:STR-PG**

**System :** Normally operating service water  
 Standby service water

**Component :** Strainer

**Failure Mode :** High dP across filter  
 No flow/plugged

**Component Group :** Self-Cleaning filter/strainer

**Prox. Cause :** State of other component  
 Design error or inadequacy  
 Manufacturing error or inadequacy  
 Construction/installation error or inadequacy  
 Setpoint drift  
 Ambient environmental stress  
 Inadequate procedure  
 Inadequate maintenance  
 Age/Wear  
 Accidental human action  
 Human action procedure  
 Other  
 Internal environment  
 Internal to component, piece-part

**Start Date :** 1997/01/01

**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 37.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9633370	0.9908870	0.9963330	0.9999820	1.0000000	4.7246E+01	4.3452E-01
$\alpha_2$	1.63E-05	9.11E-03	3.67E-03	3.67E-02	0.00E+00	4.3452E-01	4.7246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9532560	0.9837280	0.9881890	0.9989340	1.0000000	6.6555E+01	1.1009E+00
$\alpha_2$	3.88E-04	1.23E-02	7.96E-03	3.91E-02	0.00E+00	8.3366E-01	6.6822E+01
$\alpha_3$	1.38E-07	3.95E-03	7.93E-04	1.87E-02	0.00E+00	2.6722E-01	6.7389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9474900	0.9781730	0.9818070	0.9964330	1.0000000	8.3136E+01	1.8551E+00
$\alpha_2$	1.19E-03	1.44E-02	1.09E-02	4.00E-02	0.00E+00	1.2281E+00	8.3763E+01
$\alpha_3$	5.34E-06	4.76E-03	1.76E-03	1.97E-02	0.00E+00	4.0431E-01	8.4587E+01
$\alpha_4$	1.13E-08	2.62E-03	3.58E-04	1.31E-02	0.00E+00	2.2267E-01	8.4768E+01

**SERVICE WATER STRAINER PLUG NON ENVIRONMENTAL SPAR:STR-PG  
CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9486250	0.9741160	0.9763980	0.9918180	1.0000000	1.3316E+02	3.5382E+00
$\alpha_2$	2.97E-03	1.55E-02	1.32E-02	3.58E-02	0.00E+00	2.1142E+00	1.3458E+02
$\alpha_3$	3.49E-04	7.15E-03	4.93E-03	2.15E-02	0.00E+00	9.7738E-01	1.3572E+02
$\alpha_4$	1.80E-06	2.74E-03	9.22E-04	1.16E-02	0.00E+00	3.7439E-01	1.3632E+02
$\alpha_5$	4.36E-21	5.29E-04	2.99E-07	3.06E-03	0.00E+00	7.2277E-02	1.3663E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9489700	0.9729570	0.9749300	0.9902120	1.0000000	1.5394E+02	4.2787E+00
$\alpha_2$	2.90E-03	1.42E-02	1.22E-02	3.22E-02	0.00E+00	2.2392E+00	1.5598E+02
$\alpha_3$	5.07E-04	7.22E-03	5.27E-03	2.06E-02	0.00E+00	1.1418E+00	1.5708E+02
$\alpha_4$	3.34E-05	3.74E-03	1.96E-03	1.35E-02	0.00E+00	5.9222E-01	1.5763E+02
$\alpha_5$	5.87E-09	1.40E-03	1.90E-04	7.04E-03	0.00E+00	2.2220E-01	1.5800E+02
$\alpha_6$	8.91E-19	5.26E-04	9.20E-07	3.07E-03	0.00E+00	8.3237E-02	1.5814E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	37.00	37.00	37.00	37.00	37.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

**ESW STRAINER PLUG POOLED CAUSES SPAR:ESW-STR-POOL-PG  
 ESW STRAINER PLUG POOLED CAUSES SPAR:ESW-STR-POOL-PG**

**System :** Normally operating service water  
 Standby service water

**Component :** Strainer

**Failure Mode :** High dP across filter  
 No flow/plugged

**Component Group :** Self-Cleaning filter/strainer

**Prox. Cause :** State of other component  
 Design error or inadequacy  
 Manufacturing error or inadequacy  
 Construction/installation error or inadequacy  
 Setpoint drift  
 Ambient environmental stress  
 Inadequate procedure  
 Inadequate maintenance  
 Age/Wear  
 Accidental human action  
 Human action procedure  
 Other  
 Internal environment  
 Internal to component, piece-part

**Start Date :** 1997/01/01

**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 37.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9633370	0.9908870	0.9963330	0.9999820	1.0000000	4.7246E+01	4.3452E-01
$\alpha_2$	1.63E-05	9.11E-03	3.67E-03	3.67E-02	0.00E+00	4.3452E-01	4.7246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9532560	0.9837280	0.9881890	0.9989340	1.0000000	6.6555E+01	1.1009E+00
$\alpha_2$	3.88E-04	1.23E-02	7.96E-03	3.91E-02	0.00E+00	8.3366E-01	6.6822E+01
$\alpha_3$	1.38E-07	3.95E-03	7.93E-04	1.87E-02	0.00E+00	2.6722E-01	6.7389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9474900	0.9781730	0.9818070	0.9964330	1.0000000	8.3136E+01	1.8551E+00
$\alpha_2$	1.19E-03	1.44E-02	1.09E-02	4.00E-02	0.00E+00	1.2281E+00	8.3763E+01
$\alpha_3$	5.34E-06	4.76E-03	1.76E-03	1.97E-02	0.00E+00	4.0431E-01	8.4587E+01
$\alpha_4$	1.13E-08	2.62E-03	3.58E-04	1.31E-02	0.00E+00	2.2267E-01	8.4768E+01

ESW STRAINER PLUG POOLED CAUSES SPAR:ESW-STR-POOL-PG

CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9486250	0.9741160	0.9763980	0.9918180	1.0000000	1.3316E+02	3.5382E+00
$\alpha_2$	2.97E-03	1.55E-02	1.32E-02	3.58E-02	0.00E+00	2.1142E+00	1.3458E+02
$\alpha_3$	3.49E-04	7.15E-03	4.93E-03	2.15E-02	0.00E+00	9.7738E-01	1.3572E+02
$\alpha_4$	1.80E-06	2.74E-03	9.22E-04	1.16E-02	0.00E+00	3.7439E-01	1.3632E+02
$\alpha_5$	4.36E-21	5.29E-04	2.99E-07	3.06E-03	0.00E+00	7.2277E-02	1.3663E+02

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9489700	0.9729570	0.9749300	0.9902120	1.0000000	1.5394E+02	4.2787E+00
$\alpha_2$	2.90E-03	1.42E-02	1.22E-02	3.22E-02	0.00E+00	2.2392E+00	1.5598E+02
$\alpha_3$	5.07E-04	7.22E-03	5.27E-03	2.06E-02	0.00E+00	1.1418E+00	1.5708E+02
$\alpha_4$	3.34E-05	3.74E-03	1.96E-03	1.35E-02	0.00E+00	5.9222E-01	1.5763E+02
$\alpha_5$	5.87E-09	1.40E-03	1.90E-04	7.04E-03	0.00E+00	2.2220E-01	1.5800E+02
$\alpha_6$	8.91E-19	5.26E-04	9.20E-07	3.07E-03	0.00E+00	8.3237E-02	1.5814E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	37.00	37.00	37.00	37.00	37.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

**Pooled Sump Strainers**  
**SUMP SUCTION PLUGGED**

**System :** Containment spray recirculation  
High pressure core spray  
High pressure coolant injection  
Low pressure core spray  
Reactor core isolation  
Residual Heat Removal (LCI in BWRs, LPI in PWRs)

**Component :** Strainer

**Failure Mode :** High dP across filter  
No flow/plugged

**Component Group :** Sump Strainer Filter

**Start Date :** 1997/01/01

**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 1.50  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8581890	0.9643270	0.9850590	0.9999350	1.0000000	1.1746E+01	4.3452E-01
$\alpha_2$	6.69E-05	3.57E-02	1.49E-02	1.42E-01	0.00E+00	4.3452E-01	1.1746E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9025780	0.9657640	0.9748880	0.9977200	1.0000000	3.1055E+01	1.1009E+00
$\alpha_2$	8.29E-04	2.59E-02	1.69E-02	8.18E-02	0.00E+00	8.3366E-01	3.1322E+01
$\alpha_3$	2.93E-07	8.31E-03	1.69E-03	3.94E-02	0.00E+00	2.6722E-01	3.1889E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9104790	0.9625170	0.9685780	0.9938040	1.0000000	4.7636E+01	1.8551E+00
$\alpha_2$	2.06E-03	2.48E-02	1.87E-02	6.83E-02	0.00E+00	1.2281E+00	4.8263E+01
$\alpha_3$	9.23E-06	8.17E-03	3.04E-03	3.37E-02	0.00E+00	4.0431E-01	4.9087E+01
$\alpha_4$	1.95E-08	4.50E-03	6.18E-04	2.25E-02	0.00E+00	2.2267E-01	4.9268E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9308380	0.9650370	0.9680620	0.9888920	1.0000000	9.7661E+01	3.5382E+00
$\alpha_2$	4.03E-03	2.09E-02	1.78E-02	4.83E-02	0.00E+00	2.1142E+00	9.9085E+01
$\alpha_3$	4.72E-04	9.66E-03	6.68E-03	2.90E-02	0.00E+00	9.7738E-01	1.0022E+02
$\alpha_4$	2.43E-06	3.70E-03	1.25E-03	1.57E-02	0.00E+00	3.7439E-01	1.0082E+02
$\alpha_5$	5.90E-21	7.14E-04	4.04E-07	4.14E-03	0.00E+00	7.2277E-02	1.0113E+02

Pooled Sump Strainers

SUMP SUCTION PLUGGED

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9343810	0.9651340	0.9676320	0.9873370	1.0000000	1.1844E+02	4.2787E+00
$\alpha_2$	3.75E-03	1.82E-02	1.57E-02	4.15E-02	0.00E+00	2.2392E+00	1.2048E+02
$\alpha_3$	6.56E-04	9.30E-03	6.81E-03	2.65E-02	0.00E+00	1.1418E+00	1.2158E+02
$\alpha_4$	4.32E-05	4.83E-03	2.53E-03	1.74E-02	0.00E+00	5.9222E-01	1.2213E+02
$\alpha_5$	7.57E-09	1.81E-03	2.46E-04	9.07E-03	0.00E+00	2.2220E-01	1.2250E+02
$\alpha_6$	1.15E-18	6.78E-04	1.19E-06	3.96E-03	0.00E+00	8.3237E-02	1.2264E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	1.50	1.50	1.50	1.50	1.50
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000



**PWR Containment Sump Strainers**

**CONTAINMENT SPRAY SUMP STRAINER PLUG STR-PG**

**System :** Containment spray recirculation  
**Component :** Strainer  
**Failure Mode :** High dP across filter  
No flow/plugged  
**Component Group :** Sump Strainer Filter  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 0.00  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8386830	0.9593170	0.9828300	0.9999250	1.0000000	1.0246E+01	4.3452E-01
$\alpha_2$	7.70E-05	4.07E-02	1.72E-02	1.61E-01	0.00E+00	4.3452E-01	1.0246E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2
$\alpha_1$	1.0000000
$\alpha_2$	0.00E+00

MGL Parameter	CCCG=2
1-Beta	0.00E+00
Beta	0.00E+00

Avg. Impact Vector	CCCG=2
Adj. Ind. Events	0.00
$N_1$	0.0000
$N_2$	0.0000

## BWR Suppression Pool Strainers

### BWR RHR SUMP STRAINER PLUG

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
 Component : Strainer  
 Failure Mode : High dP across filter  
 No flow/plugged  
 Component Group : Sump Strainer Filter  
 Plant Type : BWR  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 0.00  
 Total Number of Common-Cause Failure Events: 0

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8386830	0.9593170	0.9828300	0.9999250	0.9877750	1.0246E+01	4.3452E-01
$\alpha_2$	7.70E-05	4.07E-02	1.72E-02	1.61E-01	0.00E+00	4.3452E-01	1.0246E+01

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8979020	0.9640890	0.9736330	0.9976040	0.9877750	2.9555E+01	1.1009E+00
$\alpha_2$	8.71E-04	2.72E-02	1.78E-02	8.57E-02	0.00E+00	8.3366E-01	2.9822E+01
$\alpha_3$	3.08E-07	8.72E-03	1.77E-03	4.13E-02	0.00E+00	2.6722E-01	3.0389E+01

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9077330	0.9613450	0.9675780	0.9936050	0.9877750	4.6136E+01	1.8551E+00
$\alpha_2$	2.13E-03	2.56E-02	1.93E-02	7.04E-02	0.00E+00	1.2281E+00	4.6763E+01
$\alpha_3$	9.52E-06	8.42E-03	3.13E-03	3.48E-02	0.00E+00	4.0431E-01	4.7587E+01
$\alpha_4$	2.01E-08	4.64E-03	6.37E-04	2.32E-02	0.00E+00	2.2267E-01	4.7768E+01

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9298110	0.9645110	0.9675740	0.9887220	0.9877750	9.6161E+01	3.5382E+00
$\alpha_2$	4.09E-03	2.12E-02	1.81E-02	4.90E-02	0.00E+00	2.1142E+00	9.7585E+01
$\alpha_3$	4.79E-04	9.80E-03	6.78E-03	2.95E-02	0.00E+00	9.7738E-01	9.8722E+01
$\alpha_4$	2.47E-06	3.76E-03	1.27E-03	1.59E-02	0.00E+00	3.7439E-01	9.9325E+01
$\alpha_5$	5.99E-21	7.25E-04	4.10E-07	4.20E-03	0.00E+00	7.2277E-02	9.9627E+01

Strainers, Trash Racks, and Filters  
 BWR Suppression Pool Strainers  
 BWR RHR SUMP STRAINER PLUG  
 CCGG = 6

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9335790	0.9647030	0.9672350	0.9871780	0.9877750	1.1694E+02	4.2787E+00
$\alpha_2$	3.80E-03	1.85E-02	1.59E-02	4.20E-02	0.00E+00	2.2392E+00	1.1898E+02
$\alpha_3$	6.64E-04	9.42E-03	6.89E-03	2.68E-02	0.00E+00	1.1418E+00	1.2008E+02
$\alpha_4$	4.37E-05	4.89E-03	2.56E-03	1.76E-02	0.00E+00	5.9222E-01	1.2063E+02
$\alpha_5$	7.67E-09	1.83E-03	2.49E-04	9.18E-03	0.00E+00	2.2220E-01	1.2100E+02
$\alpha_6$	1.16E-18	6.87E-04	1.20E-06	4.01E-03	0.00E+00	8.3237E-02	1.2114E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9877750	0.9877750	0.9877750	0.9877750	0.9877750
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	0.00	0.00	0.00	0.00	0.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

Strainers, Trash Racks, and Filters  
 Extreme Environmental Event CCF Distributions  
 CIRCULATING WATER TSA EXTREME ENVIRONMENTAL PLUG

2010

**Extreme Environmental Event CCF Distributions**  
**CIRCULATING WATER TSA EXTREME ENVIRONMENTAL PLUG**

System : Circulating water system  
 Component : Strainer  
 Failure Mode : No flow/plugged  
 Component Group : Traveling Screen  
 Prox. Cause : Extreme environmental stress  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 20.00  
 Total Number of Common-Cause Failure Events: 16

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.5679640	0.7008240	0.7047340	0.8202940	0.5852780	2.4231E+01	1.0344E+01
$\alpha_2$	1.80E-01	2.99E-01	2.95E-01	4.32E-01	4.15E-01	1.0344E+01	2.4231E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.6819680	0.7747750	0.7778270	0.8571340	0.5787480	4.6689E+01	1.3572E+01
$\alpha_2$	4.71E-02	1.02E-01	9.81E-02	1.73E-01	1.80E-01	6.1766E+00	5.4085E+01
$\alpha_3$	6.16E-02	1.23E-01	1.19E-01	1.98E-01	2.41E-01	7.3958E+00	5.2866E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.7215890	0.7978290	0.8002440	0.8658210	0.5705780	6.5839E+01	1.6684E+01
$\alpha_2$	3.84E-02	8.11E-02	7.77E-02	1.35E-01	1.58E-01	6.6924E+00	7.5830E+01
$\alpha_3$	3.16E-02	7.13E-02	6.79E-02	1.23E-01	1.59E-01	5.8853E+00	7.6637E+01
$\alpha_4$	1.77E-02	4.98E-02	4.62E-02	9.41E-02	1.12E-01	4.1060E+00	7.8417E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8093550	0.8603590	0.8620920	0.9054540	0.5954810	1.1950E+02	1.9396E+01
$\alpha_2$	1.78E-02	4.12E-02	3.90E-02	7.21E-02	9.22E-02	5.7273E+00	1.3317E+02
$\alpha_3$	2.43E-02	5.08E-02	4.86E-02	8.46E-02	1.55E-01	7.0548E+00	1.3184E+02
$\alpha_4$	1.29E-02	3.36E-02	3.14E-02	6.19E-02	1.09E-01	4.6661E+00	1.3423E+02
$\alpha_5$	2.43E-03	1.40E-02	1.18E-02	3.33E-02	4.78E-02	1.9473E+00	1.3695E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8327830	0.8771430	0.8786640	0.9163030	0.6350360	1.4478E+02	2.0279E+01
$\alpha_2$	5.97E-03	2.00E-02	1.81E-02	4.05E-02	2.42E-02	3.2997E+00	1.6176E+02
$\alpha_3$	2.19E-02	4.49E-02	4.31E-02	7.41E-02	1.43E-01	7.4077E+00	1.5765E+02
$\alpha_4$	1.43E-02	3.38E-02	3.19E-02	5.96E-02	1.14E-01	5.5783E+00	1.5948E+02
$\alpha_5$	4.92E-03	1.80E-02	1.61E-02	3.76E-02	6.27E-02	2.9722E+00	1.6209E+02
$\alpha_6$	3.36E-04	6.18E-03	4.34E-03	1.83E-02	2.14E-02	1.0207E+00	1.6404E+02

Strainers, Trash Racks, and Filters  
 Extreme Environmental Event CCF Distributions  
 CIRCULATING WATER TSA EXTREME ENVIRONMENTAL PLUG  
*ALPHA FACTOR and MGL PARAMETERS*

2010

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.5852780	0.5787480	0.5705780	0.5954810	0.6350360
$\alpha_2$	4.15E-01	1.80E-01	1.58E-01	9.22E-02	2.42E-02
$\alpha_3$		2.41E-01	1.59E-01	1.55E-01	1.43E-01
$\alpha_4$			1.12E-01	1.09E-01	1.14E-01
$\alpha_5$				4.78E-02	6.27E-02
$\alpha_6$					2.14E-02

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	5.85E-01	5.79E-01	5.71E-01	5.95E-01	6.35E-01
Beta	4.15E-01	4.21E-01	4.29E-01	4.05E-01	3.65E-01
Gamma		5.72E-01	6.32E-01	7.72E-01	9.34E-01
Delta			4.15E-01	5.04E-01	5.81E-01
Epsilon				3.04E-01	4.25E-01
Mu					2.54E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	9.28	13.92	18.56	23.20	27.84
$N_1$	4.7048	3.2143	1.1429	0.1429	0.0000
$N_2$	9.9095	5.3429	5.4643	3.6131	1.0605
$N_3$		7.1286	5.4810	6.0774	6.2659
$N_4$			3.8833	4.2917	4.9861
$N_5$				1.8750	2.7500
$N_6$					0.9375

Strainers, Trash Racks, and Filters  
 Extreme Environmental Event CCF Distributions  
 CIRCULATING WATER TSA NON ENVIRONMENTAL PLUG SPAR:CWS-PG  
**CIRCULATING WATER TSA NON ENVIRONMENTAL PLUG SPAR:CWS-PG**

2010

System : Circulating water system  
 Component : Strainer  
 Failure Mode : No flow/plugged  
 Component Group : Traveling Screen  
 Prox. Cause : State of other component  
 Design error or inadequacy  
 Manufacturing error or inadequacy  
 Construction/installation error or inadequacy  
 Setpoint drift  
 Ambient environmental stress  
 Inadequate procedure  
 Inadequate maintenance  
 Age/Wear  
 Accidental human action  
 Human action procedure  
 Other  
 Internal environment  
 Internal to component, piece-part  
 Unknown  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 8.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9069840	0.9767390	0.9904340	0.9999540	1.0000000	1.8246E+01	4.3452E-01
$\alpha_2$	4.27E-05	2.33E-02	9.56E-03	9.30E-02	0.00E+00	4.3452E-01	1.8246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9187120	0.9715210	0.9791840	0.9981180	1.0000000	3.7555E+01	1.1009E+00
$\alpha_2$	6.87E-04	2.16E-02	1.40E-02	6.82E-02	0.00E+00	8.3366E-01	3.7822E+01
$\alpha_3$	2.43E-07	6.91E-03	1.40E-03	3.28E-02	0.00E+00	2.6722E-01	3.8389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9207150	0.9668680	0.9722640	0.9945410	1.0000000	5.4136E+01	1.8551E+00
$\alpha_2$	1.82E-03	2.19E-02	1.65E-02	6.05E-02	0.00E+00	1.2281E+00	5.4763E+01
$\alpha_3$	8.14E-06	7.22E-03	2.68E-03	2.98E-02	0.00E+00	4.0431E-01	5.5587E+01
$\alpha_4$	1.72E-08	3.98E-03	5.45E-04	1.99E-02	0.00E+00	2.2267E-01	5.5768E+01

CIRCULATING WATER TSA NON ENVIRONMENTAL PLUG SPAR:CWS-PG  
 CCGG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9349600	0.9671470	0.9699980	0.9895730	1.0000000	1.0416E+02	3.5382E+00
$\alpha_2$	3.78E-03	1.96E-02	1.67E-02	4.54E-02	0.00E+00	2.1142E+00	1.0558E+02
$\alpha_3$	4.43E-04	9.08E-03	6.27E-03	2.73E-02	0.00E+00	9.7738E-01	1.0672E+02
$\alpha_4$	2.29E-06	3.48E-03	1.17E-03	1.48E-02	0.00E+00	3.7439E-01	1.0732E+02
$\alpha_5$	5.54E-21	6.71E-04	3.80E-07	3.89E-03	0.00E+00	7.2277E-02	1.0763E+02

CCGG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9376440	0.9668880	0.9692700	0.9879830	1.0000000	1.2494E+02	4.2787E+00
$\alpha_2$	3.56E-03	1.73E-02	1.49E-02	3.94E-02	0.00E+00	2.2392E+00	1.2698E+02
$\alpha_3$	6.22E-04	8.84E-03	6.46E-03	2.52E-02	0.00E+00	1.1418E+00	1.2808E+02
$\alpha_4$	4.10E-05	4.58E-03	2.40E-03	1.65E-02	0.00E+00	5.9222E-01	1.2863E+02
$\alpha_5$	7.19E-09	1.72E-03	2.33E-04	8.62E-03	0.00E+00	2.2220E-01	1.2900E+02
$\alpha_6$	1.09E-18	6.44E-04	1.13E-06	3.76E-03	0.00E+00	8.3237E-02	1.2914E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCGG=2	CCGG=3	CCGG=4	CCGG=5	CCGG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCGG=2	CCGG=3	CCGG=4	CCGG=5	CCGG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCGG=2	CCGG=3	CCGG=4	CCGG=5	CCGG=6
Adj. Ind. Events	8.00	8.00	8.00	8.00	8.00
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

**SERVICE WATER STRAINER PLUG ENVIRONMENTAL SPAR:STR-EE-PG**  
**SERVICE WATER STRAINER PLUG ENVIRONMENTAL SPAR:STR-EE-PG**

**System :** Normally operating service water  
 Standby service water  
**Component :** Strainer  
**Failure Mode :** High dP across filter  
 No flow/plugged  
**Component Group :** Self-Cleaning filter/strainer  
**Prox. Cause :** Extreme environmental stress  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 21.50  
 Total Number of Common-Cause Failure Events: 4

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8630170	0.9448060	0.9547470	0.9925020	0.9363500	2.7409E+01	1.6012E+00
$\alpha_2$	7.50E-03	5.52E-02	4.53E-02	1.37E-01	6.36E-02	1.6012E+00	2.7409E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8683090	0.9306610	0.9356900	0.9758180	0.8913750	5.2805E+01	3.9342E+00
$\alpha_2$	1.80E-02	5.88E-02	5.36E-02	1.17E-01	9.58E-02	3.3337E+00	5.3406E+01
$\alpha_3$	1.01E-04	1.06E-02	5.64E-03	3.79E-02	1.28E-02	6.0052E-01	5.6139E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8801540	0.9312460	0.9347590	0.9703330	0.8881660	7.5917E+01	5.6050E+00
$\alpha_2$	1.49E-02	4.52E-02	4.15E-02	8.81E-02	7.33E-02	3.6864E+00	7.7836E+01
$\alpha_3$	2.09E-03	1.81E-02	1.43E-02	4.70E-02	3.19E-02	1.4737E+00	8.0048E+01
$\alpha_4$	1.12E-05	5.46E-03	2.24E-03	2.18E-02	6.63E-03	4.4487E-01	8.1077E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9113660	0.9458520	0.9479600	0.9731450	0.9003610	1.3297E+02	7.6123E+00
$\alpha_2$	9.57E-03	2.80E-02	2.58E-02	5.40E-02	4.45E-02	3.9348E+00	1.3665E+02
$\alpha_3$	3.89E-03	1.73E-02	1.51E-02	3.83E-02	3.56E-02	2.4311E+00	1.3815E+02
$\alpha_4$	4.02E-04	7.30E-03	5.13E-03	2.16E-02	1.59E-02	1.0260E+00	1.3956E+02
$\alpha_5$	5.90E-09	1.57E-03	2.08E-04	7.87E-03	3.62E-03	2.2038E-01	1.4036E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9187530	0.9491320	0.9508900	0.9734970	0.9099760	1.6080E+02	8.6179E+00
$\alpha_2$	7.04E-03	2.17E-02	1.98E-02	4.27E-02	2.98E-02	3.6747E+00	1.6574E+02
$\alpha_3$	3.62E-03	1.52E-02	1.33E-02	3.32E-02	2.97E-02	2.5753E+00	1.6684E+02
$\alpha_4$	1.11E-03	9.06E-03	7.21E-03	2.33E-02	1.96E-02	1.5346E+00	1.6788E+02
$\alpha_5$	5.10E-05	3.84E-03	2.15E-03	1.34E-02	8.90E-03	6.5130E-01	1.6877E+02
$\alpha_6$	2.72E-10	1.07E-03	8.58E-05	5.67E-03	2.05E-03	1.8204E-01	1.6924E+02



Strainers, Trash Racks, and Filters  
 Extreme Environmental Event CCF Distributions

2010

SERVICE WATER STRAINER PLUG ENVIRONMENTAL SPAR:STR-EE-PG

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9363500	0.8913750	0.8881660	0.9003610	0.9099760
$\alpha_2$	6.36E-02	9.58E-02	7.33E-02	4.45E-02	2.98E-02
$\alpha_3$		1.28E-02	3.19E-02	3.56E-02	2.97E-02
$\alpha_4$			6.63E-03	1.59E-02	1.96E-02
$\alpha_5$				3.62E-03	8.90E-03
$\alpha_6$					2.05E-03

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.36E-01	8.91E-01	8.88E-01	9.00E-01	9.10E-01
Beta	6.36E-02	1.09E-01	1.12E-01	9.96E-02	9.00E-02
Gamma		1.18E-01	3.44E-01	5.53E-01	6.69E-01
Delta			1.72E-01	3.55E-01	5.06E-01
Epsilon				1.85E-01	3.59E-01
Mu					1.87E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	14.33	21.50	28.67	35.83	43.00
$N_1$	2.8333	1.7500	1.1111	0.9838	0.8623
$N_2$	1.1667	2.5000	2.4583	1.8206	1.4355
$N_3$		0.3333	1.0694	1.4537	1.4335
$N_4$			0.2222	0.6516	0.9424
$N_5$				0.1481	0.4291
$N_6$					0.0988

Strainers, Trash Racks, and Filters  
 Extreme Environmental Event CCF Distributions  
 SERVICE WATER TSA PLUG ENVIRONMENTAL SPAR:TSA-EE-PG  
**SERVICE WATER TSA PLUG ENVIRONMENTAL SPAR:TSA-EE-PG**

2010

**System :** Circulating water system  
 Normally operating service water  
 Standby service water  
**Component :** Strainer  
**Failure Mode :** No flow/plugged  
**Component Group :** Traveling Screen  
**Prox. Cause :** Extreme environmental stress  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 25.00  
 Total Number of Common-Cause Failure Events: 17

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.5912630	0.7166530	0.7205040	0.8288590	0.6211870	2.7111E+01	1.0719E+01
$\alpha_2$	1.71E-01	2.83E-01	2.79E-01	4.09E-01	3.79E-01	1.0719E+01	2.7111E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.6911370	0.7799070	0.7827980	0.8587870	0.6144970	5.0530E+01	1.4260E+01
$\alpha_2$	4.87E-02	1.03E-01	9.85E-02	1.70E-01	1.70E-01	6.6453E+00	5.8145E+01
$\alpha_3$	5.96E-02	1.18E-01	1.14E-01	1.89E-01	2.15E-01	7.6145E+00	5.7175E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.7278580	0.8010860	0.8033680	0.8665220	0.6101540	7.0714E+01	1.7559E+01
$\alpha_2$	3.88E-02	8.01E-02	7.69E-02	1.32E-01	1.45E-01	7.0674E+00	8.1205E+01
$\alpha_3$	3.24E-02	7.09E-02	6.77E-02	1.20E-01	1.45E-01	6.2603E+00	8.2012E+01
$\alpha_4$	1.74E-02	4.79E-02	4.45E-02	9.01E-02	9.95E-02	4.2310E+00	8.4042E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8108090	0.8605090	0.8621610	0.9045780	0.6358340	1.2551E+02	2.0346E+01
$\alpha_2$	1.80E-02	4.08E-02	3.87E-02	7.08E-02	8.32E-02	5.9523E+00	1.3990E+02
$\alpha_3$	2.50E-02	5.09E-02	4.89E-02	8.39E-02	1.40E-01	7.4298E+00	1.3843E+02
$\alpha_4$	1.34E-02	3.39E-02	3.18E-02	6.15E-02	9.89E-02	4.9411E+00	1.4091E+02
$\alpha_5$	2.52E-03	1.39E-02	1.17E-02	3.26E-02	4.23E-02	2.0223E+00	1.4383E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8339720	0.8772210	0.8786710	0.9155100	0.6732390	1.5194E+02	2.1266E+01
$\alpha_2$	6.09E-03	1.98E-02	1.80E-02	3.97E-02	2.29E-02	3.4272E+00	1.6978E+02
$\alpha_3$	2.21E-02	4.44E-02	4.27E-02	7.27E-02	1.26E-01	7.6927E+00	1.6551E+02
$\alpha_4$	1.49E-02	3.41E-02	3.24E-02	5.94E-02	1.02E-01	5.9133E+00	1.6729E+02
$\alpha_5$	5.27E-03	1.83E-02	1.65E-02	3.75E-02	5.66E-02	3.1672E+00	1.7004E+02
$\alpha_6$	3.70E-04	6.15E-03	4.39E-03	1.80E-02	1.89E-02	1.0657E+00	1.7214E+02

Strainers, Trash Racks, and Filters  
 Extreme Environmental Event CCF Distributions  
 SERVICE WATER TSA PLUG ENVIRONMENTAL SPAR:TSA-EE-PG  
*ALPHA FACTOR and MGL PARAMETERS*

2010

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.6211870	0.6144970	0.6101540	0.6358340	0.6732390
$\alpha_2$	3.79E-01	1.70E-01	1.45E-01	8.32E-02	2.29E-02
$\alpha_3$		2.15E-01	1.45E-01	1.40E-01	1.26E-01
$\alpha_4$			9.95E-02	9.89E-02	1.02E-01
$\alpha_5$				4.23E-02	5.66E-02
$\alpha_6$					1.89E-02

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	6.21E-01	6.14E-01	6.10E-01	6.36E-01	6.73E-01
Beta	3.79E-01	3.86E-01	3.90E-01	3.64E-01	3.27E-01
Gamma		5.58E-01	6.28E-01	7.72E-01	9.30E-01
Delta			4.06E-01	5.02E-01	5.85E-01
Epsilon				2.99E-01	4.25E-01
Mu					2.50E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	11.66	17.48	23.31	29.14	34.97
$N_1$	5.2048	3.4955	1.2679	0.2054	0.0300
$N_2$	10.2845	5.8116	5.8393	3.8381	1.1880
$N_3$		7.3473	5.8560	6.4524	6.5509
$N_4$			4.0083	4.5667	5.3211
$N_5$				1.9500	2.9450
$N_6$					0.9825

## Heat Exchangers

### PWR HEAT EXCHANGER LOSS OF HEAT TRANSFER

### PWR RHR HEAT EXCHANGER PLUG/LOSS OF HEAT TRANSFER

System : Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
Component : Heat Exchanger  
Failure Mode : High dP across filter  
Loss of heat transfer capabilities in heat exchangers  
No flow/plugged  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 2.00  
Total Number of Common-Cause Failure Events: 0

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8636860	0.9657330	0.9856730	0.9999380	1.0000000	1.2246E+01	4.3452E-01
$\alpha_2$	6.41E-05	3.43E-02	1.43E-02	1.36E-01	0.00E+00	4.3452E-01	1.2246E+01

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9040420	0.9662880	0.9752810	0.9977560	1.0000000	3.1555E+01	1.1009E+00
$\alpha_2$	8.16E-04	2.55E-02	1.67E-02	8.05E-02	0.00E+00	8.3366E-01	3.1822E+01
$\alpha_3$	2.88E-07	8.18E-03	1.66E-03	3.88E-02	0.00E+00	2.6722E-01	3.2389E+01

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9113590	0.9628920	0.9688970	0.9938680	1.0000000	4.8136E+01	1.8551E+00
$\alpha_2$	2.04E-03	2.46E-02	1.86E-02	6.77E-02	0.00E+00	1.2281E+00	4.8763E+01
$\alpha_3$	9.14E-06	8.09E-03	3.01E-03	3.34E-02	0.00E+00	4.0431E-01	4.9587E+01
$\alpha_4$	1.93E-08	4.45E-03	6.12E-04	2.23E-02	0.00E+00	2.2267E-01	4.9768E+01

#### ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

## PWR HEAT EXCHANGER LOSS OF HEAT TRANSFER

## PWR RHR HEAT EXCHANGER PLUG/LOSS OF HEAT TRANSFER

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4
Adj. Ind. Events	2.00	2.00	2.00
N <sub>1</sub>	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000
N <sub>4</sub>			0.0000

Pooled Heat Exchanger Plugged or Failure to Transfer Heat

HEAT EXCHANGER PLUGGED ALL SYSTEMS NON ENVIRO SPAR:HTX-PG

**Pooled Heat Exchanger Plugged or Failure to Transfer Heat****HEAT EXCHANGER PLUGGED ALL SYSTEMS NON ENVIRO SPAR:HTX-PG**

**Component :** Heat Exchanger  
**Failure Mode :** Loss of heat transfer capabilities in heat exchangers  
**Prox. Cause :** State of other component  
 Design error or inadequacy  
 Manufacturing error or inadequacy  
 Construction/installation error or inadequacy  
 Setpoint drift  
 Ambient environmental stress  
 Inadequate procedure  
 Inadequate maintenance  
 Age/Wear  
 Accidental human action  
 Human action procedure  
 Other  
 Internal environment  
 Internal to component, piece-part  
 Unknown

**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 19.60

Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8999170	0.9748730	0.9895490	0.9999470	0.9994530	1.7002E+01	4.3822E-01
$\alpha_2$	4.87E-05	2.51E-02	1.04E-02	1.00E-01	5.47E-04	4.3822E-01	1.7002E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9224360	0.9727520	0.9800330	0.9981620	0.9989450	3.9683E+01	1.1116E+00
$\alpha_2$	6.84E-04	2.07E-02	1.35E-02	6.52E-02	1.05E-03	8.4426E-01	3.9950E+01
$\alpha_3$	2.31E-07	6.55E-03	1.32E-03	3.11E-02	9.86E-06	2.6732E-01	4.0527E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9271730	0.9694980	0.9744410	0.9949080	0.9984460	5.9630E+01	1.8761E+00
$\alpha_2$	1.74E-03	2.03E-02	1.54E-02	5.57E-02	1.52E-03	1.2486E+00	6.0257E+01
$\alpha_3$	7.48E-06	6.58E-03	2.45E-03	2.72E-02	3.70E-05	4.0481E-01	6.1101E+01
$\alpha_4$	1.56E-08	3.62E-03	4.96E-04	1.81E-02	0.00E+00	2.2267E-01	6.1283E+01

Pooled Heat Exchanger Plugged or Failure to Transfer Heat

HEAT EXCHANGER PLUGGED ALL SYSTEMS NON ENVIRO SPAR:HTX-PG

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9994530	0.9989450	0.9984460
$\alpha_2$	5.47E-04	1.05E-03	1.52E-03
$\alpha_3$		9.86E-06	3.70E-05
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.99E-01	9.99E-01	9.98E-01
Beta	5.47E-04	1.06E-03	1.55E-03
Gamma		9.35E-03	2.38E-02
Delta			0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4
Adj. Ind. Events	6.53	9.80	13.07
$N_1$	0.2260	0.3284	0.4242
$N_2$	0.0037	0.0106	0.0205
$N_3$		0.0001	0.0005
$N_4$			0.0000

Heat Exchangers  
 Containment Spray Heat Exchanger  
 CONTAINMENT SPRAY HTX LOSS OF HEAT TRANSFER

2010

**Containment Spray Heat Exchanger**

**CONTAINMENT SPRAY HTX LOSS OF HEAT TRANSFER**

**System :** Containment spray recirculation  
**Component :** Heat Exchanger  
**Failure Mode :** Fail to Operate (General operation failure, rate based)  
 Loss of heat transfer capabilities in heat exchangers  
 No flow/plugged  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 2.50  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8687700	0.9670330	0.9862440	0.9999400	1.0000000	1.2746E+01	4.3452E-01
$\alpha_2$	6.16E-05	3.30E-02	1.38E-02	1.31E-01	0.00E+00	4.3452E-01	1.2746E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2
$\alpha_1$	1.0000000
$\alpha_2$	0.00E+00

MGL Parameter	CCCG=2
1-Beta	1.00E+00
Beta	0.00E+00

Avg. Impact Vector	CCCG=2
Adj. Ind. Events	2.50
$N_1$	0.0000
$N_2$	0.0000



**BWR Residual Heat Removal Heat Exchanger**

**BWR RHR HEAT EXCHANGER LOSS OF HEAT TRANSFER CAPABILITIES**

**System :** Residual Heat Removal (LCI in BWRs, LPI in PWRs)  
**Component :** Heat Exchanger  
**Failure Mode :** High dP across filter  
 Loss of heat transfer capabilities in heat exchangers  
 No flow/plugged  
**Plant Type :** BWR  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 2.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8636860	0.9657330	0.9856730	0.9999380	1.0000000	1.2246E+01	4.3452E-01
$\alpha_2$	6.41E-05	3.43E-02	1.43E-02	1.36E-01	0.00E+00	4.3452E-01	1.2246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9040420	0.9662880	0.9752810	0.9977560	1.0000000	3.1555E+01	1.1009E+00
$\alpha_2$	8.16E-04	2.55E-02	1.67E-02	8.05E-02	0.00E+00	8.3366E-01	3.1822E+01
$\alpha_3$	2.88E-07	8.18E-03	1.66E-03	3.88E-02	0.00E+00	2.6722E-01	3.2389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9113590	0.9628920	0.9688970	0.9938680	1.0000000	4.8136E+01	1.8551E+00
$\alpha_2$	2.04E-03	2.46E-02	1.86E-02	6.77E-02	0.00E+00	1.2281E+00	4.8763E+01
$\alpha_3$	9.14E-06	8.09E-03	3.01E-03	3.34E-02	0.00E+00	4.0431E-01	4.9587E+01
$\alpha_4$	1.93E-08	4.45E-03	6.12E-04	2.23E-02	0.00E+00	2.2267E-01	4.9768E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

## BWR Residual Heat Removal Heat Exchanger

## BWR RHR HEAT EXCHANGER LOSS OF HEAT TRANSFER CAPABILITIES

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	2.00	2.00	2.00
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

Heat Exchangers  
 BWR Isolation Condenser Heat Exchanger  
 ISO CONDENSER HEAT EXCHANGER PLUG/LOSS OF HEAT TRANSFER

2010

**BWR Isolation Condenser Heat Exchanger**

**ISO CONDENSER HEAT EXCHANGER PLUG/LOSS OF HEAT TRANSFER**

System : Isolation condenser  
 Component : Heat Exchanger  
 Failure Mode : High dP across filter  
 Loss of heat transfer capabilities in heat exchangers  
 No flow/plugged  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 0.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8386830	0.9593170	0.9828300	0.9999250	0.0000000	1.0246E+01	4.3452E-01
$\alpha_2$	7.70E-05	4.07E-02	1.72E-02	1.61E-01	0.00E+00	4.3452E-01	1.0246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8979020	0.9640890	0.9736330	0.9976040	0.0000000	2.9555E+01	1.1009E+00
$\alpha_2$	8.71E-04	2.72E-02	1.78E-02	8.57E-02	0.00E+00	8.3366E-01	2.9822E+01
$\alpha_3$	3.08E-07	8.72E-03	1.77E-03	4.13E-02	0.00E+00	2.6722E-01	3.0389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9077330	0.9613450	0.9675780	0.9936050	0.0000000	4.6136E+01	1.8551E+00
$\alpha_2$	2.13E-03	2.56E-02	1.93E-02	7.04E-02	0.00E+00	1.2281E+00	4.6763E+01
$\alpha_3$	9.52E-06	8.42E-03	3.13E-03	3.48E-02	0.00E+00	4.0431E-01	4.7587E+01
$\alpha_4$	2.01E-08	4.64E-03	6.37E-04	2.32E-02	0.00E+00	2.2267E-01	4.7768E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.0000000	0.0000000	0.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	0.00E+00	0.00E+00	0.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

## BWR Isolation Condenser Heat Exchanger

## ISO CONDENSER HEAT EXCHANGER PLUG/LOSS OF HEAT TRANSFER

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4
Adj. Ind. Events	0.00	0.00	0.00
N <sub>1</sub>	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000
N <sub>4</sub>			0.0000

**Component Cooling Heat Exchanger**

**CCW HEAT EXCHANGER LOSS OF HEAT TRANSFER SPAR: CCW-HTX-PG**

**System :** Component cooling water  
**Component :** Heat Exchanger  
**Failure Mode :** Fail to Operate (General operation failure, rate based)  
 Loss of heat transfer capabilities in heat exchangers  
 No flow/plugged  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 20.60  
 Total Number of Common-Cause Failure Events: 2

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8930490	0.9697340	0.9834560	0.9996960	0.9816940	1.9379E+01	6.0482E-01
$\alpha_2$	3.07E-04	3.03E-02	1.65E-02	1.07E-01	1.83E-02	6.0482E-01	1.9379E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9091620	0.9636650	0.9704010	0.9950860	0.9627200	4.2743E+01	1.6116E+00
$\alpha_2$	3.01E-03	3.03E-02	2.36E-02	8.07E-02	3.73E-02	1.3443E+00	4.3010E+01
$\alpha_3$	2.12E-07	6.03E-03	1.22E-03	2.86E-02	7.30E-06	2.6732E-01	4.4087E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9089030	0.9563680	0.9609160	0.9882680	0.9430410	6.3040E+01	2.8761E+00
$\alpha_2$	7.12E-03	3.41E-02	2.95E-02	7.69E-02	5.69E-02	2.2486E+00	6.3667E+01
$\alpha_3$	6.97E-06	6.14E-03	2.28E-03	2.54E-02	2.79E-05	4.0481E-01	6.5511E+01
$\alpha_4$	1.46E-08	3.38E-03	4.62E-04	1.69E-02	0.00E+00	2.2267E-01	6.5693E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9816940	0.9627200	0.9430410
$\alpha_2$	1.83E-02	3.73E-02	5.69E-02
$\alpha_3$		7.30E-06	2.79E-05
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.82E-01	9.63E-01	9.43E-01
Beta	1.83E-02	3.73E-02	5.70E-02
Gamma		1.96E-04	4.90E-04
Delta			0.00E+00

Heat Exchangers  
Component Cooling Heat Exchanger

2010

CCW HEAT EXCHANGER LOSS OF HEAT TRANSFER SPAR: CCW-HTX-PG

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4
Adj. Ind. Events	8.24	12.36	16.48
N <sub>1</sub>	0.8927	0.8284	0.4242
N <sub>2</sub>	0.1703	0.5106	1.0205
N <sub>3</sub>		0.0001	0.0005
N <sub>4</sub>			0.0000

## Safety and Relief Valves

### Pooled Safety Valves

#### SAFETY VALVES (DIRECT ACTING) FAIL TO OPEN ALL SYS

Component : Safety Valve (Single Acting)  
 Failure Mode : Fail to open on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 3.00  
 Total Number of Common-Cause Failure Events: 3

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8416100	0.9581450	0.9801360	0.9998350	0.9467440	1.1284E+01	4.9292E-01
$\alpha_2$	1.63E-04	4.19E-02	1.99E-02	1.58E-01	5.33E-02	4.9292E-01	1.1284E+01

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8939080	0.9608260	0.9699400	0.9965220	0.8964810	3.0948E+01	1.2618E+00
$\alpha_2$	1.57E-03	3.07E-02	2.16E-02	9.08E-02	9.90E-02	9.8746E-01	3.1222E+01
$\alpha_3$	3.93E-07	8.52E-03	1.81E-03	4.01E-02	4.57E-03	2.7432E-01	3.1935E+01

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9020960	0.9569720	0.9629390	0.9914180	0.8508220	4.7819E+01	2.1501E+00
$\alpha_2$	3.58E-03	2.99E-02	2.39E-02	7.69E-02	1.36E-01	1.4962E+00	4.8473E+01
$\alpha_3$	1.46E-05	8.62E-03	3.44E-03	3.48E-02	1.34E-02	4.3071E-01	4.9538E+01
$\alpha_4$	1.99E-08	4.47E-03	6.16E-04	2.24E-02	2.53E-04	2.2317E-01	4.9746E+01

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9252350	0.9609280	0.9639040	0.9864380	0.8096950	9.8074E+01	3.9878E+00
$\alpha_2$	5.70E-03	2.45E-02	2.15E-02	5.37E-02	1.64E-01	2.5006E+00	9.9561E+01
$\alpha_3$	5.77E-04	1.02E-02	7.20E-03	2.99E-02	2.56E-02	1.0378E+00	1.0102E+02
$\alpha_4$	2.56E-06	3.69E-03	1.26E-03	1.56E-02	1.14E-03	3.7709E-01	1.0168E+02
$\alpha_5$	5.85E-21	7.08E-04	4.01E-07	4.10E-03	0.00E+00	7.2277E-02	1.0199E+02

##### CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9282440	0.9605120	0.9629670	0.9843880	0.7732650	1.1904E+02	4.8939E+00
$\alpha_2$	5.60E-03	2.21E-02	1.96E-02	4.72E-02	1.83E-01	2.7363E+00	1.2120E+02
$\alpha_3$	8.61E-04	1.01E-02	7.61E-03	2.78E-02	4.05E-02	1.2517E+00	1.2268E+02
$\alpha_4$	4.60E-05	4.84E-03	2.56E-03	1.74E-02	3.02E-03	6.0042E-01	1.2333E+02
$\alpha_5$	7.50E-09	1.79E-03	2.43E-04	8.98E-03	0.00E+00	2.2220E-01	1.2371E+02
$\alpha_6$	1.14E-18	6.72E-04	1.18E-06	3.92E-03	0.00E+00	8.3237E-02	1.2385E+02

Pooled Safety Valves

SAFETY VALVES (DIRECT ACTING) FAIL TO OPEN ALL SYS

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9378850	0.9626420	0.9642250	0.9819880	0.7408230	1.8629E+02	7.2294E+00
$\alpha_2$	6.17E-03	1.90E-02	1.74E-02	3.74E-02	1.96E-01	3.6799E+00	1.8984E+02
$\alpha_3$	1.46E-03	9.32E-03	7.70E-03	2.28E-02	5.72E-02	1.8043E+00	1.9172E+02
$\alpha_4$	2.74E-04	5.21E-03	3.63E-03	1.55E-02	6.34E-03	1.0081E+00	1.9251E+02
$\alpha_5$	1.33E-05	2.70E-03	1.28E-03	1.02E-02	0.00E+00	5.2177E-01	1.9300E+02
$\alpha_6$	3.47E-10	9.63E-04	8.22E-05	5.05E-03	0.00E+00	1.8628E-01	1.9333E+02
$\alpha_7$	0.00E+00	1.50E-04	1.32E-13	5.66E-04	0.00E+00	2.9071E-02	1.9349E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9409490	0.9633480	0.9646850	0.9811730	0.7140320	2.2110E+02	8.4121E+00
$\alpha_2$	6.03E-03	1.75E-02	1.61E-02	3.36E-02	2.00E-01	4.0111E+00	2.2550E+02
$\alpha_3$	1.53E-03	8.65E-03	7.27E-03	2.05E-02	7.40E-02	1.9846E+00	2.2753E+02
$\alpha_4$	3.92E-04	5.16E-03	3.82E-03	1.45E-02	1.16E-02	1.1850E+00	2.2833E+02
$\alpha_5$	5.62E-05	3.09E-03	1.81E-03	1.04E-02	0.00E+00	7.0833E-01	2.2880E+02
$\alpha_6$	9.05E-07	1.60E-03	5.24E-04	6.84E-03	0.00E+00	3.6696E-01	2.2915E+02
$\alpha_7$	7.10E-14	5.36E-04	9.64E-06	3.05E-03	0.00E+00	1.2297E-01	2.2939E+02
$\alpha_8$	1.33E-42	1.44E-04	2.06E-12	6.10E-04	0.00E+00	3.3124E-02	2.2948E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9467440	0.8964810	0.8508220	0.8096950	0.7732650	0.7408230	0.7140320
$\alpha_2$	5.33E-02	9.90E-02	1.36E-01	1.64E-01	1.83E-01	1.96E-01	2.00E-01
$\alpha_3$		4.57E-03	1.34E-02	2.56E-02	4.05E-02	5.72E-02	7.40E-02
$\alpha_4$			2.53E-04	1.14E-03	3.02E-03	6.34E-03	1.16E-02
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.47E-01	8.96E-01	8.51E-01	8.10E-01	7.73E-01	7.41E-01	7.14E-01
Beta	5.33E-02	1.04E-01	1.49E-01	1.90E-01	2.27E-01	2.59E-01	2.86E-01
Gamma		4.41E-02	9.12E-02	1.40E-01	1.92E-01	2.45E-01	2.99E-01
Delta			1.86E-02	4.28E-02	6.94E-02	9.98E-02	1.35E-01
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00



Pooled Safety Valves

**SAFETY VALVES (DIRECT ACTING) FAIL TO OPEN ALL SYS**

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>	<b>CCCG=5</b>	<b>CCCG=6</b>	<b>CCCG=7</b>	<b>CCCG=8</b>
<b>Adj. Ind. Events</b>	0.38	0.56	0.75	0.94	1.13	1.31	1.50
<b>N<sub>1</sub></b>	0.6582	0.8334	0.9325	0.9725	0.9681	0.9321	0.8748
<b>N<sub>2</sub></b>	0.0584	0.1538	0.2681	0.3864	0.4971	0.5921	0.6664
<b>N<sub>3</sub></b>		0.0071	0.0264	0.0604	0.1099	0.1731	0.2462
<b>N<sub>4</sub></b>			0.0005	0.0027	0.0082	0.0192	0.0385
<b>N<sub>5</sub></b>				0.0000	0.0000	0.0000	0.0000
<b>N<sub>6</sub></b>					0.0000	0.0000	0.0000
<b>N<sub>7</sub></b>						0.0000	0.0000
<b>N<sub>8</sub></b>							0.0000

Pooled Safety Valves

SAFETY VALVES (DIRECT ACTING) FAIL TO CLOSE ALL SYS

**SAFETY VALVES (DIRECT ACTING) FAIL TO CLOSE ALL SYS**

Component : Safety Valve (Single Acting)  
 Failure Mode : Fail to close (reseal) on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 7.00

Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8520040	0.9624790	0.9839450	0.9999230	0.9926000	1.1359E+01	4.4282E-01
$\alpha_2$	7.92E-05	3.75E-02	1.61E-02	1.48E-01	7.40E-03	4.4282E-01	1.1359E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9016600	0.9651600	0.9742450	0.9975600	0.9849400	3.1190E+01	1.1259E+00
$\alpha_2$	9.29E-04	2.66E-02	1.76E-02	8.29E-02	1.51E-02	8.5866E-01	3.1457E+01
$\alpha_3$	2.91E-07	8.27E-03	1.68E-03	3.92E-02	0.00E+00	2.6722E-01	3.2049E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9101260	0.9620430	0.9680200	0.9935000	0.9772730	4.8286E+01	1.9051E+00
$\alpha_2$	2.29E-03	2.55E-02	1.95E-02	6.92E-02	2.27E-02	1.2781E+00	4.8913E+01
$\alpha_3$	9.10E-06	8.06E-03	3.00E-03	3.33E-02	0.00E+00	4.0431E-01	4.9787E+01
$\alpha_4$	1.92E-08	4.44E-03	6.09E-04	2.22E-02	0.00E+00	2.2267E-01	4.9968E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9305070	0.9646440	0.9676270	0.9885670	0.9695050	9.8809E+01	3.6215E+00
$\alpha_2$	4.33E-03	2.15E-02	1.84E-02	4.90E-02	3.05E-02	2.1975E+00	1.0023E+02
$\alpha_3$	4.66E-04	9.54E-03	6.60E-03	2.87E-02	0.00E+00	9.7738E-01	1.0145E+02
$\alpha_4$	2.40E-06	3.66E-03	1.23E-03	1.55E-02	0.00E+00	3.7439E-01	1.0206E+02
$\alpha_5$	5.83E-21	7.06E-04	3.99E-07	4.09E-03	0.00E+00	7.2277E-02	1.0236E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9339130	0.9646220	0.9670870	0.9869070	0.9615980	1.2007E+02	4.4037E+00
$\alpha_2$	4.15E-03	1.90E-02	1.65E-02	4.24E-02	3.84E-02	2.3642E+00	1.2211E+02
$\alpha_3$	6.46E-04	9.17E-03	6.71E-03	2.61E-02	0.00E+00	1.1418E+00	1.2333E+02
$\alpha_4$	4.26E-05	4.76E-03	2.49E-03	1.72E-02	0.00E+00	5.9222E-01	1.2388E+02
$\alpha_5$	7.47E-09	1.79E-03	2.42E-04	8.94E-03	0.00E+00	2.2220E-01	1.2425E+02
$\alpha_6$	1.13E-18	6.69E-04	1.17E-06	3.90E-03	0.00E+00	8.3237E-02	1.2439E+02

Pooled Safety Valves

SAFETY VALVES (DIRECT ACTING) FAIL TO CLOSE ALL SYS

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9421820	0.9659200	0.9675070	0.9842320	0.9534570	1.8763E+02	6.6200E+00
$\alpha_2$	4.96E-03	1.68E-02	1.52E-02	3.42E-02	4.65E-02	3.2628E+00	1.9099E+02
$\alpha_3$	1.13E-03	8.40E-03	6.78E-03	2.12E-02	0.00E+00	1.6312E+00	1.9262E+02
$\alpha_4$	2.55E-04	5.09E-03	3.52E-03	1.53E-02	0.00E+00	9.8887E-01	1.9326E+02
$\alpha_5$	1.32E-05	2.69E-03	1.27E-03	1.02E-02	0.00E+00	5.2177E-01	1.9373E+02
$\alpha_6$	3.46E-10	9.59E-04	8.19E-05	5.03E-03	0.00E+00	1.8628E-01	1.9406E+02
$\alpha_7$	0.00E+00	1.50E-04	1.31E-13	5.63E-04	0.00E+00	2.9071E-02	1.9422E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9451620	0.9666130	0.9679560	0.9834840	0.9453190	2.2276E+02	7.6943E+00
$\alpha_2$	4.93E-03	1.55E-02	1.41E-02	3.08E-02	5.47E-02	3.5780E+00	2.2688E+02
$\alpha_3$	1.12E-03	7.54E-03	6.17E-03	1.87E-02	0.00E+00	1.7384E+00	2.2872E+02
$\alpha_4$	3.52E-04	4.97E-03	3.64E-03	1.42E-02	0.00E+00	1.1465E+00	2.2931E+02
$\alpha_5$	5.60E-05	3.07E-03	1.81E-03	1.04E-02	0.00E+00	7.0833E-01	2.2975E+02
$\alpha_6$	9.01E-07	1.59E-03	5.21E-04	6.81E-03	0.00E+00	3.6696E-01	2.3009E+02
$\alpha_7$	7.07E-14	5.34E-04	9.60E-06	3.04E-03	0.00E+00	1.2297E-01	2.3033E+02
$\alpha_8$	1.32E-42	1.44E-04	2.05E-12	6.07E-04	0.00E+00	3.3124E-02	2.3042E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9926000	0.9849400	0.9772730	0.9695050	0.9615980	0.9534570	0.9453190
$\alpha_2$	7.40E-03	1.51E-02	2.27E-02	3.05E-02	3.84E-02	4.65E-02	5.47E-02
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.93E-01	9.85E-01	9.77E-01	9.70E-01	9.62E-01	9.53E-01	9.45E-01
Beta	7.40E-03	1.51E-02	2.27E-02	3.05E-02	3.84E-02	4.65E-02	5.47E-02
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Pooled Safety Valves

SAFETY VALVES (DIRECT ACTING) FAIL TO CLOSE ALL SYS

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	0.88	1.31	1.75	2.19	2.63	3.06	3.50
N <sub>1</sub>	0.2333	0.3250	0.4000	0.4583	0.5000	0.5250	0.5333
N <sub>2</sub>	0.0083	0.0250	0.0500	0.0833	0.1250	0.1750	0.2333
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Safety and Relief Valves  
PWR Steam Generator Safety Valves  
PWR MAIN STEAM CODE SAFETIES FAIL TO OPEN

2010

**PWR Steam Generator Safety Valves**

**PWR MAIN STEAM CODE SAFETIES FAIL TO OPEN**

System : Main steam  
Component : Safety Valve (Single Acting)  
Failure Mode : Fail to open on demand  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 1.00  
Total Number of Common-Cause Failure Events: 3

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8382550	0.9572370	0.9796800	0.9998310	0.9310180	1.1034E+01	4.9292E-01
$\alpha_2$	1.67E-04	4.28E-02	2.03E-02	1.62E-01	6.90E-02	4.9292E-01	1.1034E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8927010	0.9603710	0.9695830	0.9964800	0.8641390	3.0578E+01	1.2618E+00
$\alpha_2$	1.59E-03	3.10E-02	2.18E-02	9.18E-02	1.30E-01	9.8746E-01	3.0852E+01
$\alpha_3$	3.97E-07	8.62E-03	1.83E-03	4.05E-02	6.00E-03	2.7432E-01	3.1565E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9011290	0.9565370	0.9625600	0.9913290	0.8003380	4.7319E+01	2.1501E+00
$\alpha_2$	3.62E-03	3.02E-02	2.42E-02	7.77E-02	1.81E-01	1.4962E+00	4.7973E+01
$\alpha_3$	1.48E-05	8.71E-03	3.47E-03	3.51E-02	1.79E-02	4.3071E-01	4.9038E+01
$\alpha_4$	2.01E-08	4.51E-03	6.23E-04	2.26E-02	3.38E-04	2.2317E-01	4.9246E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9310180	0.8641390	0.8003380
$\alpha_2$	6.90E-02	1.30E-01	1.81E-01
$\alpha_3$		6.00E-03	1.79E-02
$\alpha_4$			3.38E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.31E-01	8.64E-01	8.00E-01
Beta	6.90E-02	1.36E-01	2.00E-01
Gamma		4.41E-02	9.12E-02
Delta			1.86E-02

PWR Steam Generator Safety Valves

PWR MAIN STEAM CODE SAFETIES FAIL TO OPEN

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	0.13	0.19	0.25
<b>N<sub>1</sub></b>	0.6582	0.8334	0.9325
<b>N<sub>2</sub></b>	0.0584	0.1538	0.2681
<b>N<sub>3</sub></b>		0.0071	0.0264
<b>N<sub>4</sub></b>			0.0005

Safety and Relief Valves  
PWR Steam Generator Safety Valves  
PWR MAIN STEAM CODE SAFETIES FAIL TO CLOSE  
**PWR MAIN STEAM CODE SAFETIES FAIL TO CLOSE**

2010

System : Main steam  
Component : Safety Valve (Single Acting)  
Failure Mode : Fail to close (reseal) on demand  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 6.00  
Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8503880	0.9620610	0.9837560	0.9999220	0.9916300	1.1229E+01	4.4282E-01
$\alpha_2$	8.01E-05	3.79E-02	1.62E-02	1.50E-01	8.37E-03	4.4282E-01	1.1229E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9011190	0.9649650	0.9740980	0.9975450	0.9831080	3.1010E+01	1.1259E+00
$\alpha_2$	9.34E-04	2.67E-02	1.77E-02	8.33E-02	1.69E-02	8.5866E-01	3.1277E+01
$\alpha_3$	2.93E-07	8.32E-03	1.69E-03	3.94E-02	0.00E+00	2.6722E-01	3.1869E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9096840	0.9618530	0.9678530	0.9934660	0.9743590	4.8036E+01	1.9051E+00
$\alpha_2$	2.30E-03	2.56E-02	1.96E-02	6.95E-02	2.56E-02	1.2781E+00	4.8663E+01
$\alpha_3$	9.14E-06	8.10E-03	3.01E-03	3.34E-02	0.00E+00	4.0431E-01	4.9537E+01
$\alpha_4$	1.93E-08	4.46E-03	6.12E-04	2.23E-02	0.00E+00	2.2267E-01	4.9718E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9302990	0.9645370	0.9675290	0.9885310	0.9656010	9.8499E+01	3.6215E+00
$\alpha_2$	4.34E-03	2.15E-02	1.85E-02	4.91E-02	3.44E-02	2.1975E+00	9.9923E+01
$\alpha_3$	4.68E-04	9.57E-03	6.62E-03	2.88E-02	0.00E+00	9.7738E-01	1.0114E+02
$\alpha_4$	2.41E-06	3.67E-03	1.24E-03	1.56E-02	0.00E+00	3.7439E-01	1.0175E+02
$\alpha_5$	5.85E-21	7.08E-04	4.00E-07	4.10E-03	0.00E+00	7.2277E-02	1.0205E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9337130	0.9645130	0.9669850	0.9868660	0.9565220	1.1969E+02	4.4037E+00
$\alpha_2$	4.16E-03	1.91E-02	1.65E-02	4.26E-02	4.35E-02	2.3642E+00	1.2173E+02
$\alpha_3$	6.48E-04	9.20E-03	6.73E-03	2.62E-02	0.00E+00	1.1418E+00	1.2295E+02
$\alpha_4$	4.27E-05	4.77E-03	2.50E-03	1.72E-02	0.00E+00	5.9222E-01	1.2350E+02
$\alpha_5$	7.49E-09	1.79E-03	2.43E-04	8.97E-03	0.00E+00	2.2220E-01	1.2387E+02
$\alpha_6$	1.14E-18	6.71E-04	1.17E-06	3.92E-03	0.00E+00	8.3237E-02	1.2401E+02

Safety and Relief Valves  
PWR Steam Generator Safety Valves  
PWR MAIN STEAM CODE SAFETIES FAIL TO CLOSE  
CCCG = 7

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Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9420580	0.9658460	0.9674360	0.9841980	0.9474470	1.8721E+02	6.6200E+00
$\alpha_2$	4.97E-03	1.68E-02	1.52E-02	3.43E-02	5.26E-02	3.2628E+00	1.9057E+02
$\alpha_3$	1.13E-03	8.42E-03	6.80E-03	2.12E-02	0.00E+00	1.6312E+00	1.9220E+02
$\alpha_4$	2.56E-04	5.10E-03	3.53E-03	1.53E-02	0.00E+00	9.8887E-01	1.9284E+02
$\alpha_5$	1.32E-05	2.69E-03	1.27E-03	1.02E-02	0.00E+00	5.2177E-01	1.9331E+02
$\alpha_6$	3.47E-10	9.61E-04	8.21E-05	5.04E-03	0.00E+00	1.8628E-01	1.9364E+02
$\alpha_7$	0.00E+00	1.50E-04	1.31E-13	5.65E-04	0.00E+00	2.9071E-02	1.9380E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9450440	0.9665400	0.9678870	0.9834470	0.9380610	2.2226E+02	7.6943E+00
$\alpha_2$	4.94E-03	1.56E-02	1.42E-02	3.09E-02	6.19E-02	3.5780E+00	2.2638E+02
$\alpha_3$	1.12E-03	7.56E-03	6.19E-03	1.87E-02	0.00E+00	1.7384E+00	2.2822E+02
$\alpha_4$	3.53E-04	4.99E-03	3.64E-03	1.42E-02	0.00E+00	1.1465E+00	2.2881E+02
$\alpha_5$	5.61E-05	3.08E-03	1.81E-03	1.04E-02	0.00E+00	7.0833E-01	2.2925E+02
$\alpha_6$	9.03E-07	1.60E-03	5.22E-04	6.83E-03	0.00E+00	3.6696E-01	2.2959E+02
$\alpha_7$	7.08E-14	5.35E-04	9.62E-06	3.04E-03	0.00E+00	1.2297E-01	2.2983E+02
$\alpha_8$	1.33E-42	1.44E-04	2.05E-12	6.09E-04	0.00E+00	3.3124E-02	2.2992E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9916300	0.9831080	0.9743590	0.9656010	0.9565220	0.9474470	0.9380610
$\alpha_2$	8.37E-03	1.69E-02	2.56E-02	3.44E-02	4.35E-02	5.26E-02	6.19E-02
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.92E-01	9.83E-01	9.74E-01	9.66E-01	9.57E-01	9.47E-01	9.38E-01
Beta	8.37E-03	1.69E-02	2.56E-02	3.44E-02	4.35E-02	5.26E-02	6.19E-02
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00



Safety and Relief Valves

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PWR Steam Generator Safety Valves

PWR MAIN STEAM CODE SAFETIES FAIL TO CLOSE

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	0.75	1.13	1.50	1.88	2.25	2.63	3.00
N <sub>1</sub>	0.2333	0.3250	0.4000	0.4583	0.5000	0.5250	0.5333
N <sub>2</sub>	0.0083	0.0250	0.0500	0.0833	0.1250	0.1750	0.2333
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

**BWR Safety Relief Valves**

**SAFETY RELIEF VALVE FAIL TO OPEN SPAR: SRV-CC**

Component : Safety Relief Valve (Dual Actuation)  
 Failure Mode : Fail to open on demand  
 Plant Type : BWR  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 21.00  
 Total Number of Common-Cause Failure Events: 5

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8791940	0.9662980	0.9820640	0.9997190	0.9777850	1.6593E+01	5.7872E-01
$\alpha_2$	2.83E-04	3.37E-02	1.79E-02	1.21E-01	2.22E-02	5.7872E-01	1.6593E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9040050	0.9623710	0.9697670	0.9953930	0.9568450	3.8670E+01	1.5120E+00
$\alpha_2$	2.59E-03	3.07E-02	2.33E-02	8.42E-02	4.20E-02	1.2341E+00	3.8948E+01
$\alpha_3$	3.62E-07	6.92E-03	1.50E-03	3.24E-02	1.12E-03	2.7792E-01	3.9904E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9066350	0.9563910	0.9613440	0.9891940	0.9372740	5.7794E+01	2.6353E+00
$\alpha_2$	5.78E-03	3.25E-02	2.75E-02	7.65E-02	5.93E-02	1.9663E+00	5.8463E+01
$\alpha_3$	1.55E-05	7.38E-03	3.04E-03	2.94E-02	3.35E-03	4.4601E-01	5.9983E+01
$\alpha_4$	1.62E-08	3.69E-03	5.07E-04	1.85E-02	2.41E-05	2.2297E-01	6.0206E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9251620	0.9592340	0.9618760	0.9842800	0.9247780	1.1028E+02	4.6868E+00
$\alpha_2$	7.75E-03	2.71E-02	2.44E-02	5.57E-02	6.58E-02	3.1182E+00	1.1185E+02
$\alpha_3$	6.59E-04	9.75E-03	7.09E-03	2.79E-02	9.37E-03	1.1204E+00	1.1385E+02
$\alpha_4$	2.21E-06	3.27E-03	1.11E-03	1.39E-02	9.82E-05	3.7589E-01	1.1459E+02
$\alpha_5$	5.19E-21	6.29E-04	3.55E-07	3.64E-03	0.00E+00	7.2277E-02	1.1489E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9271430	0.9581910	0.9603680	0.9817880	0.9143510	1.3341E+02	5.8212E+00
$\alpha_2$	7.84E-03	2.51E-02	2.28E-02	5.00E-02	6.95E-02	3.4903E+00	1.3574E+02
$\alpha_3$	1.10E-03	1.02E-02	7.98E-03	2.69E-02	1.55E-02	1.4216E+00	1.3781E+02
$\alpha_4$	4.22E-05	4.34E-03	2.30E-03	1.55E-02	6.44E-04	6.0382E-01	1.3863E+02
$\alpha_5$	6.67E-09	1.60E-03	2.16E-04	8.00E-03	0.00E+00	2.2220E-01	1.3901E+02
$\alpha_6$	1.01E-18	5.98E-04	1.05E-06	3.49E-03	0.00E+00	8.3237E-02	1.3915E+02

Safety and Relief Valves  
 BWR Safety Relief Valves  
 SAFETY RELIEF VALVE FAIL TO OPEN SPAR: SRV-CC  
 CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9360390	0.9602910	0.9617340	0.9796090	0.9061800	2.0279E+02	8.3856E+00
$\alpha_2$	8.06E-03	2.15E-02	2.00E-02	4.00E-02	7.02E-02	4.5393E+00	2.0664E+02
$\alpha_3$	1.87E-03	9.89E-03	8.39E-03	2.30E-02	2.21E-02	2.0887E+00	2.0909E+02
$\alpha_4$	2.61E-04	4.83E-03	3.38E-03	1.43E-02	1.47E-03	1.0193E+00	2.1016E+02
$\alpha_5$	1.23E-05	2.48E-03	1.17E-03	9.35E-03	5.80E-05	5.2297E-01	2.1065E+02
$\alpha_6$	3.18E-10	8.82E-04	7.53E-05	4.63E-03	0.00E+00	1.8628E-01	2.1099E+02
$\alpha_7$	0.00E+00	1.38E-04	1.20E-13	5.18E-04	0.00E+00	2.9071E-02	2.1115E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9387250	0.9607840	0.9620120	0.9786510	0.9003310	2.3972E+02	9.7847E+00
$\alpha_2$	7.77E-03	1.97E-02	1.85E-02	3.60E-02	6.78E-02	4.9258E+00	2.4458E+02
$\alpha_3$	2.16E-03	9.69E-03	8.42E-03	2.16E-02	2.91E-02	2.4180E+00	2.4709E+02
$\alpha_4$	3.80E-04	4.83E-03	3.59E-03	1.35E-02	2.51E-03	1.2051E+00	2.4830E+02
$\alpha_5$	5.31E-05	2.86E-03	1.68E-03	9.64E-03	1.80E-04	7.1253E-01	2.4879E+02
$\alpha_6$	8.36E-07	1.47E-03	4.82E-04	6.29E-03	8.58E-06	3.6716E-01	2.4914E+02
$\alpha_7$	6.53E-14	4.93E-04	8.86E-06	2.81E-03	0.00E+00	1.2297E-01	2.4938E+02
$\alpha_8$	1.22E-42	1.33E-04	1.89E-12	5.61E-04	0.00E+00	3.3124E-02	2.4947E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9777850	0.9568450	0.9372740	0.9247780	0.9143510	0.9061800	0.9003310
$\alpha_2$	2.22E-02	4.20E-02	5.93E-02	6.58E-02	6.95E-02	7.02E-02	6.78E-02
$\alpha_3$		1.12E-03	3.35E-03	9.37E-03	1.55E-02	2.21E-02	2.91E-02
$\alpha_4$			2.41E-05	9.82E-05	6.44E-04	1.47E-03	2.51E-03
$\alpha_5$				0.00E+00	0.00E+00	5.80E-05	1.80E-04
$\alpha_6$					0.00E+00	0.00E+00	8.58E-06
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.78E-01	9.57E-01	9.37E-01	9.25E-01	9.14E-01	9.06E-01	9.00E-01
Beta	2.22E-02	4.32E-02	6.27E-02	7.52E-02	8.56E-02	9.38E-02	9.97E-02
Gamma		2.60E-02	5.38E-02	1.26E-01	1.89E-01	2.52E-01	3.20E-01
Delta			7.14E-03	1.04E-02	3.98E-02	6.46E-02	8.48E-02
Epsilon				0.00E+00	0.00E+00	3.80E-02	6.98E-02
Mu					0.00E+00	0.00E+00	4.55E-02
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Safety and Relief Valves  
 BWR Safety Relief Valves

2010

SAFETY RELIEF VALVE FAIL TO OPEN SPAR: SRV-CC

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	4.67	7.00	9.33	11.67	14.00	16.33	18.67
N <sub>1</sub>	1.6770	2.1151	2.3281	2.4497	2.4670	2.4137	2.3205
N <sub>2</sub>	0.1442	0.4004	0.7382	1.0040	1.2511	1.4515	1.5811
N <sub>3</sub>		0.0107	0.0417	0.1430	0.2798	0.4575	0.6796
N <sub>4</sub>			0.0003	0.0015	0.0116	0.0304	0.0586
N <sub>5</sub>				0.0000	0.0000	0.0012	0.0042
N <sub>6</sub>					0.0000	0.0000	0.0002
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Safety and Relief Valves  
 BWR Safety Relief Valves  
 SAFETY RELIEF VALVE FAIL TO CLOSE SPAR: SRV-OO  
**SAFETY RELIEF VALVE FAIL TO CLOSE SPAR: SRV-OO**

2010

Component : Safety Relief Valve (Dual Actuation)  
 Failure Mode : Fail to close (reset) on demand  
 Plant Type : BWR  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 6.00  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8959650	0.9739500	0.9892430	0.9999480	1.0000000	1.6246E+01	4.3452E-01
$\alpha_2$	4.81E-05	2.60E-02	1.08E-02	1.04E-01	0.00E+00	4.3452E-01	1.6246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9143470	0.9699670	0.9780280	0.9980130	1.0000000	3.5555E+01	1.1009E+00
$\alpha_2$	7.25E-04	2.27E-02	1.48E-02	7.18E-02	0.00E+00	8.3366E-01	3.5822E+01
$\alpha_3$	2.56E-07	7.29E-03	1.48E-03	3.46E-02	0.00E+00	2.6722E-01	3.6389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9178250	0.9665410	0.9712250	0.9943340	1.0000000	5.2136E+01	1.8551E+00
$\alpha_2$	1.89E-03	2.27E-02	1.72E-02	6.27E-02	0.00E+00	1.2281E+00	5.2763E+01
$\alpha_3$	8.45E-06	7.49E-03	2.78E-03	3.09E-02	0.00E+00	4.0431E-01	5.3587E+01
$\alpha_4$	1.78E-08	4.12E-03	5.66E-04	2.07E-02	0.00E+00	2.2267E-01	5.3768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9337450	0.9665250	0.9694270	0.9893730	1.0000000	1.0216E+02	3.5382E+00
$\alpha_2$	3.85E-03	2.00E-02	1.71E-02	4.62E-02	0.00E+00	2.1142E+00	1.0358E+02
$\alpha_3$	4.52E-04	9.25E-03	6.39E-03	2.78E-02	0.00E+00	9.7738E-01	1.0472E+02
$\alpha_4$	2.33E-06	3.54E-03	1.19E-03	1.50E-02	0.00E+00	3.7439E-01	1.0532E+02
$\alpha_5$	5.65E-21	6.84E-04	3.87E-07	3.96E-03	0.00E+00	7.2277E-02	1.0563E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9366750	0.9663680	0.9687880	0.9877920	1.0000000	1.2294E+02	4.2787E+00
$\alpha_2$	3.62E-03	1.76E-02	1.51E-02	4.00E-02	0.00E+00	2.2392E+00	1.2498E+02
$\alpha_3$	6.32E-04	8.98E-03	6.57E-03	2.55E-02	0.00E+00	1.1418E+00	1.2608E+02
$\alpha_4$	4.16E-05	4.66E-03	2.44E-03	1.68E-02	0.00E+00	5.9222E-01	1.2663E+02
$\alpha_5$	7.30E-09	1.75E-03	2.37E-04	8.75E-03	0.00E+00	2.2220E-01	1.2700E+02
$\alpha_6$	1.11E-18	6.54E-04	1.14E-06	3.82E-03	0.00E+00	8.3237E-02	1.2714E+02

Safety and Relief Valves  
 BWR Safety Relief Valves  
 SAFETY RELIEF VALVE FAIL TO CLOSE SPAR: SRV-OO  
 CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9439980	0.9672000	0.9687770	0.9850250	1.0000000	1.9005E+02	6.4450E+00
$\alpha_2$	4.43E-03	1.57E-02	1.41E-02	3.25E-02	0.00E+00	3.0878E+00	1.9341E+02
$\alpha_3$	1.12E-03	8.30E-03	6.70E-03	2.10E-02	0.00E+00	1.6312E+00	1.9486E+02
$\alpha_4$	2.52E-04	5.03E-03	3.48E-03	1.51E-02	0.00E+00	9.8887E-01	1.9551E+02
$\alpha_5$	1.31E-05	2.66E-03	1.26E-03	1.00E-02	0.00E+00	5.2177E-01	1.9597E+02
$\alpha_6$	3.42E-10	9.48E-04	8.09E-05	4.98E-03	0.00E+00	1.8628E-01	1.9631E+02
$\alpha_7$	0.00E+00	1.48E-04	1.30E-13	5.57E-04	0.00E+00	2.9071E-02	1.9647E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9468590	0.9678670	0.9692050	0.9843190	1.0000000	2.2473E+02	7.4610E+00
$\alpha_2$	4.33E-03	1.44E-02	1.30E-02	2.92E-02	0.00E+00	3.3447E+00	2.2885E+02
$\alpha_3$	1.11E-03	7.49E-03	6.13E-03	1.85E-02	0.00E+00	1.7384E+00	2.3045E+02
$\alpha_4$	3.50E-04	4.94E-03	3.61E-03	1.41E-02	0.00E+00	1.1465E+00	2.3104E+02
$\alpha_5$	5.55E-05	3.05E-03	1.79E-03	1.03E-02	0.00E+00	7.0833E-01	2.3148E+02
$\alpha_6$	8.95E-07	1.58E-03	5.17E-04	6.76E-03	0.00E+00	3.6696E-01	2.3182E+02
$\alpha_7$	7.01E-14	5.30E-04	9.53E-06	3.02E-03	0.00E+00	1.2297E-01	2.3207E+02
$\alpha_8$	1.31E-42	1.43E-04	2.03E-12	6.03E-04	0.00E+00	3.3124E-02	2.3216E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Safety and Relief Valves  
 BWR Safety Relief Valves

2010

SAFETY RELIEF VALVE FAIL TO CLOSE SPAR: SRV-OO

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	6.00	6.00	6.00	6.00	6.00	6.00	6.00
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Safety and Relief Valves  
PWR Pressurizer Safety Valve  
PWR PRESSURIZER CODE SAFETIES FAIL TO OPEN

2010

**PWR Pressurizer Safety Valve**

**PWR PRESSURIZER CODE SAFETIES FAIL TO OPEN**

System : Reactor coolant  
Component : Safety Valve (Single Acting)  
Failure Mode : Fail to open on demand  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 2.00  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8636860	0.9657330	0.9856730	0.9999380	1.0000000	1.2246E+01	4.3452E-01
$\alpha_2$	6.41E-05	3.43E-02	1.43E-02	1.36E-01	0.00E+00	4.3452E-01	1.2246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9040420	0.9662880	0.9752810	0.9977560	1.0000000	3.1555E+01	1.1009E+00
$\alpha_2$	8.16E-04	2.55E-02	1.67E-02	8.05E-02	0.00E+00	8.3366E-01	3.1822E+01
$\alpha_3$	2.88E-07	8.18E-03	1.66E-03	3.88E-02	0.00E+00	2.6722E-01	3.2389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9113590	0.9628920	0.9688970	0.9938680	1.0000000	4.8136E+01	1.8551E+00
$\alpha_2$	2.04E-03	2.46E-02	1.86E-02	6.77E-02	0.00E+00	1.2281E+00	4.8763E+01
$\alpha_3$	9.14E-06	8.09E-03	3.01E-03	3.34E-02	0.00E+00	4.0431E-01	4.9587E+01
$\alpha_4$	1.93E-08	4.45E-03	6.12E-04	2.23E-02	0.00E+00	2.2267E-01	4.9768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9311740	0.9652090	0.9682200	0.9889480	1.0000000	9.8161E+01	3.5382E+00
$\alpha_2$	4.01E-03	2.08E-02	1.77E-02	4.80E-02	0.00E+00	2.1142E+00	9.9585E+01
$\alpha_3$	4.70E-04	9.61E-03	6.64E-03	2.89E-02	0.00E+00	9.7738E-01	1.0072E+02
$\alpha_4$	2.42E-06	3.68E-03	1.24E-03	1.56E-02	0.00E+00	3.7439E-01	1.0132E+02
$\alpha_5$	5.87E-21	7.11E-04	4.02E-07	4.12E-03	0.00E+00	7.2277E-02	1.0163E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9346440	0.9652760	0.9677640	0.9873890	1.0000000	1.1894E+02	4.2787E+00
$\alpha_2$	3.74E-03	1.82E-02	1.56E-02	4.13E-02	0.00E+00	2.2392E+00	1.2098E+02
$\alpha_3$	6.53E-04	9.27E-03	6.78E-03	2.64E-02	0.00E+00	1.1418E+00	1.2208E+02
$\alpha_4$	4.30E-05	4.81E-03	2.52E-03	1.73E-02	0.00E+00	5.9222E-01	1.2263E+02
$\alpha_5$	7.54E-09	1.80E-03	2.45E-04	9.04E-03	0.00E+00	2.2220E-01	1.2300E+02
$\alpha_6$	1.14E-18	6.76E-04	1.18E-06	3.94E-03	0.00E+00	8.3237E-02	1.2314E+02



Safety and Relief Valves  
PWR Pressurizer Safety Valve  
PWR PRESSURIZER CODE SAFETIES FAIL TO OPEN  
CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9428470	0.9665190	0.9681250	0.9847050	1.0000000	1.8605E+02	6.4450E+00
$\alpha_2$	4.52E-03	1.60E-02	1.44E-02	3.32E-02	0.00E+00	3.0878E+00	1.8941E+02
$\alpha_3$	1.14E-03	8.47E-03	6.84E-03	2.14E-02	0.00E+00	1.6312E+00	1.9086E+02
$\alpha_4$	2.57E-04	5.14E-03	3.56E-03	1.54E-02	0.00E+00	9.8887E-01	1.9151E+02
$\alpha_5$	1.33E-05	2.71E-03	1.28E-03	1.02E-02	0.00E+00	5.2177E-01	1.9197E+02
$\alpha_6$	3.49E-10	9.68E-04	8.26E-05	5.08E-03	0.00E+00	1.8628E-01	1.9231E+02
$\alpha_7$	0.00E+00	1.51E-04	1.32E-13	5.69E-04	0.00E+00	2.9071E-02	1.9247E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9459360	0.9673040	0.9686640	0.9840410	1.0000000	2.2073E+02	7.4610E+00
$\alpha_2$	4.41E-03	1.47E-02	1.33E-02	2.97E-02	0.00E+00	3.3447E+00	2.2485E+02
$\alpha_3$	1.13E-03	7.62E-03	6.24E-03	1.88E-02	0.00E+00	1.7384E+00	2.2645E+02
$\alpha_4$	3.56E-04	5.02E-03	3.67E-03	1.43E-02	0.00E+00	1.1465E+00	2.2704E+02
$\alpha_5$	5.65E-05	3.10E-03	1.82E-03	1.05E-02	0.00E+00	7.0833E-01	2.2748E+02
$\alpha_6$	9.10E-07	1.61E-03	5.27E-04	6.88E-03	0.00E+00	3.6696E-01	2.2782E+02
$\alpha_7$	7.14E-14	5.39E-04	9.69E-06	3.07E-03	0.00E+00	1.2297E-01	2.2807E+02
$\alpha_8$	1.34E-42	1.45E-04	2.07E-12	6.14E-04	0.00E+00	3.3124E-02	2.2816E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Safety and Relief Valves  
PWR Pressurizer Safety Valve

2010

PWR PRESSURIZER CODE SAFETIES FAIL TO OPEN

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	2.00	2.00	2.00	2.00	2.00	2.00	2.00
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Safety and Relief Valves  
PWR Pressurizer Safety Valve  
PWR PRESSURIZER CODE SAFETIES FAIL TO CLOSE  
**PWR PRESSURIZER CODE SAFETIES FAIL TO CLOSE**

2010

System : Reactor coolant  
Component : Safety Valve (Single Acting)  
Failure Mode : Fail to close (reseal) on demand  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 1.00  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8522320	0.9628000	0.9843830	0.9999320	1.0000000	1.1246E+01	4.3452E-01
$\alpha_2$	7.00E-05	3.72E-02	1.56E-02	1.48E-01	0.00E+00	4.3452E-01	1.1246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9010680	0.9652240	0.9744830	0.9976820	1.0000000	3.0555E+01	1.1009E+00
$\alpha_2$	8.43E-04	2.63E-02	1.72E-02	8.30E-02	0.00E+00	8.3366E-01	3.0822E+01
$\alpha_3$	2.98E-07	8.44E-03	1.71E-03	4.00E-02	0.00E+00	2.6722E-01	3.1389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9095820	0.9621340	0.9682530	0.9937390	1.0000000	4.7136E+01	1.8551E+00
$\alpha_2$	2.09E-03	2.51E-02	1.89E-02	6.90E-02	0.00E+00	1.2281E+00	4.7763E+01
$\alpha_3$	9.32E-06	8.25E-03	3.07E-03	3.41E-02	0.00E+00	4.0431E-01	4.8587E+01
$\alpha_4$	1.97E-08	4.55E-03	6.24E-04	2.28E-02	0.00E+00	2.2267E-01	4.8768E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

Safety and Relief Valves  
PWR Pressurizer Safety Valve

2010

PWR PRESSURIZER CODE SAFETIES FAIL TO CLOSE

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	1.00	1.00	1.00
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

# PORVs

## Pooled PORVs

### POWER OPERATED RELIEF VALVES FAIL TO OPEN ALL SYSTEMS

Component : Power Operated Relief Valve  
Failure Mode : Fail to open on demand  
Op. Mode : CCF Event Can Only Happen During Power Operation  
CCF Event May Occur During Both Power Operation & Shutdown  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 99.80  
Total Number of Common-Cause Failure Events: 8

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9312520	0.9745140	0.9804040	0.9976200	0.9785230	4.9849E+01	1.3037E+00
$\alpha_2$	2.38E-03	2.55E-02	1.96E-02	6.87E-02	2.15E-02	1.3037E+00	4.9849E+01

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9293350	0.9655040	0.9688890	0.9901000	0.9662310	8.7244E+01	3.1171E+00
$\alpha_2$	6.73E-03	2.83E-02	2.49E-02	6.15E-02	2.88E-02	2.5542E+00	8.7807E+01
$\alpha_3$	4.44E-05	6.23E-03	3.15E-03	2.29E-02	4.95E-03	5.6292E-01	8.9798E+01

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9369540	0.9666090	0.9690390	0.9879640	0.9698160	1.2256E+02	4.2338E+00
$\alpha_2$	4.40E-03	1.93E-02	1.69E-02	4.27E-02	1.55E-02	2.4533E+00	1.2434E+02
$\alpha_3$	1.12E-03	1.09E-02	8.45E-03	2.90E-02	1.24E-02	1.3814E+00	1.2541E+02
$\alpha_4$	3.23E-06	3.15E-03	1.14E-03	1.31E-02	2.24E-03	3.9907E-01	1.2639E+02

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9458650	0.9685690	0.9701370	0.9859100	0.9727030	1.9134E+02	6.2092E+00
$\alpha_2$	4.50E-03	1.58E-02	1.42E-02	3.26E-02	1.03E-02	3.1228E+00	1.9443E+02
$\alpha_3$	1.61E-03	9.61E-03	8.02E-03	2.31E-02	9.42E-03	1.8993E+00	1.9565E+02
$\alpha_4$	2.77E-04	5.15E-03	3.60E-03	1.53E-02	6.57E-03	1.0169E+00	1.9653E+02
$\alpha_5$	7.35E-11	8.61E-04	5.58E-05	4.62E-03	1.00E-03	1.7018E-01	1.9738E+02

Pooled PORVs

POWER OPERATED RELIEF VALVES FAIL TO OPEN ALL SYSTEMS

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9492920	0.9695440	0.9708490	0.9853270	0.9745680	2.3078E+02	7.2494E+00
$\alpha_2$	4.10E-03	1.38E-02	1.25E-02	2.81E-02	8.99E-03	3.2896E+00	2.3474E+02
$\alpha_3$	1.14E-03	7.46E-03	6.13E-03	1.83E-02	5.42E-03	1.7754E+00	2.3625E+02
$\alpha_4$	6.30E-04	5.93E-03	4.61E-03	1.57E-02	7.01E-03	1.4112E+00	2.3662E+02
$\alpha_5$	3.35E-05	2.69E-03	1.49E-03	9.45E-03	3.59E-03	6.4100E-01	2.3739E+02
$\alpha_6$	3.80E-13	5.56E-04	1.39E-05	3.13E-03	4.19E-04	1.3224E-01	2.3790E+02

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9531740	0.9701180	0.9710770	0.9837970	0.9756610	3.1649E+02	9.7488E+00
$\alpha_2$	4.83E-03	1.33E-02	1.23E-02	2.51E-02	9.23E-03	4.3403E+00	3.2190E+02
$\alpha_3$	1.14E-03	6.24E-03	5.26E-03	1.47E-02	2.97E-03	2.0350E+00	3.2420E+02
$\alpha_4$	7.09E-04	5.11E-03	4.14E-03	1.28E-02	4.99E-03	1.6660E+00	3.2457E+02
$\alpha_5$	2.96E-04	3.72E-03	2.77E-03	1.04E-02	5.09E-03	1.2128E+00	3.2503E+02
$\alpha_6$	2.77E-06	1.36E-03	5.55E-04	5.45E-03	1.90E-03	4.4458E-01	3.2579E+02
$\alpha_7$	1.86E-29	1.53E-04	1.75E-09	8.18E-04	1.55E-04	5.0071E-02	3.2619E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9553170	0.9707620	0.9715850	0.9834100	0.9762440	3.6966E+02	1.1134E+01
$\alpha_2$	5.00E-03	1.28E-02	1.20E-02	2.35E-02	9.90E-03	4.8748E+00	3.7592E+02
$\alpha_3$	9.91E-04	5.39E-03	4.55E-03	1.26E-02	2.02E-03	2.0512E+00	3.7874E+02
$\alpha_4$	5.25E-04	4.13E-03	3.30E-03	1.06E-02	2.76E-03	1.5731E+00	3.7922E+02
$\alpha_5$	3.95E-04	3.71E-03	2.89E-03	9.85E-03	4.56E-03	1.4135E+00	3.7938E+02
$\alpha_6$	9.79E-05	2.40E-03	1.61E-03	7.42E-03	3.54E-03	9.1486E-01	3.7988E+02
$\alpha_7$	2.31E-08	6.99E-04	1.38E-04	3.32E-03	9.26E-04	2.6607E-01	3.8053E+02
$\alpha_8$	5.73E-36	1.05E-04	4.80E-11	5.07E-04	4.53E-05	4.0124E-02	3.8075E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9785230	0.9662310	0.9698160	0.9727030	0.9745680	0.9756610	0.9762440
$\alpha_2$	2.15E-02	2.88E-02	1.55E-02	1.03E-02	8.99E-03	9.23E-03	9.90E-03
$\alpha_3$		4.95E-03	1.24E-02	9.42E-03	5.42E-03	2.97E-03	2.02E-03
$\alpha_4$			2.24E-03	6.57E-03	7.01E-03	4.99E-03	2.76E-03
$\alpha_5$				1.00E-03	3.59E-03	5.09E-03	4.56E-03
$\alpha_6$					4.19E-04	1.90E-03	3.54E-03
$\alpha_7$						1.55E-04	9.26E-04
$\alpha_8$							4.53E-05

Pooled PORVs

POWER OPERATED RELIEF VALVES FAIL TO OPEN ALL SYSTEMS

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.79E-01	9.66E-01	9.70E-01	9.73E-01	9.75E-01	9.76E-01	9.76E-01
Beta	2.15E-02	3.38E-02	3.02E-02	2.73E-02	2.54E-02	2.43E-02	2.38E-02
Gamma		1.47E-01	4.85E-01	6.22E-01	6.46E-01	6.21E-01	5.83E-01
Delta			1.53E-01	4.45E-01	6.70E-01	8.03E-01	8.54E-01
Epsilon				1.32E-01	3.64E-01	5.89E-01	7.67E-01
Mu					1.05E-01	2.88E-01	4.97E-01
Upsilon						7.52E-02	2.15E-01
Sigma							4.66E-02

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	36.29	54.44	72.58	90.73	108.87	127.02	145.16
N <sub>1</sub>	3.3129	3.2489	3.8484	4.4453	4.9747	5.4152	5.7670
N <sub>2</sub>	0.8692	1.7205	1.2252	1.0086	1.0504	1.2525	1.5301
N <sub>3</sub>		0.2957	0.9771	0.9219	0.6336	0.4038	0.3128
N <sub>4</sub>			0.1764	0.6425	0.8190	0.6771	0.4266
N <sub>5</sub>				0.0979	0.4188	0.6910	0.7052
N <sub>6</sub>					0.0490	0.2583	0.5479
N <sub>7</sub>						0.0210	0.1431
N <sub>8</sub>							0.0070

Pooled PORVs

POWER OPERATED RELIEF VALVES FAIL TO CLOSE ALL SYSTEMS

**POWER OPERATED RELIEF VALVES FAIL TO CLOSE ALL SYSTEMS**

**Component :** Power Operated Relief Valve  
**Failure Mode :** Fail to close (reseal) on demand  
**Op. Mode :** CCF Event Can Only Happen During Power Operation  
 CCF Event May Occur During Both Power Operation & Shutdown  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 31.10

Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9336460	0.9834320	0.9932310	0.9999660	0.9998910	2.5893E+01	4.3622E-01
$\alpha_2$	3.08E-05	1.66E-02	6.77E-03	6.64E-02	1.09E-04	4.3622E-01	2.5893E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9415350	0.9795700	0.9851170	0.9986480	0.9997870	5.3025E+01	1.1059E+00
$\alpha_2$	4.99E-04	1.55E-02	1.01E-02	4.90E-02	2.13E-04	8.3866E-01	5.3292E+01
$\alpha_3$	1.73E-07	4.94E-03	9.94E-04	2.34E-02	0.00E+00	2.6722E-01	5.3864E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9435460	0.9764750	0.9803590	0.9961230	0.9996800	7.7416E+01	1.8651E+00
$\alpha_2$	1.31E-03	1.56E-02	1.18E-02	4.31E-02	3.20E-04	1.2381E+00	7.8043E+01
$\alpha_3$	5.73E-06	5.10E-03	1.89E-03	2.11E-02	0.00E+00	4.0431E-01	7.8877E+01
$\alpha_4$	1.21E-08	2.81E-03	3.84E-04	1.41E-02	0.00E+00	2.2267E-01	7.9058E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9492370	0.9743960	0.9766440	0.9918800	0.9995910	1.3526E+02	3.5542E+00
$\alpha_2$	2.97E-03	1.53E-02	1.31E-02	3.54E-02	4.01E-04	2.1299E+00	1.3668E+02
$\alpha_3$	3.44E-04	7.04E-03	4.86E-03	2.12E-02	7.67E-06	9.7768E-01	1.3784E+02
$\alpha_4$	1.77E-06	2.70E-03	9.07E-04	1.15E-02	0.00E+00	3.7439E-01	1.3844E+02
$\alpha_5$	4.29E-21	5.21E-04	2.94E-07	3.01E-03	0.00E+00	7.2277E-02	1.3874E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9517600	0.9744150	0.9762770	0.9907130	0.9995060	1.6384E+02	4.3019E+00
$\alpha_2$	2.79E-03	1.35E-02	1.16E-02	3.05E-02	4.77E-04	2.2616E+00	1.6588E+02
$\alpha_3$	4.78E-04	6.80E-03	4.97E-03	1.94E-02	1.70E-05	1.1426E+00	1.6700E+02
$\alpha_4$	3.15E-05	3.52E-03	1.84E-03	1.27E-02	0.00E+00	5.9222E-01	1.6755E+02
$\alpha_5$	5.52E-09	1.32E-03	1.79E-04	6.62E-03	0.00E+00	2.2220E-01	1.6792E+02
$\alpha_6$	8.38E-19	4.95E-04	8.65E-07	2.89E-03	0.00E+00	8.3237E-02	1.6806E+02



Pooled PORVs

POWER OPERATED RELIEF VALVES FAIL TO CLOSE ALL SYSTEMS

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9548720	0.9735890	0.9748690	0.9879420	0.9994210	2.3875E+02	6.4767E+00
$\alpha_2$	3.61E-03	1.27E-02	1.14E-02	2.63E-02	5.50E-04	3.1179E+00	2.4211E+02
$\alpha_3$	8.98E-04	6.66E-03	5.37E-03	1.68E-02	2.92E-05	1.6328E+00	2.4359E+02
$\alpha_4$	2.02E-04	4.03E-03	2.79E-03	1.21E-02	0.00E+00	9.8887E-01	2.4424E+02
$\alpha_5$	1.05E-05	2.13E-03	1.01E-03	8.04E-03	0.00E+00	5.2177E-01	2.4470E+02
$\alpha_6$	2.74E-10	7.60E-04	6.48E-05	3.99E-03	0.00E+00	1.8628E-01	2.4504E+02
$\alpha_7$	0.00E+00	1.19E-04	1.04E-13	4.46E-04	0.00E+00	2.9071E-02	2.4520E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9570100	0.9740180	0.9751080	0.9873170	0.9993430	2.8124E+02	7.5021E+00
$\alpha_2$	3.55E-03	1.17E-02	1.06E-02	2.37E-02	6.15E-04	3.3832E+00	2.8536E+02
$\alpha_3$	8.93E-04	6.03E-03	4.93E-03	1.49E-02	4.00E-05	1.7409E+00	2.8700E+02
$\alpha_4$	2.81E-04	3.97E-03	2.90E-03	1.13E-02	1.60E-06	1.1466E+00	2.8760E+02
$\alpha_5$	4.46E-05	2.45E-03	1.44E-03	8.30E-03	0.00E+00	7.0833E-01	2.8803E+02
$\alpha_6$	7.19E-07	1.27E-03	4.16E-04	5.44E-03	0.00E+00	3.6696E-01	2.8838E+02
$\alpha_7$	5.64E-14	4.26E-04	7.66E-06	2.42E-03	0.00E+00	1.2297E-01	2.8862E+02
$\alpha_8$	1.06E-42	1.15E-04	1.63E-12	4.85E-04	0.00E+00	3.3124E-02	2.8871E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9998910	0.9997870	0.9996800	0.9995910	0.9995060	0.9994210	0.9993430
$\alpha_2$	1.09E-04	2.13E-04	3.20E-04	4.01E-04	4.77E-04	5.50E-04	6.15E-04
$\alpha_3$		0.00E+00	0.00E+00	7.67E-06	1.70E-05	2.92E-05	4.00E-05
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.60E-06
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	9.99E-01	9.99E-01
Beta	1.09E-04	2.13E-04	3.20E-04	4.09E-04	4.94E-04	5.79E-04	6.57E-04
Gamma		0.00E+00	0.00E+00	1.88E-02	3.45E-02	5.05E-02	6.33E-02
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.85E-02
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

PORVs

2010

Pooled PORVs

**POWER OPERATED RELIEF VALVES FAIL TO CLOSE ALL SYSTEMS**

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>	<b>CCCG=5</b>	<b>CCCG=6</b>	<b>CCCG=7</b>	<b>CCCG=8</b>
<b>Adj. Ind. Events</b>	15.55	23.33	31.10	38.88	46.65	54.42	62.20
<b>N<sub>1</sub></b>	0.0967	0.1400	0.1800	0.2175	0.2523	0.2845	0.3143
<b>N<sub>2</sub></b>	0.0017	0.0050	0.0100	0.0157	0.0224	0.0301	0.0385
<b>N<sub>3</sub></b>		0.0000	0.0000	0.0003	0.0008	0.0016	0.0025
<b>N<sub>4</sub></b>			0.0000	0.0000	0.0000	0.0000	0.0001
<b>N<sub>5</sub></b>				0.0000	0.0000	0.0000	0.0000
<b>N<sub>6</sub></b>					0.0000	0.0000	0.0000
<b>N<sub>7</sub></b>						0.0000	0.0000
<b>N<sub>8</sub></b>							0.0000

**PWR Steam Generator PORV**

**PWR MAIN STEAM PORV FAIL TO OPEN SPAR: ADV-CC**

System : Main steam  
Component : Power Operated Relief Valve  
Failure Mode : Fail to open on demand  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 78.70  
Total Number of Common-Cause Failure Events: 6

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9089810	0.9662920	0.9740850	0.9969210	0.9690100	3.6799E+01	1.2837E+00
$\alpha_2$	3.08E-03	3.37E-02	2.59E-02	9.10E-02	3.10E-02	1.2837E+00	3.6799E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9112620	0.9567510	0.9609950	0.9877200	0.9511450	6.7718E+01	3.0611E+00
$\alpha_2$	8.26E-03	3.53E-02	3.10E-02	7.71E-02	4.15E-02	2.5002E+00	6.8279E+01
$\alpha_3$	5.57E-05	7.92E-03	4.00E-03	2.91E-02	7.32E-03	5.6092E-01	7.0218E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9223160	0.9590080	0.9620120	0.9854180	0.9568800	9.6601E+01	4.1292E+00
$\alpha_2$	5.11E-03	2.34E-02	2.03E-02	5.22E-02	2.14E-02	2.3561E+00	9.8374E+01
$\alpha_3$	1.39E-03	1.36E-02	1.06E-02	3.64E-02	1.84E-02	1.3742E+00	9.9356E+01
$\alpha_4$	4.06E-06	3.96E-03	1.44E-03	1.64E-02	3.34E-03	3.9887E-01	1.0033E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9366010	0.9633550	0.9652170	0.9837580	0.9615910	1.5895E+02	6.0463E+00
$\alpha_2$	4.93E-03	1.80E-02	1.61E-02	3.77E-02	1.32E-02	2.9770E+00	1.6202E+02
$\alpha_3$	1.89E-03	1.14E-02	9.51E-03	2.75E-02	1.39E-02	1.8831E+00	1.6311E+02
$\alpha_4$	3.30E-04	6.16E-03	4.31E-03	1.83E-02	9.83E-03	1.0160E+00	1.6398E+02
$\alpha_5$	8.80E-11	1.03E-03	6.68E-05	5.53E-03	1.50E-03	1.7018E-01	1.6483E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9409440	0.9647240	0.9662690	0.9832240	0.9647540	1.9200E+02	7.0207E+00
$\alpha_2$	4.38E-03	1.55E-02	1.39E-02	3.21E-02	1.10E-02	3.0927E+00	1.9593E+02
$\alpha_3$	1.31E-03	8.77E-03	7.19E-03	2.17E-02	7.77E-03	1.7462E+00	1.9727E+02
$\alpha_4$	7.50E-04	7.08E-03	5.51E-03	1.88E-02	1.05E-02	1.4087E+00	1.9761E+02
$\alpha_5$	4.01E-05	3.22E-03	1.78E-03	1.13E-02	5.38E-03	6.4090E-01	1.9838E+02
$\alpha_6$	4.55E-13	6.64E-04	1.66E-05	3.74E-03	6.30E-04	1.3224E-01	1.9889E+02

PORVs  
PWR Steam Generator PORV  
PWR MAIN STEAM PORV FAIL TO OPEN SPAR: ADV-CC  
CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9469870	0.9663440	0.9674440	0.9819420	0.9667170	2.7131E+02	9.4494E+00
$\alpha_2$	5.09E-03	1.46E-02	1.34E-02	2.79E-02	1.11E-02	4.0923E+00	2.7667E+02
$\alpha_3$	1.26E-03	7.08E-03	5.95E-03	1.68E-02	3.96E-03	1.9891E+00	2.7877E+02
$\alpha_4$	8.18E-04	5.92E-03	4.79E-03	1.49E-02	7.44E-03	1.6609E+00	2.7910E+02
$\alpha_5$	3.44E-04	4.32E-03	3.21E-03	1.21E-02	7.65E-03	1.2124E+00	2.7955E+02
$\alpha_6$	3.22E-06	1.58E-03	6.46E-04	6.34E-03	2.86E-03	4.4458E-01	2.8031E+02
$\alpha_7$	2.17E-29	1.78E-04	2.03E-09	9.50E-04	2.33E-04	5.0071E-02	2.8071E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9497200	0.9672830	0.9682280	0.9816250	0.9678740	3.1812E+02	1.0760E+01
$\alpha_2$	5.23E-03	1.39E-02	1.29E-02	2.59E-02	1.20E-02	4.5772E+00	3.2430E+02
$\alpha_3$	1.07E-03	6.04E-03	5.07E-03	1.43E-02	2.40E-03	1.9850E+00	3.2689E+02
$\alpha_4$	5.99E-04	4.76E-03	3.80E-03	1.22E-02	4.07E-03	1.5640E+00	3.2732E+02
$\alpha_5$	4.56E-04	4.30E-03	3.34E-03	1.14E-02	6.86E-03	1.4127E+00	3.2747E+02
$\alpha_6$	1.13E-04	2.78E-03	1.86E-03	8.59E-03	5.34E-03	9.1486E-01	3.2797E+02
$\alpha_7$	2.68E-08	8.09E-04	1.60E-04	3.84E-03	1.39E-03	2.6607E-01	3.2861E+02
$\alpha_8$	6.63E-36	1.22E-04	5.55E-11	5.87E-04	6.82E-05	4.0124E-02	3.2884E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9690100	0.9511450	0.9568800	0.9615910	0.9647540	0.9667170	0.9678740
$\alpha_2$	3.10E-02	4.15E-02	2.14E-02	1.32E-02	1.10E-02	1.11E-02	1.20E-02
$\alpha_3$		7.32E-03	1.84E-02	1.39E-02	7.77E-03	3.96E-03	2.40E-03
$\alpha_4$			3.34E-03	9.83E-03	1.05E-02	7.44E-03	4.07E-03
$\alpha_5$				1.50E-03	5.38E-03	7.65E-03	6.86E-03
$\alpha_6$					6.30E-04	2.86E-03	5.34E-03
$\alpha_7$						2.33E-04	1.39E-03
$\alpha_8$							6.82E-05

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.69E-01	9.51E-01	9.57E-01	9.62E-01	9.65E-01	9.67E-01	9.68E-01
Beta	3.10E-02	4.89E-02	4.31E-02	3.84E-02	3.52E-02	3.33E-02	3.21E-02
Gamma		1.50E-01	5.04E-01	6.56E-01	6.89E-01	6.66E-01	6.26E-01
Delta			1.54E-01	4.49E-01	6.80E-01	8.21E-01	8.81E-01
Epsilon				1.32E-01	3.64E-01	5.91E-01	7.71E-01
Mu					1.05E-01	2.88E-01	4.98E-01
Upsilon						7.52E-02	2.15E-01
Sigma							4.66E-02

PORVs

2010

PWR Steam Generator PORV

PWR MAIN STEAM PORV FAIL TO OPEN SPAR: ADV-CC

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	23.60	35.40	47.20	59.00	70.79	82.59	94.39
N <sub>1</sub>	2.9529	2.7629	3.2652	3.7892	4.2661	4.6712	5.0018
N <sub>2</sub>	0.8492	1.6665	1.1280	0.8628	0.8535	1.0045	1.2325
N <sub>3</sub>		0.2937	0.9699	0.9057	0.6044	0.3579	0.2466
N <sub>4</sub>			0.1762	0.6416	0.8165	0.6720	0.4175
N <sub>5</sub>				0.0979	0.4187	0.6906	0.7044
N <sub>6</sub>					0.0490	0.2583	0.5479
N <sub>7</sub>						0.0210	0.1431
N <sub>8</sub>							0.0070

PORVs  
PWR Steam Generator PORV  
PWR MAIN STEAM PORV FAIL TO CLOSE SPAR: ADV-OO  
**PWR MAIN STEAM PORV FAIL TO CLOSE SPAR: ADV-OO**

2010

System : Main steam  
Component : Power Operated Relief Valve  
Failure Mode : Fail to close (reseal) on demand  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 25.00  
Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9250270	0.9812610	0.9923200	0.9999620	0.9998650	2.2843E+01	4.3622E-01
$\alpha_2$	3.50E-05	1.87E-02	7.68E-03	7.50E-02	1.35E-04	4.3622E-01	2.2843E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9361880	0.9776820	0.9837230	0.9985190	0.9997350	4.8445E+01	1.1059E+00
$\alpha_2$	5.46E-04	1.69E-02	1.10E-02	5.35E-02	2.65E-04	8.3866E-01	4.8712E+01
$\alpha_3$	1.89E-07	5.39E-03	1.09E-03	2.56E-02	0.00E+00	2.6722E-01	4.9284E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9388960	0.9745140	0.9787070	0.9957890	0.9996030	7.1316E+01	1.8651E+00
$\alpha_2$	1.42E-03	1.69E-02	1.28E-02	4.66E-02	3.97E-04	1.2381E+00	7.1943E+01
$\alpha_3$	6.21E-06	5.52E-03	2.05E-03	2.28E-02	0.00E+00	4.0431E-01	7.2777E+01
$\alpha_4$	1.31E-08	3.04E-03	4.16E-04	1.52E-02	0.00E+00	2.2267E-01	7.2958E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9463140	0.9729060	0.9752780	0.9913960	0.9994920	1.2763E+02	3.5542E+00
$\alpha_2$	3.15E-03	1.62E-02	1.38E-02	3.75E-02	4.99E-04	2.1299E+00	1.2905E+02
$\alpha_3$	3.64E-04	7.45E-03	5.14E-03	2.24E-02	9.53E-06	9.7768E-01	1.3021E+02
$\alpha_4$	1.87E-06	2.85E-03	9.60E-04	1.21E-02	0.00E+00	3.7439E-01	1.3081E+02
$\alpha_5$	4.55E-21	5.51E-04	3.11E-07	3.19E-03	0.00E+00	7.2277E-02	1.3111E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9490140	0.9729430	0.9749060	0.9901720	0.9993860	1.5469E+02	4.3019E+00
$\alpha_2$	2.95E-03	1.42E-02	1.22E-02	3.23E-02	5.93E-04	2.2616E+00	1.5673E+02
$\alpha_3$	5.06E-04	7.19E-03	5.25E-03	2.05E-02	2.12E-05	1.1426E+00	1.5785E+02
$\alpha_4$	3.33E-05	3.72E-03	1.95E-03	1.34E-02	0.00E+00	5.9222E-01	1.5840E+02
$\alpha_5$	5.84E-09	1.40E-03	1.89E-04	7.00E-03	0.00E+00	2.2220E-01	1.5877E+02
$\alpha_6$	8.86E-19	5.24E-04	9.15E-07	3.05E-03	0.00E+00	8.3237E-02	1.5891E+02

PORVs  
PWR Steam Generator PORV  
PWR MAIN STEAM PORV FAIL TO CLOSE SPAR: ADV-OO  
CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9528350	0.9723880	0.9737220	0.9873880	0.9992810	2.2808E+02	6.4767E+00
$\alpha_2$	3.77E-03	1.33E-02	1.19E-02	2.75E-02	6.83E-04	3.1179E+00	2.3144E+02
$\alpha_3$	9.39E-04	6.96E-03	5.62E-03	1.76E-02	3.63E-05	1.6328E+00	2.3292E+02
$\alpha_4$	2.11E-04	4.22E-03	2.92E-03	1.27E-02	0.00E+00	9.8887E-01	2.3357E+02
$\alpha_5$	1.09E-05	2.22E-03	1.05E-03	8.41E-03	0.00E+00	5.2177E-01	2.3403E+02
$\alpha_6$	2.86E-10	7.94E-04	6.78E-05	4.17E-03	0.00E+00	1.8628E-01	2.3437E+02
$\alpha_7$	0.00E+00	1.24E-04	1.08E-13	4.66E-04	0.00E+00	2.9071E-02	2.3453E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9551270	0.9728720	0.9740060	0.9867510	0.9991840	2.6904E+02	7.5021E+00
$\alpha_2$	3.71E-03	1.22E-02	1.11E-02	2.47E-02	7.65E-04	3.3832E+00	2.7316E+02
$\alpha_3$	9.33E-04	6.30E-03	5.15E-03	1.56E-02	4.96E-05	1.7409E+00	2.7480E+02
$\alpha_4$	2.93E-04	4.15E-03	3.03E-03	1.18E-02	1.99E-06	1.1466E+00	2.7540E+02
$\alpha_5$	4.66E-05	2.56E-03	1.50E-03	8.67E-03	0.00E+00	7.0833E-01	2.7583E+02
$\alpha_6$	7.51E-07	1.33E-03	4.34E-04	5.68E-03	0.00E+00	3.6696E-01	2.7618E+02
$\alpha_7$	5.89E-14	4.45E-04	7.99E-06	2.53E-03	0.00E+00	1.2297E-01	2.7642E+02
$\alpha_8$	1.10E-42	1.20E-04	1.71E-12	5.06E-04	0.00E+00	3.3124E-02	2.7651E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9998650	0.9997350	0.9996030	0.9994920	0.9993860	0.9992810	0.9991840
$\alpha_2$	1.35E-04	2.65E-04	3.97E-04	4.99E-04	5.93E-04	6.83E-04	7.65E-04
$\alpha_3$		0.00E+00	0.00E+00	9.53E-06	2.12E-05	3.63E-05	4.96E-05
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.99E-06
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	9.99E-01	9.99E-01	9.99E-01	9.99E-01
Beta	1.35E-04	2.65E-04	3.97E-04	5.08E-04	6.14E-04	7.19E-04	8.16E-04
Gamma		0.00E+00	0.00E+00	1.88E-02	3.45E-02	5.05E-02	6.33E-02
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.85E-02
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

PWR Steam Generator PORV

PWR MAIN STEAM PORV FAIL TO CLOSE SPAR: ADV-OO

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	12.50	18.75	25.00	31.25	37.50	43.75	50.00
N <sub>1</sub>	0.0967	0.1400	0.1800	0.2175	0.2523	0.2845	0.3143
N <sub>2</sub>	0.0017	0.0050	0.0100	0.0157	0.0224	0.0301	0.0385
N <sub>3</sub>		0.0000	0.0000	0.0003	0.0008	0.0016	0.0025
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0001
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000



**PWR Pressurizer Power Operated Relief Valves**  
**PRESSURIZER PORVS FAIL TO OPEN SPAR: PPR-SRV-CC**

System : Reactor coolant  
Component : Power Operated Relief Valve  
Failure Mode : Fail to open on demand  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 19.10  
Total Number of Common-Cause Failure Events: 2

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9404860	0.9849300	0.9936000	0.9999610	0.9989730	2.9706E+01	4.5452E-01
$\alpha_2$	3.57E-05	1.51E-02	6.40E-03	5.95E-02	1.03E-03	4.5452E-01	2.9706E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9455050	0.9806700	0.9857140	0.9985830	0.9980820	5.8691E+01	1.1569E+00
$\alpha_2$	5.63E-04	1.48E-02	9.88E-03	4.60E-02	1.85E-03	8.8766E-01	5.8960E+01
$\alpha_3$	1.70E-07	4.50E-03	9.17E-04	2.13E-02	6.85E-05	2.6922E-01	5.9579E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9466870	0.9774440	0.9810010	0.9960380	0.9973100	8.4919E+01	1.9597E+00
$\alpha_2$	1.46E-03	1.53E-02	1.17E-02	4.11E-02	2.50E-03	1.3253E+00	8.5553E+01
$\alpha_3$	5.97E-06	4.74E-03	1.79E-03	1.95E-02	1.85E-04	4.1151E-01	8.6467E+01
$\alpha_4$	1.12E-08	2.57E-03	3.51E-04	1.28E-02	5.14E-06	2.2287E-01	8.6656E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	0.9989730	0.9980820	0.9973100
$\alpha_2$	1.03E-03	1.85E-03	2.50E-03
$\alpha_3$		6.85E-05	1.85E-04
$\alpha_4$			5.14E-06

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	9.99E-01	9.98E-01	9.97E-01
Beta	1.03E-03	1.92E-03	2.69E-03
Gamma		3.57E-02	7.07E-02
Delta			2.70E-02

PWR Pressurizer Power Operated Relief Valves

PRESSURIZER PORVS FAIL TO OPEN SPAR: PPR-SRV-CC

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	19.10	28.65	38.20
<b>N<sub>1</sub></b>	0.3600	0.4860	0.5832
<b>N<sub>2</sub></b>	0.0200	0.0540	0.0972
<b>N<sub>3</sub></b>		0.0020	0.0072
<b>N<sub>4</sub></b>			0.0002

PORVs  
PWR Pressurizer Power Operated Relief Valves  
PWR PRESSURIZER PORVS FAIL TO CLOSE  
**PWR PRESSURIZER PORVS FAIL TO CLOSE**

2010

System : Reactor coolant  
Component : Power Operated Relief Valve  
Failure Mode : Fail to close (reseal) on demand  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 5.10  
Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8901120	0.9724650	0.9886040	0.9999450	1.0000000	1.5346E+01	4.3452E-01
$\alpha_2$	5.09E-05	2.75E-02	1.14E-02	1.10E-01	0.00E+00	4.3452E-01	1.5346E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9122210	0.9692110	0.9774640	0.9979560	1.0000000	3.4655E+01	1.1009E+00
$\alpha_2$	7.44E-04	2.33E-02	1.52E-02	7.36E-02	0.00E+00	8.3366E-01	3.4922E+01
$\alpha_3$	2.63E-07	7.47E-03	1.51E-03	3.54E-02	0.00E+00	2.6722E-01	3.5489E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9164510	0.9650590	0.9707310	0.9942350	1.0000000	5.1236E+01	1.8551E+00
$\alpha_2$	1.92E-03	2.31E-02	1.75E-02	6.38E-02	0.00E+00	1.2281E+00	5.1863E+01
$\alpha_3$	8.59E-06	7.62E-03	2.83E-03	3.14E-02	0.00E+00	4.0431E-01	5.2687E+01
$\alpha_4$	1.81E-08	4.19E-03	5.75E-04	2.10E-02	0.00E+00	2.2267E-01	5.2868E+01

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4
$\alpha_1$	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00
$\alpha_4$			0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4
1-Beta	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00
Delta			0.00E+00

PORVs  
PWR Pressurizer Power Operated Relief Valves  
PWR PRESSURIZER PORVS FAIL TO CLOSE

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<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>
<b>Adj. Ind. Events</b>	5.10	5.10	5.10
<b>N<sub>1</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>2</sub></b>	0.0000	0.0000	0.0000
<b>N<sub>3</sub></b>		0.0000	0.0000
<b>N<sub>4</sub></b>			0.0000

# Main Steam Isolation Valves

## PWR Main Steam Isolation Valves

### PWR MSIV FAIL TO OPEN

System : Main steam  
Component : Main Steam Stop Valve  
Failure Mode : Fail to open on demand  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 19.30

Total Number of Common-Cause Failure Events: 1

### ALPHA FACTOR DISTRIBUTIONS

#### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9244300	0.9777250	0.9869320	0.9996320	0.9875310	3.0046E+01	6.8452E-01
$\alpha_2$	3.66E-04	2.23E-02	1.31E-02	7.56E-02	1.25E-02	6.8452E-01	3.0046E+01

#### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9333660	0.9735300	0.9785610	0.9964880	0.9832360	5.8880E+01	1.6009E+00
$\alpha_2$	1.60E-03	2.00E-02	1.50E-02	5.55E-02	1.26E-02	1.2087E+00	5.9272E+01
$\alpha_3$	5.95E-06	6.49E-03	2.32E-03	2.71E-02	4.19E-03	3.9222E-01	6.0089E+01

#### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9367670	0.9709510	0.9744670	0.9931150	0.9826110	8.4986E+01	2.5426E+00
$\alpha_2$	2.42E-03	1.83E-02	1.48E-02	4.63E-02	9.48E-03	1.6031E+00	8.5925E+01
$\alpha_3$	1.02E-04	7.48E-03	4.20E-03	2.60E-02	6.32E-03	6.5431E-01	8.6874E+01
$\alpha_4$	2.18E-07	3.26E-03	7.34E-04	1.51E-02	1.58E-03	2.8517E-01	8.7243E+01

#### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9451450	0.9707840	0.9728700	0.9893000	0.9834900	1.4457E+02	4.3509E+00
$\alpha_2$	3.65E-03	1.63E-02	1.42E-02	3.62E-02	6.35E-03	2.4267E+00	1.4649E+02
$\alpha_3$	7.82E-04	8.66E-03	6.58E-03	2.36E-02	6.35E-03	1.2899E+00	1.4763E+02
$\alpha_4$	1.91E-05	3.56E-03	1.71E-03	1.34E-02	3.18E-03	5.3069E-01	1.4839E+02
$\alpha_5$	1.13E-15	6.96E-04	5.10E-06	4.03E-03	6.36E-04	1.0358E-01	1.4882E+02

Main Steam Isolation Valves  
PWR Main Steam Isolation Valves  
PWR MSIV FAIL TO OPEN  
**CCCG = 6**

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9483500	0.9712970	0.9730280	0.9883350	0.9848740	1.7493E+02	5.1694E+00
$\alpha_2$	3.14E-03	1.37E-02	1.20E-02	3.03E-02	3.98E-03	2.4736E+00	1.7763E+02
$\alpha_3$	9.05E-04	8.07E-03	6.34E-03	2.12E-02	5.31E-03	1.4543E+00	1.7865E+02
$\alpha_4$	1.40E-04	4.59E-03	2.93E-03	1.47E-02	3.98E-03	8.2662E-01	1.7927E+02
$\alpha_5$	3.00E-07	1.75E-03	4.66E-04	7.89E-03	1.59E-03	3.1600E-01	1.7978E+02
$\alpha_6$	2.32E-16	5.49E-04	3.04E-06	3.19E-03	2.65E-04	9.8837E-02	1.8000E+02

**CCCG = 7**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9527130	0.9715000	0.9727030	0.9861680	0.9863220	2.5165E+02	7.3825E+00
$\alpha_2$	3.69E-03	1.26E-02	1.13E-02	2.56E-02	2.39E-03	3.2519E+00	2.5578E+02
$\alpha_3$	1.23E-03	7.35E-03	6.13E-03	1.77E-02	3.99E-03	1.9046E+00	2.5713E+02
$\alpha_4$	4.21E-04	4.87E-03	3.67E-03	1.34E-02	3.99E-03	1.2623E+00	2.5777E+02
$\alpha_5$	4.28E-05	2.65E-03	1.53E-03	9.07E-03	2.39E-03	6.8587E-01	2.5835E+02
$\alpha_6$	1.04E-08	9.30E-04	1.51E-04	4.55E-03	7.98E-04	2.4098E-01	2.5879E+02
$\alpha_7$	1.16E-38	1.42E-04	1.53E-11	6.50E-04	1.14E-04	3.6871E-02	2.5900E+02

**CCCG = 8**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9553120	0.9723180	0.9733440	0.9858070	0.9876590	2.9596E+02	8.4260E+00
$\alpha_2$	3.50E-03	1.13E-02	1.03E-02	2.28E-02	1.40E-03	3.4541E+00	3.0093E+02
$\alpha_3$	1.12E-03	6.43E-03	5.39E-03	1.53E-02	2.80E-03	1.9572E+00	3.0243E+02
$\alpha_4$	5.00E-04	4.66E-03	3.63E-03	1.24E-02	3.50E-03	1.4199E+00	3.0297E+02
$\alpha_5$	1.29E-04	3.05E-03	2.05E-03	9.36E-03	2.80E-03	9.2713E-01	3.0346E+02
$\alpha_6$	4.74E-06	1.56E-03	6.83E-04	6.11E-03	1.40E-03	4.7636E-01	3.0391E+02
$\alpha_7$	7.67E-12	5.07E-04	2.34E-05	2.78E-03	4.00E-04	1.5427E-01	3.0423E+02
$\alpha_8$	1.38E-38	1.22E-04	1.41E-11	5.57E-04	4.99E-05	3.7024E-02	3.0435E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9875310	0.9832360	0.9826110	0.9834900	0.9848740	0.9863220	0.9876590
$\alpha_2$	1.25E-02	1.26E-02	9.48E-03	6.35E-03	3.98E-03	2.39E-03	1.40E-03
$\alpha_3$		4.19E-03	6.32E-03	6.35E-03	5.31E-03	3.99E-03	2.80E-03
$\alpha_4$			1.58E-03	3.18E-03	3.98E-03	3.99E-03	3.50E-03
$\alpha_5$				6.36E-04	1.59E-03	2.39E-03	2.80E-03
$\alpha_6$					2.65E-04	7.98E-04	1.40E-03
$\alpha_7$						1.14E-04	4.00E-04
$\alpha_8$							4.99E-05

Main Steam Isolation Valves  
PWR Main Steam Isolation Valves  
PWR MSIV FAIL TO OPEN

2010

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.88E-01	9.83E-01	9.83E-01	9.83E-01	9.85E-01	9.86E-01	9.88E-01
Beta	1.25E-02	1.68E-02	1.74E-02	1.65E-02	1.51E-02	1.37E-02	1.23E-02
Gamma		2.50E-01	4.55E-01	6.15E-01	7.37E-01	8.25E-01	8.87E-01
Delta			2.00E-01	3.75E-01	5.24E-01	6.46E-01	7.44E-01
Epsilon				1.67E-01	3.18E-01	4.53E-01	5.71E-01
Mu					1.43E-01	2.76E-01	3.98E-01
Upsilon						1.25E-01	2.43E-01
Sigma							1.11E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	19.30	28.95	38.60	48.25	57.90	67.55	77.20
N <sub>1</sub>	0.5000	0.3750	0.2500	0.1563	0.0938	0.0547	0.0313
N <sub>2</sub>	0.2500	0.3750	0.3750	0.3125	0.2344	0.1641	0.1094
N <sub>3</sub>		0.1250	0.2500	0.3125	0.3125	0.2734	0.2188
N <sub>4</sub>			0.0625	0.1563	0.2344	0.2734	0.2734
N <sub>5</sub>				0.0313	0.0938	0.1641	0.2188
N <sub>6</sub>					0.0156	0.0547	0.1094
N <sub>7</sub>						0.0078	0.0313
N <sub>8</sub>							0.0039

Main Steam Isolation Valves  
PWR Main Steam Isolation Valves  
PWR MSIV FAIL TO CLOSE  
**PWR MSIV FAIL TO CLOSE**

2010

System : Main steam  
Component : Main Steam Stop Valve  
Failure Mode : Fail to close (reset) on demand  
Plant Type : PWR  
Start Date : 1997/01/01  
Data Version : 2010/12/31

Total Number of Independent Failure Events: 28.30  
Total Number of Common-Cause Failure Events: 4

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8762750	0.9567710	0.9684440	0.9972900	0.9548290	2.3633E+01	1.0678E+00
$\alpha_2$	2.71E-03	4.32E-02	3.16E-02	1.24E-01	4.52E-02	1.0678E+00	2.3633E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8891090	0.9479300	0.9537080	0.9869590	0.9234760	4.8260E+01	2.6509E+00
$\alpha_2$	8.93E-03	4.34E-02	3.75E-02	9.79E-02	6.79E-02	2.2087E+00	4.8702E+01
$\alpha_3$	1.73E-05	8.69E-03	3.56E-03	3.47E-02	8.64E-03	4.4222E-01	5.0469E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8892480	0.9400750	0.9440080	0.9774600	0.9010300	6.9693E+01	4.4426E+00
$\alpha_2$	1.35E-02	4.46E-02	4.05E-02	8.95E-02	7.94E-02	3.3031E+00	7.0832E+01
$\alpha_3$	3.90E-04	1.15E-02	7.53E-03	3.63E-02	1.72E-02	8.5431E-01	7.3281E+01
$\alpha_4$	2.57E-07	3.85E-03	8.68E-04	1.79E-02	2.39E-03	2.8517E-01	7.3850E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9160930	0.9504890	0.9527610	0.9771360	0.9067120	1.2512E+02	6.5175E+00
$\alpha_2$	9.46E-03	2.86E-02	2.62E-02	5.57E-02	5.15E-02	3.7600E+00	1.2788E+02
$\alpha_3$	3.12E-03	1.61E-02	1.37E-02	3.73E-02	3.59E-02	2.1232E+00	1.2951E+02
$\alpha_4$	2.16E-05	4.03E-03	1.94E-03	1.51E-02	4.89E-03	5.3069E-01	1.3111E+02
$\alpha_5$	1.28E-15	7.87E-04	5.77E-06	4.57E-03	9.80E-04	1.0358E-01	1.3153E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9230000	0.9533110	0.9552020	0.9771540	0.9166830	1.5149E+02	7.4193E+00
$\alpha_2$	5.75E-03	1.99E-02	1.80E-02	4.09E-02	2.46E-02	3.1680E+00	1.5574E+02
$\alpha_3$	4.87E-03	1.82E-02	1.63E-02	3.84E-02	4.66E-02	2.8987E+00	1.5601E+02
$\alpha_4$	2.58E-04	5.90E-03	4.00E-03	1.80E-02	9.17E-03	9.3772E-01	1.5797E+02
$\alpha_5$	3.40E-07	1.99E-03	5.28E-04	8.94E-03	2.49E-03	3.1600E-01	1.5859E+02
$\alpha_6$	2.63E-16	6.22E-04	3.45E-06	3.62E-03	4.14E-04	9.8837E-02	1.5881E+02



Main Steam Isolation Valves  
PWR Main Steam Isolation Valves  
PWR MSIV FAIL TO CLOSE  
**CCCG = 7**

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9352350	0.9586090	0.9599140	0.9775420	0.9254650	2.2425E+02	9.6826E+00
$\alpha_2$	5.45E-03	1.63E-02	1.50E-02	3.19E-02	1.69E-02	3.8232E+00	2.3011E+02
$\alpha_3$	3.46E-03	1.27E-02	1.14E-02	2.66E-02	3.09E-02	2.9741E+00	2.3096E+02
$\alpha_4$	1.33E-03	8.06E-03	6.70E-03	1.94E-02	2.06E-02	1.8846E+00	2.3205E+02
$\alpha_5$	6.05E-05	3.09E-03	1.84E-03	1.04E-02	4.63E-03	7.2287E-01	2.3321E+02
$\alpha_6$	1.15E-08	1.03E-03	1.67E-04	5.04E-03	1.26E-03	2.4098E-01	2.3369E+02
$\alpha_7$	1.28E-38	1.58E-04	1.70E-11	7.20E-04	1.80E-04	3.6871E-02	2.3390E+02

**CCCG = 8**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9399540	0.9608570	0.9619710	0.9779650	0.9325320	2.6458E+02	1.0778E+01
$\alpha_2$	4.89E-03	1.44E-02	1.32E-02	2.78E-02	1.23E-02	3.9516E+00	2.7141E+02
$\alpha_3$	2.55E-03	1.00E-02	8.87E-03	2.15E-02	2.08E-02	2.7622E+00	2.7260E+02
$\alpha_4$	1.60E-03	7.98E-03	6.83E-03	1.83E-02	2.14E-02	2.1987E+00	2.7316E+02
$\alpha_5$	3.27E-04	4.31E-03	3.18E-03	1.21E-02	9.71E-03	1.1858E+00	2.7417E+02
$\alpha_6$	6.19E-06	1.77E-03	7.93E-04	6.87E-03	2.48E-03	4.8866E-01	2.7487E+02
$\alpha_7$	8.48E-12	5.60E-04	2.59E-05	3.07E-03	6.37E-04	1.5427E-01	2.7520E+02
$\alpha_8$	1.52E-38	1.34E-04	1.56E-11	6.16E-04	7.93E-05	3.7024E-02	2.7532E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9548290	0.9234760	0.9010300	0.9067120	0.9166830	0.9254650	0.9325320
$\alpha_2$	4.52E-02	6.79E-02	7.94E-02	5.15E-02	2.46E-02	1.69E-02	1.23E-02
$\alpha_3$		8.64E-03	1.72E-02	3.59E-02	4.66E-02	3.09E-02	2.08E-02
$\alpha_4$			2.39E-03	4.89E-03	9.17E-03	2.06E-02	2.14E-02
$\alpha_5$				9.80E-04	2.49E-03	4.63E-03	9.71E-03
$\alpha_6$					4.14E-04	1.26E-03	2.48E-03
$\alpha_7$						1.80E-04	6.37E-04
$\alpha_8$							7.93E-05

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.55E-01	9.23E-01	9.01E-01	9.07E-01	9.17E-01	9.25E-01	9.33E-01
Beta	4.52E-02	7.65E-02	9.90E-02	9.33E-02	8.33E-02	7.45E-02	6.75E-02
Gamma		1.13E-01	1.98E-01	4.48E-01	7.04E-01	7.73E-01	8.17E-01
Delta			1.22E-01	1.41E-01	2.06E-01	4.63E-01	6.22E-01
Epsilon				1.67E-01	2.40E-01	2.27E-01	3.76E-01
Mu					1.43E-01	2.37E-01	2.47E-01
Upsilon						1.25E-01	2.24E-01
Sigma							1.11E-01

Main Steam Isolation Valves  
PWR Main Steam Isolation Valves  
PWR MSIV FAIL TO CLOSE

2010

<b>Avg. Impact Vector</b>	<b>CCCG=2</b>	<b>CCCG=3</b>	<b>CCCG=4</b>	<b>CCCG=5</b>	<b>CCCG=6</b>	<b>CCCG=7</b>	<b>CCCG=8</b>
<b>Adj. Ind. Events</b>	11.32	16.98	22.64	28.30	33.96	39.62	45.28
<b>N<sub>1</sub></b>	2.0667	1.7250	0.9167	0.6563	0.5938	0.5797	0.5713
<b>N<sub>2</sub></b>	0.6333	1.3750	2.0750	1.6458	0.9288	0.7354	0.6069
<b>N<sub>3</sub></b>		0.1750	0.4500	1.1458	1.7569	1.3429	1.0238
<b>N<sub>4</sub></b>			0.0625	0.1563	0.3455	0.8957	1.0522
<b>N<sub>5</sub></b>				0.0313	0.0938	0.2011	0.4775
<b>N<sub>6</sub></b>					0.0156	0.0547	0.1217
<b>N<sub>7</sub></b>						0.0078	0.0313
<b>N<sub>8</sub></b>							0.0039

## BWR Main Steam Isolation Valves

### BWR MSIV FAIL TO OPEN

Component : Main Steam Stop Valve  
 Failure Mode : Fail to open on demand  
 Plant Type : BWR  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 3.50  
 Total Number of Common-Cause Failure Events: 1

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8513580	0.9625750	0.9842830	0.9999310	1.0000000	1.1176E+01	4.3452E-01
$\alpha_2$	7.04E-05	3.74E-02	1.57E-02	1.49E-01	0.00E+00	4.3452E-01	1.1176E+01

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9022300	0.9656380	0.9747930	0.9977110	0.9999280	3.0940E+01	1.1010E+00
$\alpha_2$	8.33E-04	2.60E-02	1.70E-02	8.21E-02	7.22E-05	8.3376E-01	3.1207E+01
$\alpha_3$	2.94E-07	8.34E-03	1.69E-03	3.96E-02	0.00E+00	2.6722E-01	3.1774E+01

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9110910	0.9627760	0.9687980	0.9938470	0.9998920	4.7986E+01	1.8553E+00
$\alpha_2$	2.05E-03	2.46E-02	1.86E-02	6.79E-02	1.08E-04	1.2283E+00	4.8613E+01
$\alpha_3$	9.16E-06	8.11E-03	3.02E-03	3.35E-02	0.00E+00	4.0431E-01	4.9437E+01
$\alpha_4$	1.93E-08	4.47E-03	6.13E-04	2.24E-02	0.00E+00	2.2267E-01	4.9619E+01

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9313770	0.9653120	0.9683150	0.9889800	0.9998270	9.8475E+01	3.5386E+00
$\alpha_2$	4.00E-03	2.07E-02	1.77E-02	4.79E-02	1.73E-04	2.1146E+00	9.9899E+01
$\alpha_3$	4.68E-04	9.58E-03	6.62E-03	2.88E-02	0.00E+00	9.7738E-01	1.0104E+02
$\alpha_4$	2.41E-06	3.67E-03	1.24E-03	1.56E-02	0.00E+00	3.7439E-01	1.0164E+02
$\alpha_5$	5.85E-21	7.09E-04	4.01E-07	4.10E-03	0.00E+00	7.2277E-02	1.0194E+02

##### CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9350450	0.9654900	0.9679680	0.9874670	0.9998200	1.1972E+02	4.2792E+00
$\alpha_2$	3.72E-03	1.81E-02	1.55E-02	4.10E-02	1.80E-04	2.2397E+00	1.2176E+02
$\alpha_3$	6.49E-04	9.21E-03	6.74E-03	2.62E-02	0.00E+00	1.1418E+00	1.2286E+02
$\alpha_4$	4.27E-05	4.78E-03	2.50E-03	1.72E-02	0.00E+00	5.9222E-01	1.2341E+02
$\alpha_5$	7.49E-09	1.79E-03	2.43E-04	8.98E-03	0.00E+00	2.2220E-01	1.2378E+02
$\alpha_6$	1.14E-18	6.71E-04	1.17E-06	3.92E-03	0.00E+00	8.3237E-02	1.2392E+02

Main Steam Isolation Valves  
 BWR Main Steam Isolation Valves  
 BWR MSIV FAIL TO OPEN  
 CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9432010	0.9667270	0.9683250	0.9848010	0.9997530	1.8728E+02	6.4458E+00
$\alpha_2$	4.49E-03	1.59E-02	1.43E-02	3.30E-02	2.47E-04	3.0886E+00	1.9064E+02
$\alpha_3$	1.14E-03	8.42E-03	6.80E-03	2.12E-02	0.00E+00	1.6312E+00	1.9209E+02
$\alpha_4$	2.56E-04	5.10E-03	3.53E-03	1.53E-02	0.00E+00	9.8887E-01	1.9274E+02
$\alpha_5$	1.32E-05	2.69E-03	1.28E-03	1.02E-02	0.00E+00	5.2177E-01	1.9320E+02
$\alpha_6$	3.47E-10	9.62E-04	8.21E-05	5.05E-03	0.00E+00	1.8628E-01	1.9354E+02
$\alpha_7$	0.00E+00	1.50E-04	1.31E-13	5.65E-04	0.00E+00	2.9071E-02	1.9370E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9463270	0.9675410	0.9688920	0.9841570	0.9997300	2.2243E+02	7.4620E+00
$\alpha_2$	4.38E-03	1.46E-02	1.32E-02	2.95E-02	2.70E-04	3.3457E+00	2.2655E+02
$\alpha_3$	1.12E-03	7.56E-03	6.19E-03	1.87E-02	0.00E+00	1.7384E+00	2.2815E+02
$\alpha_4$	3.53E-04	4.99E-03	3.65E-03	1.42E-02	0.00E+00	1.1465E+00	2.2875E+02
$\alpha_5$	5.61E-05	3.08E-03	1.81E-03	1.04E-02	0.00E+00	7.0833E-01	2.2918E+02
$\alpha_6$	9.03E-07	1.60E-03	5.23E-04	6.83E-03	0.00E+00	3.6696E-01	2.2953E+02
$\alpha_7$	7.08E-14	5.35E-04	9.62E-06	3.05E-03	0.00E+00	1.2297E-01	2.2977E+02
$\alpha_8$	1.33E-42	1.44E-04	2.05E-12	6.09E-04	0.00E+00	3.3124E-02	2.2986E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	0.9999280	0.9998920	0.9998270	0.9998200	0.9997530	0.9997300
$\alpha_2$	0.00E+00	7.22E-05	1.08E-04	1.73E-04	1.80E-04	2.47E-04	2.70E-04
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	7.22E-05	1.08E-04	1.73E-04	1.80E-04	2.47E-04	2.70E-04
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Main Steam Isolation Valves  
 BWR Main Steam Isolation Valves  
 BWR MSIV FAIL TO OPEN

2010

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	0.88	1.31	1.75	2.19	2.63	3.06	3.50
N <sub>1</sub>	0.0499	0.0748	0.0996	0.1243	0.1489	0.1735	0.1980
N <sub>2</sub>	0.0000	0.0001	0.0002	0.0004	0.0005	0.0008	0.0010
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Main Steam Isolation Valves  
 BWR Main Steam Isolation Valves  
 BWR MSIV FAIL TO CLOSE  
**BWR MSIV FAIL TO CLOSE**

2010

Component : Main Steam Stop Valve  
 Failure Mode : Fail to close (reset) on demand  
 Plant Type : BWR  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 9.00  
 Total Number of Common-Cause Failure Events: 2

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8651700	0.9648640	0.9838790	0.9998860	0.9849080	1.3157E+01	4.7912E-01
$\alpha_2$	1.16E-04	3.51E-02	1.61E-02	1.35E-01	1.51E-02	4.7912E-01	1.3157E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9036240	0.9647480	0.9731720	0.9970110	0.9693660	3.3792E+01	1.2348E+00
$\alpha_2$	1.34E-03	2.76E-02	1.93E-02	8.25E-02	3.06E-02	9.6756E-01	3.4059E+01
$\alpha_3$	2.69E-07	7.63E-03	1.54E-03	3.62E-02	0.00E+00	2.6722E-01	3.4760E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9095910	0.9604830	0.9660640	0.9922520	0.9532640	5.1600E+01	2.1230E+00
$\alpha_2$	3.32E-03	2.78E-02	2.22E-02	7.16E-02	4.67E-02	1.4960E+00	5.2227E+01
$\alpha_3$	8.49E-06	7.53E-03	2.80E-03	3.11E-02	0.00E+00	4.0431E-01	5.3319E+01
$\alpha_4$	1.79E-08	4.14E-03	5.69E-04	2.08E-02	0.00E+00	2.2267E-01	5.3500E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9285140	0.9626750	0.9655350	0.9870620	0.9367570	1.0277E+02	3.9846E+00
$\alpha_2$	5.71E-03	2.40E-02	2.11E-02	5.22E-02	6.32E-02	2.5606E+00	1.0419E+02
$\alpha_3$	4.47E-04	9.16E-03	6.33E-03	2.75E-02	0.00E+00	9.7738E-01	1.0578E+02
$\alpha_4$	2.31E-06	3.51E-03	1.18E-03	1.49E-02	0.00E+00	3.7439E-01	1.0638E+02
$\alpha_5$	5.59E-21	6.77E-04	3.83E-07	3.92E-03	0.00E+00	7.2277E-02	1.0668E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9307480	0.9618040	0.9641580	0.9848090	0.9196190	1.2460E+02	4.9483E+00
$\alpha_2$	6.03E-03	2.25E-02	2.00E-02	4.71E-02	8.04E-02	2.9088E+00	1.2664E+02
$\alpha_3$	6.21E-04	8.81E-03	6.45E-03	2.51E-02	0.00E+00	1.1418E+00	1.2841E+02
$\alpha_4$	4.09E-05	4.57E-03	2.39E-03	1.65E-02	0.00E+00	5.9222E-01	1.2896E+02
$\alpha_5$	7.17E-09	1.72E-03	2.33E-04	8.59E-03	0.00E+00	2.2220E-01	1.2933E+02
$\alpha_6$	1.09E-18	6.43E-04	1.12E-06	3.75E-03	0.00E+00	8.3237E-02	1.2947E+02

Main Steam Isolation Valves  
 BWR Main Steam Isolation Valves  
 BWR MSIV FAIL TO CLOSE  
 CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9389120	0.9630990	0.9646360	0.9820470	0.9020120	1.9268E+02	7.3825E+00
$\alpha_2$	6.97E-03	2.01E-02	1.85E-02	3.87E-02	9.80E-02	4.0253E+00	1.9604E+02
$\alpha_3$	1.10E-03	8.15E-03	6.58E-03	2.06E-02	0.00E+00	1.6312E+00	1.9843E+02
$\alpha_4$	2.48E-04	4.94E-03	3.42E-03	1.48E-02	0.00E+00	9.8887E-01	1.9907E+02
$\alpha_5$	1.28E-05	2.61E-03	1.23E-03	9.86E-03	0.00E+00	5.2177E-01	1.9954E+02
$\alpha_6$	3.36E-10	9.31E-04	7.95E-05	4.89E-03	0.00E+00	1.8628E-01	1.9988E+02
$\alpha_7$	0.00E+00	1.45E-04	1.27E-13	5.47E-04	0.00E+00	2.9071E-02	2.0003E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9411920	0.9632360	0.9645350	0.9808530	0.8837210	2.2823E+02	8.7110E+00
$\alpha_2$	7.32E-03	1.94E-02	1.81E-02	3.60E-02	1.16E-01	4.5947E+00	2.3235E+02
$\alpha_3$	1.09E-03	7.34E-03	6.00E-03	1.81E-02	0.00E+00	1.7384E+00	2.3520E+02
$\alpha_4$	3.43E-04	4.84E-03	3.54E-03	1.38E-02	0.00E+00	1.1465E+00	2.3579E+02
$\alpha_5$	5.44E-05	2.99E-03	1.76E-03	1.01E-02	0.00E+00	7.0833E-01	2.3623E+02
$\alpha_6$	8.77E-07	1.55E-03	5.07E-04	6.62E-03	0.00E+00	3.6696E-01	2.3657E+02
$\alpha_7$	6.87E-14	5.19E-04	9.33E-06	2.95E-03	0.00E+00	1.2297E-01	2.3682E+02
$\alpha_8$	1.29E-42	1.40E-04	1.99E-12	5.91E-04	0.00E+00	3.3124E-02	2.3691E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9849080	0.9693660	0.9532640	0.9367570	0.9196190	0.9020120	0.8837210
$\alpha_2$	1.51E-02	3.06E-02	4.67E-02	6.32E-02	8.04E-02	9.80E-02	1.16E-01
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.85E-01	9.69E-01	9.53E-01	9.37E-01	9.20E-01	9.02E-01	8.84E-01
Beta	1.51E-02	3.06E-02	4.67E-02	6.32E-02	8.04E-02	9.80E-02	1.16E-01
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Main Steam Isolation Valves  
 BWR Main Steam Isolation Valves  
 BWR MSIV FAIL TO CLOSE

2010

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	2.25	3.38	4.50	5.63	6.75	7.88	9.00
N <sub>1</sub>	0.6607	0.8571	0.9643	0.9821	0.9107	0.7500	0.5000
N <sub>2</sub>	0.0446	0.1339	0.2679	0.4464	0.6696	0.9375	1.2500
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000



# Generators

## Emergency Diesel Generators

### EMERGENCY DIESEL GENERATOR SPAR:DGN-FS

System : Emergency power supply  
 Component : Generator  
 Failure Mode : Fail to start  
 Component Group : Emergency Diesel Generator  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 197.90

Total Number of Common-Cause Failure Events: 4

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9733480	0.9877110	0.9891910	0.9970130	0.9892000	2.1175E+02	2.6345E+00
$\alpha_2$	2.99E-03	1.23E-02	1.08E-02	2.67E-02	1.08E-02	2.6345E+00	2.1175E+02

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9783850	0.9890700	0.9900250	0.9964770	0.9915860	3.3127E+02	3.6609E+00
$\alpha_2$	1.54E-03	7.09E-03	6.13E-03	1.59E-02	5.06E-03	2.3737E+00	3.3256E+02
$\alpha_3$	3.44E-04	3.84E-03	2.91E-03	1.05E-02	3.35E-03	1.2872E+00	3.3364E+02

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9801470	0.9891730	0.9898880	0.9957630	0.9924730	4.4777E+02	4.9011E+00
$\alpha_2$	1.48E-03	5.96E-03	5.25E-03	1.29E-02	3.64E-03	2.7001E+00	4.4997E+02
$\alpha_3$	3.73E-04	3.26E-03	2.57E-03	8.53E-03	2.65E-03	1.4763E+00	4.5119E+02
$\alpha_4$	3.16E-05	1.60E-03	9.52E-04	5.38E-03	1.24E-03	7.2467E-01	4.5195E+02

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9801170	0.9881460	0.9886820	0.9943520	0.9928130	5.9747E+02	7.1675E+00
$\alpha_2$	2.10E-03	6.32E-03	5.79E-03	1.24E-02	3.38E-03	3.8222E+00	6.0082E+02
$\alpha_3$	5.17E-04	3.12E-03	2.60E-03	7.54E-03	1.81E-03	1.8894E+00	6.0275E+02
$\alpha_4$	1.29E-04	1.87E-03	1.36E-03	5.37E-03	1.50E-03	1.1334E+00	6.0350E+02
$\alpha_5$	1.08E-07	5.33E-04	1.46E-04	2.38E-03	4.96E-04	3.2248E-01	6.0432E+02

## Emergency Diesel Generators

## EMERGENCY DIESEL GENERATOR SPAR:DGN-FS

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9809500	0.9882090	0.9886560	0.9939430	0.9929180	7.1773E+02	8.5639E+00
$\alpha_2$	2.16E-03	5.97E-03	5.52E-03	1.13E-02	3.46E-03	4.3325E+00	7.2196E+02
$\alpha_3$	4.54E-04	2.66E-03	2.22E-03	6.37E-03	1.31E-03	1.9334E+00	7.2436E+02
$\alpha_4$	1.88E-04	1.88E-03	1.45E-03	5.05E-03	1.28E-03	1.3665E+00	7.2493E+02
$\alpha_5$	1.95E-05	9.96E-04	5.91E-04	3.35E-03	8.28E-04	7.2330E-01	7.2557E+02
$\alpha_6$	5.11E-10	2.87E-04	3.31E-05	1.46E-03	2.07E-04	2.0824E-01	7.2609E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9892000	0.9915860	0.9924730	0.9928130	0.9929180
$\alpha_2$	1.08E-02	5.06E-03	3.64E-03	3.38E-03	3.46E-03
$\alpha_3$		3.35E-03	2.65E-03	1.81E-03	1.31E-03
$\alpha_4$			1.24E-03	1.50E-03	1.28E-03
$\alpha_5$				4.96E-04	8.28E-04
$\alpha_6$					2.07E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.89E-01	9.92E-01	9.92E-01	9.93E-01	9.93E-01
Beta	1.08E-02	8.41E-03	7.53E-03	7.19E-03	7.08E-03
Gamma		3.98E-01	5.17E-01	5.29E-01	5.12E-01
Delta			3.19E-01	5.25E-01	6.39E-01
Epsilon				2.48E-01	4.47E-01
Mu					2.00E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	197.90	296.85	395.80	494.75	593.70
$N_1$	3.6000	4.8600	5.8320	6.5610	7.0859
$N_2$	2.2000	1.5400	1.4720	1.7080	2.0933
$N_3$		1.0200	1.0720	0.9120	0.7916
$N_4$			0.5020	0.7590	0.7743
$N_5$				0.2502	0.5011
$N_6$					0.1250

Generators  
 Emergency Diesel Generators  
 EMERGENCY DIESEL GENERATOR SPAR:DGN-LR  
**EMERGENCY DIESEL GENERATOR SPAR:DGN-LR**

2010

System : Emergency power supply  
 Component : Generator  
 Failure Mode : Fail to Load/Run  
 Component Group : Emergency Diesel Generator  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 209.70  
 Total Number of Common-Cause Failure Events: 3

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9791800	0.9940090	0.9966350	0.9999200	0.9977620	1.0877E+02	6.5552E-01
$\alpha_2$	8.18E-05	5.99E-03	3.37E-03	2.08E-02	2.24E-03	6.5552E-01	1.0877E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9758210	0.9901870	0.9919470	0.9985320	0.9956010	1.7670E+02	1.7511E+00
$\alpha_2$	9.53E-04	8.28E-03	6.53E-03	2.16E-02	4.36E-03	1.4775E+00	1.7697E+02
$\alpha_3$	6.78E-08	1.53E-03	3.20E-04	7.22E-03	4.33E-05	2.7362E-01	1.7818E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9735840	0.9871960	0.9885000	0.9963500	0.9935050	2.4150E+02	3.1323E+00
$\alpha_2$	2.32E-03	1.01E-02	8.85E-03	2.24E-02	6.38E-03	2.4822E+00	2.4215E+02
$\alpha_3$	2.76E-06	1.74E-03	6.81E-04	7.08E-03	1.13E-04	4.2661E-01	2.4421E+02
$\alpha_4$	4.09E-09	9.13E-04	1.25E-04	4.57E-03	4.07E-06	2.2347E-01	2.4441E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9737510	0.9856220	0.9865480	0.9943250	0.9941970	3.4018E+02	4.9625E+00
$\alpha_2$	2.61E-03	9.13E-03	8.20E-03	1.88E-02	4.23E-03	3.1513E+00	3.4199E+02
$\alpha_3$	3.92E-04	3.94E-03	3.04E-03	1.06E-02	1.56E-03	1.3608E+00	3.4378E+02
$\alpha_4$	7.68E-07	1.10E-03	3.72E-04	4.64E-03	1.47E-05	3.7799E-01	3.4476E+02
$\alpha_5$	1.82E-21	2.10E-04	1.20E-07	1.21E-03	4.07E-07	7.2377E-02	3.4507E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9752900	0.9859250	0.9866950	0.9939170	0.9946680	4.0959E+02	5.8475E+00
$\alpha_2$	2.16E-03	7.58E-03	6.80E-03	1.56E-02	3.09E-03	3.1483E+00	4.1229E+02
$\alpha_3$	5.67E-04	4.04E-03	3.28E-03	1.01E-02	1.82E-03	1.6786E+00	4.1376E+02
$\alpha_4$	3.22E-05	1.72E-03	1.01E-03	5.81E-03	4.15E-04	7.1442E-01	4.1472E+02
$\alpha_5$	2.33E-09	5.37E-04	7.31E-05	2.69E-03	2.38E-06	2.2290E-01	4.1521E+02
$\alpha_6$	3.38E-19	2.00E-04	3.50E-07	1.17E-03	0.00E+00	8.3237E-02	4.1535E+02

## Emergency Diesel Generators

## EMERGENCY DIESEL GENERATOR SPAR:DGN-LR

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9977620	0.9956010	0.9935050	0.9941970	0.9946680
$\alpha_2$	2.24E-03	4.36E-03	6.38E-03	4.23E-03	3.09E-03
$\alpha_3$		4.33E-05	1.13E-04	1.56E-03	1.82E-03
$\alpha_4$			4.07E-06	1.47E-05	4.15E-04
$\alpha_5$				4.07E-07	2.38E-06
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.98E-01	9.96E-01	9.94E-01	9.94E-01	9.95E-01
Beta	2.24E-03	4.40E-03	6.50E-03	5.80E-03	5.33E-03
Gamma		9.84E-03	1.81E-02	2.72E-01	4.21E-01
Delta			3.46E-02	9.56E-03	1.86E-01
Epsilon				2.70E-02	5.70E-03
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	96.86	145.29	193.72	242.15	290.58
$N_1$	1.6680	1.8582	1.6415	1.8682	2.0684
$N_2$	0.2210	0.6438	1.2541	1.0371	0.9091
$N_3$		0.0064	0.0223	0.3834	0.5368
$N_4$			0.0008	0.0036	0.1222
$N_5$				0.0001	0.0007
$N_6$					0.0000

Generators  
 Emergency Diesel Generators  
 EMERGENCY DIESEL GENERATOR SPAR:DGN-FR  
**EMERGENCY DIESEL GENERATOR SPAR:DGN-FR**

2010

System : Emergency power supply  
 Component : Generator  
 Failure Mode : Fail to Run (Normally running equipment)  
 Component Group : Emergency Diesel Generator  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 140.20  
 Total Number of Common-Cause Failure Events: 4

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9660900	0.9868990	0.9896050	0.9984490	0.9897360	1.1303E+02	1.5005E+00
$\alpha_2$	1.55E-03	1.31E-02	1.04E-02	3.39E-02	1.03E-02	1.5005E+00	1.1303E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9721900	0.9877210	0.9894200	0.9974310	0.9923890	1.8357E+02	2.2821E+00
$\alpha_2$	9.64E-04	8.11E-03	6.42E-03	2.10E-02	4.34E-03	1.5065E+00	1.8435E+02
$\alpha_3$	1.04E-04	4.17E-03	2.58E-03	1.37E-02	3.28E-03	7.7562E-01	1.8508E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9742860	0.9874770	0.9887270	0.9963790	0.9935500	2.5129E+02	3.1869E+00
$\alpha_2$	1.07E-03	6.99E-03	5.75E-03	1.72E-02	2.67E-03	1.7794E+00	2.5270E+02
$\alpha_3$	1.58E-04	3.67E-03	2.48E-03	1.12E-02	2.56E-03	9.3381E-01	2.5354E+02
$\alpha_4$	5.47E-06	1.86E-03	8.08E-04	7.28E-03	1.22E-03	4.7367E-01	2.5400E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9743300	0.9858850	0.9867800	0.9943750	0.9941540	3.5238E+02	5.0451E+00
$\alpha_2$	1.84E-03	7.49E-03	6.59E-03	1.62E-02	2.18E-03	2.6766E+00	3.5475E+02
$\alpha_3$	4.24E-04	3.97E-03	3.09E-03	1.05E-02	1.71E-03	1.4172E+00	3.5601E+02
$\alpha_4$	4.77E-05	2.11E-03	1.28E-03	6.98E-03	1.47E-03	7.5389E-01	3.5667E+02
$\alpha_5$	4.68E-10	5.52E-04	5.54E-05	2.86E-03	4.85E-04	1.9738E-01	3.5723E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9757860	0.9861470	0.9868920	0.9939550	0.9945610	4.2420E+02	5.9589E+00
$\alpha_2$	1.73E-03	6.63E-03	5.88E-03	1.41E-02	1.98E-03	2.8500E+00	4.2731E+02
$\alpha_3$	4.17E-04	3.51E-03	2.78E-03	9.11E-03	1.19E-03	1.5095E+00	4.2865E+02
$\alpha_4$	1.12E-04	2.28E-03	1.57E-03	6.87E-03	1.26E-03	9.8062E-01	4.2918E+02
$\alpha_5$	3.20E-06	1.10E-03	4.76E-04	4.31E-03	8.12E-04	4.7300E-01	4.2969E+02
$\alpha_6$	1.73E-12	3.39E-04	1.26E-05	1.88E-03	2.02E-04	1.4574E-01	4.3001E+02

Generators

2010

Emergency Diesel Generators

EMERGENCY DIESEL GENERATOR SPAR:DGN-FR

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9897360	0.9923890	0.9935500	0.9941540	0.9945610
$\alpha_2$	1.03E-02	4.34E-03	2.67E-03	2.18E-03	1.98E-03
$\alpha_3$		3.28E-03	2.56E-03	1.71E-03	1.19E-03
$\alpha_4$			1.22E-03	1.47E-03	1.26E-03
$\alpha_5$				4.85E-04	8.12E-04
$\alpha_6$					2.02E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.90E-01	9.92E-01	9.94E-01	9.94E-01	9.95E-01
Beta	1.03E-02	7.61E-03	6.45E-03	5.85E-03	5.44E-03
Gamma		4.30E-01	5.86E-01	6.27E-01	6.36E-01
Delta			3.22E-01	5.34E-01	6.56E-01
Epsilon				2.48E-01	4.46E-01
Mu					1.99E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	101.96	152.95	203.93	254.91	305.89
$N_1$	0.8280	1.0692	1.2247	1.3122	1.3666
$N_2$	1.0660	0.6728	0.5513	0.5624	0.6108
$N_3$		0.5084	0.5295	0.4398	0.3677
$N_4$			0.2510	0.3795	0.3884
$N_5$				0.1251	0.2508
$N_6$					0.0625

## Vacuum Breakers

### BWR Pressure Suppression Vacuum Breakers

#### CONTAINMENT VACUUM RELIEF CHECK FAIL TO OPEN

System : Vapor suppression  
 Component : Vacuum Breaker  
 Failure Mode : Fail to open on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 7.50  
 Total Number of Common-Cause Failure Events: 1

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8612040	0.9606120	0.9783400	0.9996040	0.9636300	1.4663E+01	6.0122E-01
$\alpha_2$	3.94E-04	3.94E-02	2.17E-02	1.39E-01	3.64E-02	6.0122E-01	1.4663E+01

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8927750	0.9570640	0.9649780	0.9942240	0.9245850	3.5685E+01	1.6009E+00
$\alpha_2$	3.52E-03	3.58E-02	2.78E-02	9.52E-02	7.54E-02	1.3337E+00	3.5952E+01
$\alpha_3$	2.52E-07	7.17E-03	1.45E-03	3.40E-02	0.00E+00	2.6722E-01	3.7019E+01

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8945600	0.9494600	0.9546940	0.9864480	0.8823530	5.3636E+01	2.8551E+00
$\alpha_2$	8.18E-03	3.94E-02	3.41E-02	8.89E-02	1.18E-01	2.2281E+00	5.4263E+01
$\alpha_3$	8.07E-06	7.16E-03	2.66E-03	2.96E-02	0.00E+00	4.0431E-01	5.6087E+01
$\alpha_4$	1.70E-08	3.94E-03	5.40E-04	1.97E-02	0.00E+00	2.2267E-01	5.6268E+01

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9237230	0.9587720	0.9615280	0.9844100	0.9036610	1.0554E+02	4.5383E+00
$\alpha_2$	6.52E-03	2.53E-02	2.24E-02	5.37E-02	6.42E-02	2.7809E+00	1.0730E+02
$\alpha_3$	1.11E-03	1.19E-02	9.11E-03	3.23E-02	3.21E-02	1.3107E+00	1.0877E+02
$\alpha_4$	2.24E-06	3.40E-03	1.15E-03	1.44E-02	0.00E+00	3.7439E-01	1.0970E+02
$\alpha_5$	5.42E-21	6.57E-04	3.71E-07	3.80E-03	0.00E+00	7.2277E-02	1.1001E+02

BWR Pressure Suppression Vacuum Breakers

CONTAINMENT VACUUM RELIEF CHECK FAIL TO OPEN

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9294330	0.9604510	0.9627350	0.9836660	0.9183750	1.2819E+02	5.2786E+00
$\alpha_2$	5.00E-03	2.01E-02	1.78E-02	4.32E-02	3.63E-02	2.6836E+00	1.3078E+02
$\alpha_3$	1.54E-03	1.19E-02	9.55E-03	3.02E-02	3.63E-02	1.5862E+00	1.3188E+02
$\alpha_4$	9.38E-05	5.27E-03	3.09E-03	1.79E-02	9.07E-03	7.0332E-01	1.3277E+02
$\alpha_5$	6.96E-09	1.66E-03	2.26E-04	8.34E-03	0.00E+00	2.2220E-01	1.3325E+02
$\alpha_6$	1.06E-18	6.24E-04	1.09E-06	3.64E-03	0.00E+00	8.3237E-02	1.3339E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9636300	0.9245850	0.8823530	0.9036610	0.9183750
$\alpha_2$	3.64E-02	7.54E-02	1.18E-01	6.42E-02	3.63E-02
$\alpha_3$		0.00E+00	0.00E+00	3.21E-02	3.63E-02
$\alpha_4$			0.00E+00	0.00E+00	9.07E-03
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.64E-01	9.25E-01	8.82E-01	9.04E-01	9.18E-01
Beta	3.64E-02	7.54E-02	1.18E-01	9.63E-02	8.16E-02
Gamma		0.00E+00	0.00E+00	3.33E-01	5.56E-01
Delta			0.00E+00	0.00E+00	2.00E-01
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	3.75	5.63	7.50	9.38	11.25
$N_1$	0.6667	0.5000	0.0000	0.0000	0.0000
$N_2$	0.1667	0.5000	1.0000	0.6667	0.4444
$N_3$		0.0000	0.0000	0.3333	0.4444
$N_4$			0.0000	0.0000	0.1111
$N_5$				0.0000	0.0000
$N_6$					0.0000



## AC Power Distribution Breakers

### 480 Vac Circuit Breakers

#### 480 V CIRCUIT BREAKERS FAIL TO OPEN

System : Plant ac power  
 Component : Circuit Breaker  
 Failure Mode : Fail to open on demand  
 Component Group : 480 Volt  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 12.20

Total Number of Common-Cause Failure Events: 3

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8574060	0.9632090	0.9835270	0.9998990	0.9844030	1.2177E+01	4.6512E-01
$\alpha_2$	1.03E-04	3.68E-02	1.65E-02	1.43E-01	1.56E-02	4.6512E-01	1.2177E+01

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9021370	0.9647150	0.9734900	0.9972530	0.9713440	3.2368E+01	1.1839E+00
$\alpha_2$	1.13E-03	2.72E-02	1.85E-02	8.30E-02	2.71E-02	9.1226E-01	3.2640E+01
$\alpha_3$	3.37E-07	8.10E-03	1.69E-03	3.82E-02	1.52E-03	2.7162E-01	3.3280E+01

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9098200	0.9612840	0.9670770	0.9929170	0.9605090	4.9794E+01	2.0055E+00
$\alpha_2$	2.67E-03	2.63E-02	2.05E-02	6.99E-02	3.54E-02	1.3628E+00	5.0437E+01
$\alpha_3$	1.16E-05	8.10E-03	3.14E-03	3.30E-02	3.96E-03	4.1941E-01	5.1380E+01
$\alpha_4$	1.93E-08	4.31E-03	5.95E-04	2.16E-02	1.58E-04	2.2327E-01	5.1576E+01

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9298630	0.9639350	0.9668600	0.9879950	0.9516930	1.0064E+02	3.7654E+00
$\alpha_2$	4.71E-03	2.21E-02	1.91E-02	4.97E-02	4.08E-02	2.3062E+00	1.0210E+02
$\alpha_3$	5.13E-04	9.67E-03	6.77E-03	2.87E-02	6.89E-03	1.0098E+00	1.0340E+02
$\alpha_4$	2.50E-06	3.61E-03	1.23E-03	1.53E-02	5.53E-04	3.7699E-01	1.0403E+02
$\alpha_5$	6.05E-21	6.93E-04	3.97E-07	4.01E-03	2.13E-05	7.2377E-02	1.0433E+02

AC Power Distribution Breakers  
 480 Vac Circuit Breakers  
 480 V CIRCUIT BREAKERS FAIL TO OPEN  
 CCCG = 6

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9331270	0.9638210	0.9662340	0.9862570	0.9446800	1.2222E+02	4.5878E+00
$\alpha_2$	4.52E-03	1.96E-02	1.71E-02	4.31E-02	4.41E-02	2.4854E+00	1.2432E+02
$\alpha_3$	7.36E-04	9.44E-03	7.02E-03	2.64E-02	9.97E-03	1.1975E+00	1.2561E+02
$\alpha_4$	4.44E-05	4.72E-03	2.50E-03	1.70E-02	1.22E-03	5.9902E-01	1.2621E+02
$\alpha_5$	7.51E-09	1.76E-03	2.39E-04	8.79E-03	7.16E-05	2.2260E-01	1.2659E+02
$\alpha_6$	1.11E-18	6.56E-04	1.15E-06	3.83E-03	0.00E+00	8.3237E-02	1.2672E+02

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9415240	0.9652780	0.9668410	0.9836880	0.9390090	1.9011E+02	6.8384E+00
$\alpha_2$	5.22E-03	1.72E-02	1.56E-02	3.46E-02	4.56E-02	3.3822E+00	1.9357E+02
$\alpha_3$	1.26E-03	8.71E-03	7.11E-03	2.16E-02	1.30E-02	1.7150E+00	1.9523E+02
$\alpha_4$	2.64E-04	5.09E-03	3.54E-03	1.52E-02	2.14E-03	1.0027E+00	1.9595E+02
$\alpha_5$	1.32E-05	2.66E-03	1.26E-03	1.00E-02	2.02E-04	5.2307E-01	1.9643E+02
$\alpha_6$	3.44E-10	9.46E-04	8.09E-05	4.97E-03	1.55E-05	1.8638E-01	1.9676E+02
$\alpha_7$	0.00E+00	1.48E-04	1.29E-13	5.56E-04	0.00E+00	2.9071E-02	1.9692E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9445330	0.9660020	0.9673240	0.9829570	0.9346470	2.2555E+02	7.9381E+00
$\alpha_2$	5.11E-03	1.58E-02	1.44E-02	3.11E-02	4.59E-02	3.6798E+00	2.2981E+02
$\alpha_3$	1.28E-03	7.94E-03	6.58E-03	1.92E-02	1.58E-02	1.8534E+00	2.3163E+02
$\alpha_4$	3.71E-04	5.01E-03	3.69E-03	1.42E-02	3.26E-03	1.1703E+00	2.3232E+02
$\alpha_5$	5.63E-05	3.05E-03	1.80E-03	1.03E-02	4.11E-04	7.1133E-01	2.3278E+02
$\alpha_6$	8.94E-07	1.57E-03	5.15E-04	6.73E-03	2.74E-05	3.6716E-01	2.3312E+02
$\alpha_7$	6.97E-14	5.27E-04	9.47E-06	3.00E-03	0.00E+00	1.2297E-01	2.3337E+02
$\alpha_8$	1.31E-42	1.42E-04	2.02E-12	6.00E-04	0.00E+00	3.3124E-02	2.3345E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9844030	0.9713440	0.9605090	0.9516930	0.9446800	0.9390090	0.9346470
$\alpha_2$	1.56E-02	2.71E-02	3.54E-02	4.08E-02	4.41E-02	4.56E-02	4.59E-02
$\alpha_3$		1.52E-03	3.96E-03	6.89E-03	9.97E-03	1.30E-02	1.58E-02
$\alpha_4$			1.58E-04	5.53E-04	1.22E-03	2.14E-03	3.26E-03
$\alpha_5$				2.13E-05	7.16E-05	2.02E-04	4.11E-04
$\alpha_6$					0.00E+00	1.55E-05	2.74E-05
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

## 480 Vac Circuit Breakers

## 480 V CIRCUIT BREAKERS FAIL TO OPEN

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.84E-01	9.71E-01	9.61E-01	9.52E-01	9.45E-01	9.39E-01	9.35E-01
Beta	1.56E-02	2.87E-02	3.95E-02	4.83E-02	5.53E-02	6.10E-02	6.54E-02
Gamma		5.30E-02	1.04E-01	1.55E-01	2.03E-01	2.52E-01	2.98E-01
Delta			3.82E-02	7.69E-02	1.14E-01	1.54E-01	1.90E-01
Epsilon				3.70E-02	5.56E-02	9.21E-02	1.19E-01
Mu					0.00E+00	7.14E-02	6.25E-02
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	1.53	2.29	3.05	3.81	4.58	5.34	6.10
N <sub>1</sub>	0.4013	0.5234	0.6081	0.6641	0.6984	0.7167	0.7233
N <sub>2</sub>	0.0306	0.0786	0.1347	0.1920	0.2462	0.2944	0.3351
N <sub>3</sub>		0.0044	0.0151	0.0324	0.0557	0.0838	0.1150
N <sub>4</sub>			0.0006	0.0026	0.0068	0.0138	0.0238
N <sub>5</sub>				0.0001	0.0004	0.0013	0.0030
N <sub>6</sub>					0.0000	0.0001	0.0002
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

AC Power Distribution Breakers  
 480 Vac Circuit Breakers  
 480 V CIRCUIT BREAKERS FAIL TO CLOSE  
**480 V CIRCUIT BREAKERS FAIL TO CLOSE**

2010

System : Plant ac power  
 Component : Circuit Breaker  
 Failure Mode : Fail to close (reset) on demand  
 Component Group : 480 Volt  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 48.20  
 Total Number of Common-Cause Failure Events: 1

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8946290	0.9730650	0.9882370	0.9999270	0.9960820	1.6601E+01	4.5952E-01
$\alpha_2$	6.94E-05	2.69E-02	1.18E-02	1.05E-01	3.92E-03	4.5952E-01	1.6601E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9185560	0.9708280	0.9782260	0.9977840	0.9925070	3.9013E+01	1.1723E+00
$\alpha_2$	9.03E-04	2.25E-02	1.52E-02	6.90E-02	7.30E-03	9.0326E-01	3.9282E+01
$\alpha_3$	2.52E-07	6.69E-03	1.37E-03	3.17E-02	1.89E-04	2.6902E-01	3.9916E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9231590	0.9671750	0.9721710	0.9940750	0.9892790	5.8657E+01	1.9908E+00
$\alpha_2$	2.24E-03	2.24E-02	1.74E-02	5.96E-02	1.02E-02	1.3567E+00	5.9291E+01
$\alpha_3$	8.57E-06	6.78E-03	2.57E-03	2.78E-02	5.61E-04	4.1141E-01	6.0236E+01
$\alpha_4$	1.59E-08	3.67E-03	5.03E-04	1.84E-02	0.00E+00	2.2267E-01	6.0425E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9366560	0.9675000	0.9701630	0.9892270	0.9864070	1.1171E+02	3.7525E+00
$\alpha_2$	4.27E-03	2.00E-02	1.73E-02	4.50E-02	1.25E-02	2.3106E+00	1.1315E+02
$\alpha_3$	4.41E-04	8.62E-03	6.00E-03	2.58E-02	1.14E-03	9.9528E-01	1.1447E+02
$\alpha_4$	2.13E-06	3.24E-03	1.09E-03	1.38E-02	0.00E+00	3.7439E-01	1.1509E+02
$\alpha_5$	5.17E-21	6.26E-04	3.54E-07	3.62E-03	0.00E+00	7.2277E-02	1.1539E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9394480	0.9672890	0.9694890	0.9876020	0.9839070	1.3550E+02	4.5823E+00
$\alpha_2$	4.16E-03	1.79E-02	1.57E-02	3.93E-02	1.42E-02	2.5071E+00	1.3758E+02
$\alpha_3$	6.32E-04	8.41E-03	6.21E-03	2.37E-02	1.89E-03	1.1775E+00	1.3890E+02
$\alpha_4$	3.78E-05	4.23E-03	2.21E-03	1.53E-02	0.00E+00	5.9222E-01	1.3949E+02
$\alpha_5$	6.63E-09	1.59E-03	2.15E-04	7.95E-03	0.00E+00	2.2220E-01	1.3986E+02
$\alpha_6$	1.01E-18	5.94E-04	1.04E-06	3.47E-03	0.00E+00	8.3237E-02	1.4000E+02

AC Power Distribution Breakers  
 480 Vac Circuit Breakers  
 480 V CIRCUIT BREAKERS FAIL TO CLOSE  
 CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9457110	0.9677780	0.9692400	0.9848640	0.9817680	2.0559E+02	6.8450E+00
$\alpha_2$	4.95E-03	1.61E-02	1.46E-02	3.24E-02	1.54E-02	3.4253E+00	2.0901E+02
$\alpha_3$	1.14E-03	7.97E-03	6.49E-03	1.99E-02	2.85E-03	1.6937E+00	2.1074E+02
$\alpha_4$	2.33E-04	4.65E-03	3.22E-03	1.40E-02	0.00E+00	9.8887E-01	2.1145E+02
$\alpha_5$	1.21E-05	2.46E-03	1.16E-03	9.28E-03	0.00E+00	5.2177E-01	2.1191E+02
$\alpha_6$	3.16E-10	8.77E-04	7.49E-05	4.60E-03	0.00E+00	1.8628E-01	2.1225E+02
$\alpha_7$	0.00E+00	1.37E-04	1.20E-13	5.15E-04	0.00E+00	2.9071E-02	2.1241E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9482890	0.9683070	0.9695460	0.9841050	0.9800000	2.4323E+02	7.9610E+00
$\alpha_2$	4.89E-03	1.49E-02	1.36E-02	2.93E-02	1.60E-02	3.7447E+00	2.4745E+02
$\alpha_3$	1.17E-03	7.32E-03	6.06E-03	1.78E-02	4.00E-03	1.8384E+00	2.4935E+02
$\alpha_4$	3.23E-04	4.56E-03	3.34E-03	1.30E-02	0.00E+00	1.1465E+00	2.5004E+02
$\alpha_5$	5.13E-05	2.82E-03	1.66E-03	9.54E-03	0.00E+00	7.0833E-01	2.5048E+02
$\alpha_6$	8.27E-07	1.46E-03	4.78E-04	6.25E-03	0.00E+00	3.6696E-01	2.5082E+02
$\alpha_7$	6.48E-14	4.90E-04	8.80E-06	2.79E-03	0.00E+00	1.2297E-01	2.5107E+02
$\alpha_8$	1.21E-42	1.32E-04	1.88E-12	5.57E-04	0.00E+00	3.3124E-02	2.5116E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9960820	0.9925070	0.9892790	0.9864070	0.9839070	0.9817680	0.9800000
$\alpha_2$	3.92E-03	7.30E-03	1.02E-02	1.25E-02	1.42E-02	1.54E-02	1.60E-02
$\alpha_3$		1.89E-04	5.61E-04	1.14E-03	1.89E-03	2.85E-03	4.00E-03
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.96E-01	9.93E-01	9.89E-01	9.86E-01	9.84E-01	9.82E-01	9.80E-01
Beta	3.92E-03	7.49E-03	1.07E-02	1.36E-02	1.61E-02	1.82E-02	2.00E-02
Gamma		2.52E-02	5.23E-02	8.35E-02	1.18E-01	1.56E-01	2.00E-01
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

AC Power Distribution Breakers  
 480 Vac Circuit Breakers  
 480 V CIRCUIT BREAKERS FAIL TO CLOSE

2010

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	6.03	9.04	12.05	15.06	18.08	21.09	24.10
N <sub>1</sub>	0.3250	0.4179	0.4714	0.4911	0.4821	0.4500	0.4000
N <sub>2</sub>	0.0250	0.0696	0.1286	0.1964	0.2679	0.3375	0.4000
N <sub>3</sub>		0.0018	0.0071	0.0179	0.0357	0.0625	0.1000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

AC Power Distribution Breakers  
 480 Vac Circuit Breakers  
 480 V CIRCUIT BREAKERS SPURIOUS ACTUATION  
**480 V CIRCUIT BREAKERS SPURIOUS ACTUATION**

2010

System : Plant ac power  
 Component : Circuit Breaker  
 Failure Mode : Spurious operation open or close  
 Component Group : 480 Volt  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 42.20  
 Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9669310	0.9917830	0.9966990	0.9999840	1.0000000	5.2446E+01	4.3452E-01
$\alpha_2$	1.47E-05	8.22E-03	3.30E-03	3.31E-02	0.00E+00	4.3452E-01	5.2446E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9565670	0.9848900	0.9890400	0.9990100	1.0000000	7.1755E+01	1.1009E+00
$\alpha_2$	3.60E-04	1.14E-02	7.39E-03	3.64E-02	0.00E+00	8.3366E-01	7.2022E+01
$\alpha_3$	1.28E-07	3.67E-03	7.36E-04	1.74E-02	0.00E+00	2.6722E-01	7.2589E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9504890	0.9794320	0.9828630	0.9966420	1.0000000	8.8336E+01	1.8551E+00
$\alpha_2$	1.12E-03	1.36E-02	1.02E-02	3.77E-02	0.00E+00	1.2281E+00	8.8963E+01
$\alpha_3$	5.03E-06	4.48E-03	1.66E-03	1.85E-02	0.00E+00	4.0431E-01	8.9787E+01
$\alpha_4$	1.06E-08	2.47E-03	3.37E-04	1.24E-02	0.00E+00	2.2267E-01	8.9968E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9504910	0.9750650	0.9772670	0.9921220	1.0000000	1.3836E+02	3.5382E+00
$\alpha_2$	2.86E-03	1.49E-02	1.27E-02	3.45E-02	0.00E+00	2.1142E+00	1.3978E+02
$\alpha_3$	3.36E-04	6.89E-03	4.75E-03	2.07E-02	0.00E+00	9.7738E-01	1.4092E+02
$\alpha_4$	1.73E-06	2.64E-03	8.88E-04	1.12E-02	0.00E+00	3.7439E-01	1.4152E+02
$\alpha_5$	4.20E-21	5.09E-04	2.88E-07	2.95E-03	0.00E+00	7.2277E-02	1.4183E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9505740	0.9738180	0.9757310	0.9905280	1.0000000	1.5914E+02	4.2787E+00
$\alpha_2$	2.81E-03	1.37E-02	1.18E-02	3.12E-02	0.00E+00	2.2392E+00	1.6118E+02
$\alpha_3$	4.91E-04	6.99E-03	5.11E-03	1.99E-02	0.00E+00	1.1418E+00	1.6228E+02
$\alpha_4$	3.24E-05	3.62E-03	1.90E-03	1.31E-02	0.00E+00	5.9222E-01	1.6283E+02
$\alpha_5$	5.68E-09	1.36E-03	1.84E-04	6.81E-03	0.00E+00	2.2220E-01	1.6320E+02
$\alpha_6$	8.62E-19	5.09E-04	8.90E-07	2.97E-03	0.00E+00	8.3237E-02	1.6334E+02

AC Power Distribution Breakers  
 480 Vac Circuit Breakers  
 480 V CIRCUIT BREAKERS SPURIOUS ACTUATION  
 CCCG = 7

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9526440	0.9723030	0.9736480	0.9873780	1.0000000	2.2625E+02	6.4450E+00
$\alpha_2$	3.73E-03	1.33E-02	1.19E-02	2.75E-02	0.00E+00	3.0878E+00	2.2961E+02
$\alpha_3$	9.44E-04	7.01E-03	5.66E-03	1.77E-02	0.00E+00	1.6312E+00	2.3106E+02
$\alpha_4$	2.13E-04	4.25E-03	2.94E-03	1.28E-02	0.00E+00	9.8887E-01	2.3171E+02
$\alpha_5$	1.10E-05	2.24E-03	1.06E-03	8.48E-03	0.00E+00	5.2177E-01	2.3217E+02
$\alpha_6$	2.89E-10	8.01E-04	6.83E-05	4.20E-03	0.00E+00	1.8628E-01	2.3251E+02
$\alpha_7$	0.00E+00	1.25E-04	1.09E-13	4.70E-04	0.00E+00	2.9071E-02	2.3267E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9539690	0.9722010	0.9733640	0.9864490	1.0000000	2.6093E+02	7.4610E+00
$\alpha_2$	3.75E-03	1.25E-02	1.13E-02	2.52E-02	0.00E+00	3.3447E+00	2.6505E+02
$\alpha_3$	9.58E-04	6.48E-03	5.30E-03	1.60E-02	0.00E+00	1.7384E+00	2.6665E+02
$\alpha_4$	3.02E-04	4.27E-03	3.12E-03	1.22E-02	0.00E+00	1.1465E+00	2.6724E+02
$\alpha_5$	4.80E-05	2.64E-03	1.55E-03	8.93E-03	0.00E+00	7.0833E-01	2.6768E+02
$\alpha_6$	7.74E-07	1.37E-03	4.47E-04	5.85E-03	0.00E+00	3.6696E-01	2.6802E+02
$\alpha_7$	6.07E-14	4.58E-04	8.24E-06	2.61E-03	0.00E+00	1.2297E-01	2.6827E+02
$\alpha_8$	1.14E-42	1.23E-04	1.76E-12	5.21E-04	0.00E+00	3.3124E-02	2.6836E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00



## 480 Vac Circuit Breakers

## 480 V CIRCUIT BREAKERS SPURIOUS ACTUATION

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	42.20	42.20	42.20	42.20	42.20	42.20	42.20
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

**4160 vac and 6.9Kva Distribution Circuit Breakers****ACP 4160 AND 6.9 CIRCUIT BREAKERS FAIL TO OPEN SPAR: CRB-CC**

**System :** Plant ac power  
**Component :** Circuit Breaker  
**Failure Mode :** Fail to open on demand  
**Component Group :** 4160 - 6900 Volt  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 16.10

Total Number of Common-Cause Failure Events: 2

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8699270	0.9661810	0.9845710	0.9998930	0.9875910	1.3628E+01	4.7702E-01
$\alpha_2$	1.09E-04	3.38E-02	1.54E-02	1.30E-01	1.24E-02	4.7702E-01	1.3628E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9058520	0.9656470	0.9739180	0.9971220	0.9750400	3.4512E+01	1.2278E+00
$\alpha_2$	1.28E-03	2.69E-02	1.87E-02	8.05E-02	2.49E-02	9.6026E-01	3.4780E+01
$\alpha_3$	2.66E-07	7.49E-03	1.52E-03	3.55E-02	5.90E-05	2.6752E-01	3.5472E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9115860	0.9614580	0.9669550	0.9925130	0.9622640	5.2575E+01	2.1076E+00
$\alpha_2$	3.17E-03	2.71E-02	2.15E-02	6.99E-02	3.75E-02	1.4793E+00	5.3203E+01
$\alpha_3$	8.55E-06	7.42E-03	2.77E-03	3.06E-02	1.94E-04	4.0561E-01	5.4277E+01
$\alpha_4$	1.76E-08	4.07E-03	5.58E-04	2.04E-02	0.00E+00	2.2267E-01	5.4460E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9296570	0.9633470	0.9661740	0.9873600	0.9492900	1.0400E+02	3.9569E+00
$\alpha_2$	5.51E-03	2.34E-02	2.06E-02	5.12E-02	5.03E-02	2.5299E+00	1.0543E+02
$\alpha_3$	4.47E-04	9.08E-03	6.28E-03	2.73E-02	3.63E-04	9.8038E-01	1.0698E+02
$\alpha_4$	2.28E-06	3.47E-03	1.17E-03	1.47E-02	0.00E+00	3.7439E-01	1.0758E+02
$\alpha_5$	5.53E-21	6.69E-04	3.79E-07	3.88E-03	0.00E+00	7.2277E-02	1.0788E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9319670	0.9625690	0.9649000	0.9851910	0.9361010	1.2610E+02	4.9037E+00
$\alpha_2$	5.76E-03	2.18E-02	1.94E-02	4.60E-02	6.33E-02	2.8582E+00	1.2815E+02
$\alpha_3$	6.24E-04	8.76E-03	6.42E-03	2.49E-02	6.03E-04	1.1477E+00	1.2986E+02
$\alpha_4$	4.05E-05	4.52E-03	2.37E-03	1.63E-02	1.02E-05	5.9232E-01	1.3041E+02
$\alpha_5$	7.09E-09	1.70E-03	2.30E-04	8.50E-03	0.00E+00	2.2220E-01	1.3078E+02
$\alpha_6$	1.08E-18	6.35E-04	1.11E-06	3.71E-03	0.00E+00	8.3237E-02	1.3092E+02

## 4160 vac and 6.9Kva Distribution Circuit Breakers

## ACP 4160 AND 6.9 CIRCUIT BREAKERS FAIL TO OPEN SPAR: CRB-CC

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9398470	0.9637380	0.9652650	0.9824310	0.9226780	1.9444E+02	7.3160E+00
$\alpha_2$	6.68E-03	1.96E-02	1.80E-02	3.78E-02	7.64E-02	3.9484E+00	1.9781E+02
$\alpha_3$	1.11E-03	8.14E-03	6.58E-03	2.05E-02	8.97E-04	1.6413E+00	2.0011E+02
$\alpha_4$	2.46E-04	4.90E-03	3.39E-03	1.47E-02	2.66E-05	9.8917E-01	2.0077E+02
$\alpha_5$	1.27E-05	2.59E-03	1.22E-03	9.77E-03	0.00E+00	5.2177E-01	2.0123E+02
$\alpha_6$	3.33E-10	9.23E-04	7.88E-05	4.85E-03	0.00E+00	1.8628E-01	2.0157E+02
$\alpha_7$	0.00E+00	1.44E-04	1.26E-13	5.42E-04	0.00E+00	2.9071E-02	2.0173E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9421670	0.9639310	0.9652210	0.9812980	0.9090370	2.3028E+02	8.6169E+00
$\alpha_2$	6.98E-03	1.88E-02	1.74E-02	3.51E-02	8.97E-02	4.4843E+00	2.3441E+02
$\alpha_3$	1.10E-03	7.34E-03	6.02E-03	1.81E-02	1.24E-03	1.7541E+00	2.3714E+02
$\alpha_4$	3.40E-04	4.80E-03	3.51E-03	1.37E-02	4.72E-05	1.1471E+00	2.3775E+02
$\alpha_5$	5.40E-05	2.97E-03	1.74E-03	1.00E-02	0.00E+00	7.0833E-01	2.3819E+02
$\alpha_6$	8.69E-07	1.54E-03	5.03E-04	6.57E-03	0.00E+00	3.6696E-01	2.3853E+02
$\alpha_7$	6.82E-14	5.15E-04	9.26E-06	2.93E-03	0.00E+00	1.2297E-01	2.3877E+02
$\alpha_8$	1.28E-42	1.39E-04	1.98E-12	5.86E-04	0.00E+00	3.3124E-02	2.3886E+02

## ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9875910	0.9750400	0.9622640	0.9492900	0.9361010	0.9226780	0.9090370
$\alpha_2$	1.24E-02	2.49E-02	3.75E-02	5.03E-02	6.33E-02	7.64E-02	8.97E-02
$\alpha_3$		5.90E-05	1.94E-04	3.63E-04	6.03E-04	8.97E-04	1.24E-03
$\alpha_4$			0.00E+00	0.00E+00	1.02E-05	2.66E-05	4.72E-05
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.88E-01	9.75E-01	9.62E-01	9.49E-01	9.36E-01	9.23E-01	9.09E-01
Beta	1.24E-02	2.50E-02	3.77E-02	5.07E-02	6.39E-02	7.73E-02	9.10E-02
Gamma		2.36E-03	5.15E-03	7.17E-03	9.60E-03	1.19E-02	1.41E-02
Delta			0.00E+00	0.00E+00	1.67E-02	2.88E-02	3.68E-02
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

AC Power Distribution Breakers  
 4160 vac and 6.9Kva Distribution Circuit Breakers

2010

ACP 4160 AND 6.9 CIRCUIT BREAKERS FAIL TO OPEN SPAR: CRB-CC

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	2.68	4.03	5.37	6.71	8.05	9.39	10.73
N <sub>1</sub>	0.7025	0.9272	1.0688	1.1281	1.1061	1.0036	0.8214
N <sub>2</sub>	0.0425	0.1266	0.2512	0.4157	0.6190	0.8606	1.1396
N <sub>3</sub>		0.0003	0.0013	0.0030	0.0059	0.0101	0.0157
N <sub>4</sub>			0.0000	0.0000	0.0001	0.0003	0.0006
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

**ACP 4160 AND 6.9 CIRCUIT BREAKERS FAIL TO CLOSE SPAR: CRB-OO**

System : Plant ac power  
 Component : Circuit Breaker  
 Failure Mode : Fail to close (reset) on demand  
 Component Group : 4160 - 6900 Volt  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 59.80

Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9751720	0.9938350	0.9975270	0.9999880	1.0000000	7.0046E+01	4.3452E-01
$\alpha_2$	1.10E-05	6.17E-03	2.47E-03	2.48E-02	0.00E+00	4.3452E-01	7.0046E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9649640	0.9827910	0.9911930	0.9992040	1.0000000	8.9355E+01	1.1009E+00
$\alpha_2$	2.89E-04	9.22E-03	5.94E-03	2.93E-02	0.00E+00	8.3366E-01	8.9622E+01
$\alpha_3$	1.03E-07	2.95E-03	5.92E-04	1.40E-02	0.00E+00	2.6722E-01	9.0189E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9585110	0.9827910	0.9856790	0.9971970	1.0000000	1.0594E+02	1.8551E+00
$\alpha_2$	9.36E-04	1.14E-02	8.54E-03	3.16E-02	0.00E+00	1.2281E+00	1.0657E+02
$\alpha_3$	4.20E-06	3.75E-03	1.39E-03	1.55E-02	0.00E+00	4.0431E-01	1.0739E+02
$\alpha_4$	8.88E-09	2.07E-03	2.82E-04	1.03E-02	0.00E+00	2.2267E-01	1.0757E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9559140	0.9778160	0.9797820	0.9930000	1.0000000	1.5596E+02	3.5382E+00
$\alpha_2$	2.54E-03	1.33E-02	1.13E-02	3.07E-02	0.00E+00	2.1142E+00	1.5738E+02
$\alpha_3$	2.98E-04	6.13E-03	4.23E-03	1.84E-02	0.00E+00	9.7738E-01	1.5852E+02
$\alpha_4$	1.54E-06	2.35E-03	7.89E-04	9.97E-03	0.00E+00	3.7439E-01	1.5912E+02
$\alpha_5$	3.74E-21	4.53E-04	2.56E-07	2.62E-03	0.00E+00	7.2277E-02	1.5943E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9553410	0.9763630	0.9781000	0.9914630	1.0000000	1.7674E+02	4.2787E+00
$\alpha_2$	2.54E-03	1.24E-02	1.06E-02	2.82E-02	0.00E+00	2.2392E+00	1.7878E+02
$\alpha_3$	4.43E-04	6.31E-03	4.61E-03	1.80E-02	0.00E+00	1.1418E+00	1.7988E+02
$\alpha_4$	2.92E-05	3.27E-03	1.71E-03	1.18E-02	0.00E+00	5.9222E-01	1.8043E+02
$\alpha_5$	5.13E-09	1.23E-03	1.66E-04	6.15E-03	0.00E+00	2.2220E-01	1.8080E+02
$\alpha_6$	7.78E-19	4.60E-04	8.04E-07	2.68E-03	0.00E+00	8.3237E-02	1.8094E+02

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9559450	0.9742500	0.9755060	0.9882740	1.0000000	2.4385E+02	6.4450E+00
$\alpha_2$	3.47E-03	1.23E-02	1.11E-02	2.56E-02	0.00E+00	3.0878E+00	2.4721E+02
$\alpha_3$	8.77E-04	6.52E-03	5.26E-03	1.65E-02	0.00E+00	1.6312E+00	2.4866E+02
$\alpha_4$	1.98E-04	3.95E-03	2.73E-03	1.19E-02	0.00E+00	9.8887E-01	2.4931E+02
$\alpha_5$	1.02E-05	2.08E-03	9.86E-04	7.88E-03	0.00E+00	5.2177E-01	2.4977E+02
$\alpha_6$	2.68E-10	7.44E-04	6.35E-05	3.91E-03	0.00E+00	1.8628E-01	2.5011E+02
$\alpha_7$	0.00E+00	1.16E-04	1.02E-13	4.37E-04	0.00E+00	2.9071E-02	2.5027E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9567850	0.9739120	0.9750110	0.9872950	1.0000000	2.7853E+02	7.4610E+00
$\alpha_2$	3.51E-03	1.17E-02	1.06E-02	2.37E-02	0.00E+00	3.3447E+00	2.8265E+02
$\alpha_3$	8.99E-04	6.08E-03	4.97E-03	1.50E-02	0.00E+00	1.7384E+00	2.8425E+02
$\alpha_4$	2.84E-04	4.01E-03	2.93E-03	1.14E-02	0.00E+00	1.1465E+00	2.8484E+02
$\alpha_5$	4.51E-05	2.48E-03	1.46E-03	8.38E-03	0.00E+00	7.0833E-01	2.8528E+02
$\alpha_6$	7.26E-07	1.28E-03	4.20E-04	5.49E-03	0.00E+00	3.6696E-01	2.8562E+02
$\alpha_7$	5.69E-14	4.30E-04	7.73E-06	2.45E-03	0.00E+00	1.2297E-01	2.8587E+02
$\alpha_8$	1.07E-42	1.16E-04	1.65E-12	4.89E-04	0.00E+00	3.3124E-02	2.8596E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

AC Power Distribution Breakers  
 4160 vac and 6.9Kva Distribution Circuit Breakers

2010

ACP 4160 AND 6.9 CIRCUIT BREAKERS FAIL TO CLOSE SPAR: CRB-OO

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	59.80	59.80	59.80	59.80	59.80	59.80	59.80
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

**ACP 4160 AND 6.9 CIRCUIT BREAKERS SPURIOUS OP SPAR: CRB-CO**

System : Plant ac power  
 Component : Circuit Breaker  
 Failure Mode : Spurious operation open or close  
 Component Group : 4160 - 6900 Volt  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 34.50

Total Number of Common-Cause Failure Events: 3

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8873580	0.9699960	0.9855150	0.9998620	0.9878150	1.6569E+01	5.1252E-01
$\alpha_2$	1.40E-04	3.00E-02	1.45E-02	1.13E-01	1.22E-02	5.1252E-01	1.6569E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9113590	0.9667450	0.9741620	0.9967340	0.9753380	3.8801E+01	1.3347E+00
$\alpha_2$	1.64E-03	2.66E-02	1.92E-02	7.68E-02	2.46E-02	1.0673E+00	3.9068E+01
$\alpha_3$	2.36E-07	6.66E-03	1.35E-03	3.16E-02	2.11E-05	2.6742E-01	3.9868E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9144750	0.9616040	0.9665900	0.9916710	0.9625990	5.8150E+01	2.3219E+00
$\alpha_2$	4.06E-03	2.80E-02	2.30E-02	6.92E-02	3.74E-02	1.6943E+00	5.8778E+01
$\alpha_3$	7.62E-06	6.70E-03	2.49E-03	2.76E-02	4.81E-05	4.0491E-01	6.0067E+01
$\alpha_4$	1.59E-08	3.68E-03	5.04E-04	1.84E-02	0.00E+00	2.2267E-01	6.0249E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9296580	0.9625100	0.9651600	0.9862920	0.9495530	1.1079E+02	4.3153E+00
$\alpha_2$	6.71E-03	2.51E-02	2.24E-02	5.27E-02	5.04E-02	2.8899E+00	1.1222E+02
$\alpha_3$	4.17E-04	8.50E-03	5.88E-03	2.56E-02	9.09E-05	9.7878E-01	1.1413E+02
$\alpha_4$	2.14E-06	3.25E-03	1.10E-03	1.38E-02	0.00E+00	3.7439E-01	1.1473E+02
$\alpha_5$	5.18E-21	6.28E-04	3.55E-07	3.63E-03	0.00E+00	7.2277E-02	1.1503E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9308660	0.9609780	0.9631660	0.9836140	0.9362390	1.3404E+02	5.4430E+00
$\alpha_2$	7.47E-03	2.44E-02	2.21E-02	4.89E-02	6.36E-02	3.4008E+00	1.3608E+02
$\alpha_3$	5.80E-04	8.20E-03	6.00E-03	2.33E-02	1.42E-04	1.1444E+00	1.3834E+02
$\alpha_4$	3.80E-05	4.25E-03	2.22E-03	1.53E-02	5.48E-06	5.9232E-01	1.3889E+02
$\alpha_5$	6.66E-09	1.59E-03	2.16E-04	7.98E-03	0.00E+00	2.2220E-01	1.3926E+02
$\alpha_6$	1.01E-18	5.97E-04	1.04E-06	3.48E-03	0.00E+00	8.3237E-02	1.3940E+02



ACP 4160 AND 6.9 CIRCUIT BREAKERS SPURIOUS OP SPAR: CRB-CO  
CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9404460	0.9637370	0.9651920	0.9820650	0.9417840	2.0392E+02	7.6731E+00
$\alpha_2$	6.82E-03	1.94E-02	1.79E-02	3.71E-02	4.85E-02	4.1114E+00	2.0748E+02
$\alpha_3$	1.39E-03	8.67E-03	7.18E-03	2.11E-02	9.68E-03	1.8355E+00	2.0976E+02
$\alpha_4$	2.34E-04	4.67E-03	3.24E-03	1.40E-02	9.48E-06	9.8907E-01	2.1060E+02
$\alpha_5$	1.21E-05	2.47E-03	1.17E-03	9.32E-03	0.00E+00	5.2177E-01	2.1107E+02
$\alpha_6$	3.18E-10	8.80E-04	7.52E-05	4.62E-03	0.00E+00	1.8628E-01	2.1141E+02
$\alpha_7$	0.00E+00	1.37E-04	1.20E-13	5.17E-04	0.00E+00	2.9071E-02	2.1156E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9440000	0.9649640	0.9661950	0.9817210	0.9455740	2.4135E+02	8.7629E+00
$\alpha_2$	6.17E-03	1.71E-02	1.58E-02	3.24E-02	3.91E-02	4.2796E+00	2.4583E+02
$\alpha_3$	1.53E-03	8.26E-03	6.99E-03	1.93E-02	1.37E-02	2.0650E+00	2.4805E+02
$\alpha_4$	3.62E-04	4.75E-03	3.51E-03	1.34E-02	1.69E-03	1.1869E+00	2.4893E+02
$\alpha_5$	5.15E-05	2.83E-03	1.66E-03	9.59E-03	0.00E+00	7.0833E-01	2.4940E+02
$\alpha_6$	8.30E-07	1.47E-03	4.80E-04	6.28E-03	0.00E+00	3.6696E-01	2.4975E+02
$\alpha_7$	6.51E-14	4.92E-04	8.84E-06	2.80E-03	0.00E+00	1.2297E-01	2.4999E+02
$\alpha_8$	1.22E-42	1.32E-04	1.89E-12	5.60E-04	0.00E+00	3.3124E-02	2.5008E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9878150	0.9753380	0.9625990	0.9495530	0.9362390	0.9417840	0.9455740
$\alpha_2$	1.22E-02	2.46E-02	3.74E-02	5.04E-02	6.36E-02	4.85E-02	3.91E-02
$\alpha_3$		2.11E-05	4.81E-05	9.09E-05	1.42E-04	9.68E-03	1.37E-02
$\alpha_4$			0.00E+00	0.00E+00	5.48E-06	9.48E-06	1.69E-03
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.88E-01	9.75E-01	9.63E-01	9.50E-01	9.36E-01	9.42E-01	9.46E-01
Beta	1.22E-02	2.47E-02	3.74E-02	5.04E-02	6.38E-02	5.82E-02	5.44E-02
Gamma		8.55E-04	1.29E-03	1.80E-03	2.32E-03	1.67E-01	2.82E-01
Delta			0.00E+00	0.00E+00	3.70E-02	9.78E-04	1.10E-01
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

AC Power Distribution Breakers  
 4160 vac and 6.9Kva Distribution Circuit Breakers

2010

ACP 4160 AND 6.9 CIRCUIT BREAKERS SPURIOUS OP SPAR: CRB-CO

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	5.45	8.17	10.89	13.61	16.34	19.06	21.78
N <sub>1</sub>	0.8732	1.0762	1.1241	1.0173	0.7561	0.8076	0.8387
N <sub>2</sub>	0.0780	0.2336	0.4662	0.7757	1.1616	1.0236	0.9349
N <sub>3</sub>		0.0002	0.0006	0.0014	0.0026	0.2043	0.3266
N <sub>4</sub>			0.0000	0.0000	0.0001	0.0002	0.0404
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

Batteries

DC POWER BATTERY NO OUTPUT SPAR:BAT-LP

# DC Power System - Batteries, Chargers, and Breakers

## Batteries

DC POWER BATTERY NO OUTPUT SPAR:BAT-LP

System : dc power  
 Component : Battery  
 Failure Mode :  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 50.60

Total Number of Common-Cause Failure Events: 0

### ALPHA FACTOR DISTRIBUTIONS

#### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9714550	0.9929090	0.9971570	0.9999860	1.0000000	6.0846E+01	4.3452E-01
$\alpha_2$	1.27E-05	7.09E-03	2.85E-03	2.85E-02	0.00E+00	4.3452E-01	6.0846E+01

#### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9610260	0.9864520	0.9901830	0.9991130	1.0000000	8.0155E+01	1.1009E+00
$\alpha_2$	3.23E-04	1.03E-02	6.62E-03	3.26E-02	0.00E+00	8.3366E-01	8.0422E+01
$\alpha_3$	1.15E-07	3.29E-03	6.59E-04	1.56E-02	0.00E+00	2.6722E-01	8.0989E+01

#### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9546710	0.9811840	0.9843330	0.9969320	1.0000000	9.6736E+01	1.8551E+00
$\alpha_2$	1.02E-03	1.25E-02	9.35E-03	3.45E-02	0.00E+00	1.2281E+00	9.7363E+01
$\alpha_3$	4.60E-06	4.10E-03	1.52E-03	1.70E-02	0.00E+00	4.0431E-01	9.8187E+01
$\alpha_4$	9.71E-09	2.26E-03	3.08E-04	1.13E-02	0.00E+00	2.2267E-01	9.8368E+01

#### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9532340	0.9764580	0.9785440	0.9925670	1.0000000	1.4676E+02	3.5382E+00
$\alpha_2$	2.70E-03	1.41E-02	1.20E-02	3.26E-02	0.00E+00	2.1142E+00	1.4818E+02
$\alpha_3$	3.17E-04	6.50E-03	4.49E-03	1.96E-02	0.00E+00	9.7738E-01	1.4932E+02
$\alpha_4$	1.63E-06	2.49E-03	8.38E-04	1.06E-02	0.00E+00	3.7439E-01	1.4992E+02
$\alpha_5$	3.97E-21	4.81E-04	2.72E-07	2.78E-03	0.00E+00	7.2277E-02	1.5023E+02

Batteries

DC POWER BATTERY NO OUTPUT SPAR:BAT-LP

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9529700	0.9750980	0.9769220	0.9910010	1.0000000	1.6754E+02	4.2787E+00
$\alpha_2$	2.67E-03	1.30E-02	1.12E-02	2.97E-02	0.00E+00	2.2392E+00	1.6958E+02
$\alpha_3$	4.67E-04	6.65E-03	4.86E-03	1.89E-02	0.00E+00	1.1418E+00	1.7068E+02
$\alpha_4$	3.08E-05	3.45E-03	1.80E-03	1.24E-02	0.00E+00	5.9222E-01	1.7123E+02
$\alpha_5$	5.40E-09	1.29E-03	1.75E-04	6.48E-03	0.00E+00	2.2220E-01	1.7160E+02
$\alpha_6$	8.20E-19	4.84E-04	8.47E-07	2.83E-03	0.00E+00	8.3237E-02	1.7174E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	50.60	50.60	50.60	50.60	50.60
$N_1$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_2$	0.0000	0.0000	0.0000	0.0000	0.0000
$N_3$		0.0000	0.0000	0.0000	0.0000
$N_4$			0.0000	0.0000	0.0000
$N_5$				0.0000	0.0000
$N_6$					0.0000

## Battery Chargers

## DC POWER BATTERY CHARGER LOSS OF FUNCTION SPAR: BCH-FC

**Battery Chargers****DC POWER BATTERY CHARGER LOSS OF FUNCTION SPAR: BCH-FC**

System : dc power  
 Component : Battery Charger  
 Failure Mode : Fail to Operate (General operation failure, rate based)

Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 238.50

Total Number of Common-Cause Failure Events: 9

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9633400	0.9834110	0.9855350	0.9962300	0.9852820	1.4575E+02	2.4587E+00
$\alpha_2$	3.77E-03	1.66E-02	1.45E-02	3.67E-02	1.47E-02	2.4587E+00	1.4575E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9633440	0.9802020	0.9815460	0.9924670	0.9826170	2.3052E+02	4.6560E+00
$\alpha_2$	4.95E-03	1.54E-02	1.41E-02	3.05E-02	1.37E-02	3.6300E+00	2.3155E+02
$\alpha_3$	2.39E-04	4.36E-03	3.06E-03	1.29E-02	3.71E-03	1.0260E+00	2.3415E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9659810	0.9802460	0.9812390	0.9911150	0.9835910	3.1290E+02	6.3055E+00
$\alpha_2$	3.89E-03	1.18E-02	1.08E-02	2.32E-02	9.37E-03	3.7689E+00	3.1544E+02
$\alpha_3$	1.04E-03	6.07E-03	5.08E-03	1.45E-02	5.66E-03	1.9388E+00	3.1727E+02
$\alpha_4$	1.74E-05	1.87E-03	9.85E-04	6.74E-03	1.38E-03	5.9777E-01	3.1861E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9681070	0.9801650	0.9808910	0.9897400	0.9847870	4.2875E+02	8.6763E+00
$\alpha_2$	3.72E-03	1.01E-02	9.39E-03	1.91E-02	6.86E-03	4.4304E+00	4.3300E+02
$\alpha_3$	1.50E-03	6.11E-03	5.38E-03	1.32E-02	5.02E-03	2.6736E+00	4.3475E+02
$\alpha_4$	2.79E-04	3.00E-03	2.29E-03	8.17E-03	2.78E-03	1.3125E+00	4.3611E+02
$\alpha_5$	1.53E-08	5.94E-04	1.12E-04	2.84E-03	5.55E-04	2.5978E-01	4.3717E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9701290	0.9808750	0.9814800	0.9895540	0.9857260	5.1529E+02	1.0047E+01
$\alpha_2$	3.17E-03	8.55E-03	7.93E-03	1.60E-02	5.57E-03	4.4907E+00	5.2085E+02
$\alpha_3$	1.33E-03	5.25E-03	4.64E-03	1.13E-02	4.00E-03	2.7572E+00	5.2258E+02
$\alpha_4$	5.57E-04	3.50E-03	2.89E-03	8.51E-03	3.08E-03	1.8373E+00	5.2350E+02
$\alpha_5$	3.85E-05	1.49E-03	9.28E-04	4.88E-03	1.39E-03	7.8470E-01	5.2455E+02
$\alpha_6$	5.48E-11	3.37E-04	2.47E-05	1.79E-03	2.32E-04	1.7704E-01	5.2516E+02

Battery Chargers

DC POWER BATTERY CHARGER LOSS OF FUNCTION SPAR: BCH-FC

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9711530	0.9807000	0.9811800	0.9885930	0.9865840	6.4816E+02	1.2756E+01
$\alpha_2$	3.31E-03	8.07E-03	7.58E-03	1.45E-02	4.78E-03	5.3358E+00	6.5558E+02
$\alpha_3$	1.32E-03	4.69E-03	4.20E-03	9.73E-03	3.12E-03	3.0967E+00	6.5782E+02
$\alpha_4$	7.41E-04	3.50E-03	3.02E-03	7.93E-03	2.82E-03	2.3151E+00	6.5860E+02
$\alpha_5$	2.29E-04	2.15E-03	1.67E-03	5.69E-03	1.91E-03	1.4180E+00	6.5950E+02
$\alpha_6$	3.55E-06	7.78E-04	3.63E-04	2.96E-03	6.97E-04	5.1438E-01	6.6040E+02
$\alpha_7$	6.77E-21	1.15E-04	9.85E-08	6.67E-04	9.97E-05	7.5971E-02	6.6084E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9725450	0.9812650	0.9816810	0.9885540	0.9872710	7.4855E+02	1.4292E+01
$\alpha_2$	3.16E-03	7.44E-03	7.01E-03	1.32E-02	4.34E-03	5.6753E+00	7.5717E+02
$\alpha_3$	1.12E-03	4.02E-03	3.60E-03	8.37E-03	2.48E-03	3.0677E+00	7.5977E+02
$\alpha_4$	6.98E-04	3.16E-03	2.74E-03	7.06E-03	2.35E-03	2.4102E+00	7.6043E+02
$\alpha_5$	3.63E-04	2.35E-03	1.93E-03	5.77E-03	2.02E-03	1.7944E+00	7.6105E+02
$\alpha_6$	6.21E-05	1.28E-03	8.81E-04	3.87E-03	1.14E-03	9.7756E-01	7.6186E+02
$\alpha_7$	5.94E-08	4.07E-04	1.05E-04	1.84E-03	3.49E-04	3.1047E-01	7.6253E+02
$\alpha_8$	7.41E-27	7.41E-05	3.64E-09	4.10E-04	4.36E-05	5.6524E-02	7.6279E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9852820	0.9826170	0.9835910	0.9847870	0.9857260	0.9865840	0.9872710
$\alpha_2$	1.47E-02	1.37E-02	9.37E-03	6.86E-03	5.57E-03	4.78E-03	4.34E-03
$\alpha_3$		3.71E-03	5.66E-03	5.02E-03	4.00E-03	3.12E-03	2.48E-03
$\alpha_4$			1.38E-03	2.78E-03	3.08E-03	2.82E-03	2.35E-03
$\alpha_5$				5.55E-04	1.39E-03	1.91E-03	2.02E-03
$\alpha_6$					2.32E-04	6.97E-04	1.14E-03
$\alpha_7$						9.97E-05	3.49E-04
$\alpha_8$							4.36E-05

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.85E-01	9.83E-01	9.84E-01	9.85E-01	9.86E-01	9.87E-01	9.87E-01
Beta	1.47E-02	1.74E-02	1.64E-02	1.52E-02	1.43E-02	1.34E-02	1.27E-02
Gamma		2.13E-01	4.29E-01	5.49E-01	6.10E-01	6.44E-01	6.59E-01
Delta			1.96E-01	3.99E-01	5.41E-01	6.39E-01	7.05E-01
Epsilon				1.67E-01	3.45E-01	4.89E-01	6.02E-01
Mu					1.43E-01	2.95E-01	4.31E-01
Upsilon						1.25E-01	2.57E-01
Sigma							1.11E-01

## Battery Chargers

## DC POWER BATTERY CHARGER LOSS OF FUNCTION SPAR: BCH-FC

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	129.97	194.96	259.95	324.93	389.92	454.90	519.89
N <sub>1</sub>	5.5350	6.0063	6.8145	7.6586	8.4339	9.2065	9.9271
N <sub>2</sub>	2.0242	2.7963	2.5408	2.3162	2.2515	2.2480	2.3306
N <sub>3</sub>		0.7588	1.5345	1.6962	1.6154	1.4655	1.3293
N <sub>4</sub>			0.3751	0.9381	1.2451	1.3262	1.2637
N <sub>5</sub>				0.1875	0.5625	0.8962	1.0861
N <sub>6</sub>					0.0938	0.3281	0.6106
N <sub>7</sub>						0.0469	0.1875
N <sub>8</sub>							0.0234

## Battery Chargers

## DC POWER BATTERY CHARGER NO OUTPUT SPAR:BCH-LP

**DC POWER BATTERY CHARGER NO OUTPUT SPAR:BCH-LP**

System : dc power  
 Component : Battery Charger  
 Failure Mode : Fail to Operate (General operation failure, rate based)

Start Date : 1997/01/01

Data Version : 2010/12/31

Total Number of Independent Failure Events: 238.50

Total Number of Common-Cause Failure Events: 9

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9633400	0.9834110	0.9855350	0.9962300	0.9852820	1.4575E+02	2.4587E+00
$\alpha_2$	3.77E-03	1.66E-02	1.45E-02	3.67E-02	1.47E-02	2.4587E+00	1.4575E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9633440	0.9802020	0.9815460	0.9924670	0.9826170	2.3052E+02	4.6560E+00
$\alpha_2$	4.95E-03	1.54E-02	1.41E-02	3.05E-02	1.37E-02	3.6300E+00	2.3155E+02
$\alpha_3$	2.39E-04	4.36E-03	3.06E-03	1.29E-02	3.71E-03	1.0260E+00	2.3415E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9659810	0.9802460	0.9812390	0.9911150	0.9835910	3.1290E+02	6.3055E+00
$\alpha_2$	3.89E-03	1.18E-02	1.08E-02	2.32E-02	9.37E-03	3.7689E+00	3.1544E+02
$\alpha_3$	1.04E-03	6.07E-03	5.08E-03	1.45E-02	5.66E-03	1.9388E+00	3.1727E+02
$\alpha_4$	1.74E-05	1.87E-03	9.85E-04	6.74E-03	1.38E-03	5.9777E-01	3.1861E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9681070	0.9801650	0.9808910	0.9897400	0.9847870	4.2875E+02	8.6763E+00
$\alpha_2$	3.72E-03	1.01E-02	9.39E-03	1.91E-02	6.86E-03	4.4304E+00	4.3300E+02
$\alpha_3$	1.50E-03	6.11E-03	5.38E-03	1.32E-02	5.02E-03	2.6736E+00	4.3475E+02
$\alpha_4$	2.79E-04	3.00E-03	2.29E-03	8.17E-03	2.78E-03	1.3125E+00	4.3611E+02
$\alpha_5$	1.53E-08	5.94E-04	1.12E-04	2.84E-03	5.55E-04	2.5978E-01	4.3717E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9701290	0.9808750	0.9814800	0.9895540	0.9857260	5.1529E+02	1.0047E+01
$\alpha_2$	3.17E-03	8.55E-03	7.93E-03	1.60E-02	5.57E-03	4.4907E+00	5.2085E+02
$\alpha_3$	1.33E-03	5.25E-03	4.64E-03	1.13E-02	4.00E-03	2.7572E+00	5.2258E+02
$\alpha_4$	5.57E-04	3.50E-03	2.89E-03	8.51E-03	3.08E-03	1.8373E+00	5.2350E+02
$\alpha_5$	3.85E-05	1.49E-03	9.28E-04	4.88E-03	1.39E-03	7.8470E-01	5.2455E+02
$\alpha_6$	5.48E-11	3.37E-04	2.47E-05	1.79E-03	2.32E-04	1.7704E-01	5.2516E+02



Battery Chargers

DC POWER BATTERY CHARGER NO OUTPUT SPAR:BCH-LP

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9711530	0.9807000	0.9811800	0.9885930	0.9865840	6.4816E+02	1.2756E+01
$\alpha_2$	3.31E-03	8.07E-03	7.58E-03	1.45E-02	4.78E-03	5.3358E+00	6.5558E+02
$\alpha_3$	1.32E-03	4.69E-03	4.20E-03	9.73E-03	3.12E-03	3.0967E+00	6.5782E+02
$\alpha_4$	7.41E-04	3.50E-03	3.02E-03	7.93E-03	2.82E-03	2.3151E+00	6.5860E+02
$\alpha_5$	2.29E-04	2.15E-03	1.67E-03	5.69E-03	1.91E-03	1.4180E+00	6.5950E+02
$\alpha_6$	3.55E-06	7.78E-04	3.63E-04	2.96E-03	6.97E-04	5.1438E-01	6.6040E+02
$\alpha_7$	6.77E-21	1.15E-04	9.85E-08	6.67E-04	9.97E-05	7.5971E-02	6.6084E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9725450	0.9812650	0.9816810	0.9885540	0.9872710	7.4855E+02	1.4292E+01
$\alpha_2$	3.16E-03	7.44E-03	7.01E-03	1.32E-02	4.34E-03	5.6753E+00	7.5717E+02
$\alpha_3$	1.12E-03	4.02E-03	3.60E-03	8.37E-03	2.48E-03	3.0677E+00	7.5977E+02
$\alpha_4$	6.98E-04	3.16E-03	2.74E-03	7.06E-03	2.35E-03	2.4102E+00	7.6043E+02
$\alpha_5$	3.63E-04	2.35E-03	1.93E-03	5.77E-03	2.02E-03	1.7944E+00	7.6105E+02
$\alpha_6$	6.21E-05	1.28E-03	8.81E-04	3.87E-03	1.14E-03	9.7756E-01	7.6186E+02
$\alpha_7$	5.94E-08	4.07E-04	1.05E-04	1.84E-03	3.49E-04	3.1047E-01	7.6253E+02
$\alpha_8$	7.41E-27	7.41E-05	3.64E-09	4.10E-04	4.36E-05	5.6524E-02	7.6279E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.9852820	0.9826170	0.9835910	0.9847870	0.9857260	0.9865840	0.9872710
$\alpha_2$	1.47E-02	1.37E-02	9.37E-03	6.86E-03	5.57E-03	4.78E-03	4.34E-03
$\alpha_3$		3.71E-03	5.66E-03	5.02E-03	4.00E-03	3.12E-03	2.48E-03
$\alpha_4$			1.38E-03	2.78E-03	3.08E-03	2.82E-03	2.35E-03
$\alpha_5$				5.55E-04	1.39E-03	1.91E-03	2.02E-03
$\alpha_6$					2.32E-04	6.97E-04	1.14E-03
$\alpha_7$						9.97E-05	3.49E-04
$\alpha_8$							4.36E-05

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	9.85E-01	9.83E-01	9.84E-01	9.85E-01	9.86E-01	9.87E-01	9.87E-01
Beta	1.47E-02	1.74E-02	1.64E-02	1.52E-02	1.43E-02	1.34E-02	1.27E-02
Gamma		2.13E-01	4.29E-01	5.49E-01	6.10E-01	6.44E-01	6.59E-01
Delta			1.96E-01	3.99E-01	5.41E-01	6.39E-01	7.05E-01
Epsilon				1.67E-01	3.45E-01	4.89E-01	6.02E-01
Mu					1.43E-01	2.95E-01	4.31E-01
Upsilon						1.25E-01	2.57E-01
Sigma							1.11E-01

## Battery Chargers

## DC POWER BATTERY CHARGER NO OUTPUT SPAR:BCH-LP

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	129.97	194.96	259.95	324.93	389.92	454.90	519.89
N <sub>1</sub>	5.5350	6.0063	6.8145	7.6586	8.4339	9.2065	9.9271
N <sub>2</sub>	2.0242	2.7963	2.5408	2.3162	2.2515	2.2480	2.3306
N <sub>3</sub>		0.7588	1.5345	1.6962	1.6154	1.4655	1.3293
N <sub>4</sub>			0.3751	0.9381	1.2451	1.3262	1.2637
N <sub>5</sub>				0.1875	0.5625	0.8962	1.0861
N <sub>6</sub>					0.0938	0.3281	0.6106
N <sub>7</sub>						0.0469	0.1875
N <sub>8</sub>							0.0234

**DC Power Distribution Circuit Breakers****DC POWER BREAKER FAIL TO OPEN**

**System :** dc power  
**Component :** Circuit Breaker  
**Failure Mode :** Fail to open on demand  
**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 1.50

Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8581890	0.9643270	0.9850590	0.9999350	1.0000000	1.1746E+01	4.3452E-01
$\alpha_2$	6.69E-05	3.57E-02	1.49E-02	1.42E-01	0.00E+00	4.3452E-01	1.1746E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9025780	0.9657640	0.9748880	0.9977200	1.0000000	3.1055E+01	1.1009E+00
$\alpha_2$	8.29E-04	2.59E-02	1.69E-02	8.18E-02	0.00E+00	8.3366E-01	3.1322E+01
$\alpha_3$	2.93E-07	8.31E-03	1.69E-03	3.94E-02	0.00E+00	2.6722E-01	3.1889E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9104790	0.9625170	0.9685780	0.9938040	1.0000000	4.7636E+01	1.8551E+00
$\alpha_2$	2.06E-03	2.48E-02	1.87E-02	6.83E-02	0.00E+00	1.2281E+00	4.8263E+01
$\alpha_3$	9.23E-06	8.17E-03	3.04E-03	3.37E-02	0.00E+00	4.0431E-01	4.9087E+01
$\alpha_4$	1.95E-08	4.50E-03	6.18E-04	2.25E-02	0.00E+00	2.2267E-01	4.9268E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9308380	0.9650370	0.9680620	0.9888920	1.0000000	9.7661E+01	3.5382E+00
$\alpha_2$	4.03E-03	2.09E-02	1.78E-02	4.83E-02	0.00E+00	2.1142E+00	9.9085E+01
$\alpha_3$	4.72E-04	9.66E-03	6.68E-03	2.90E-02	0.00E+00	9.7738E-01	1.0022E+02
$\alpha_4$	2.43E-06	3.70E-03	1.25E-03	1.57E-02	0.00E+00	3.7439E-01	1.0082E+02
$\alpha_5$	5.90E-21	7.14E-04	4.04E-07	4.14E-03	0.00E+00	7.2277E-02	1.0113E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9343810	0.9651340	0.9676320	0.9873370	1.0000000	1.1844E+02	4.2787E+00
$\alpha_2$	3.75E-03	1.82E-02	1.57E-02	4.15E-02	0.00E+00	2.2392E+00	1.2048E+02
$\alpha_3$	6.56E-04	9.30E-03	6.81E-03	2.65E-02	0.00E+00	1.1418E+00	1.2158E+02
$\alpha_4$	4.32E-05	4.83E-03	2.53E-03	1.74E-02	0.00E+00	5.9222E-01	1.2213E+02
$\alpha_5$	7.57E-09	1.81E-03	2.46E-04	9.07E-03	0.00E+00	2.2220E-01	1.2250E+02
$\alpha_6$	1.15E-18	6.78E-04	1.19E-06	3.96E-03	0.00E+00	8.3237E-02	1.2264E+02

DC Power Distribution Circuit Breakers

DC POWER BREAKER FAIL TO OPEN

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9426990	0.9664310	0.9680420	0.9846650	1.0000000	1.8555E+02	6.4450E+00
$\alpha_2$	4.53E-03	1.61E-02	1.44E-02	3.33E-02	0.00E+00	3.0878E+00	1.8891E+02
$\alpha_3$	1.15E-03	8.50E-03	6.86E-03	2.14E-02	0.00E+00	1.6312E+00	1.9036E+02
$\alpha_4$	2.58E-04	5.15E-03	3.57E-03	1.55E-02	0.00E+00	9.8887E-01	1.9101E+02
$\alpha_5$	1.34E-05	2.72E-03	1.29E-03	1.03E-02	0.00E+00	5.2177E-01	1.9147E+02
$\alpha_6$	3.50E-10	9.70E-04	8.29E-05	5.09E-03	0.00E+00	1.8628E-01	1.9181E+02
$\alpha_7$	0.00E+00	1.51E-04	1.33E-13	5.70E-04	0.00E+00	2.9071E-02	1.9197E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9458180	0.9672320	0.9685940	0.9840060	1.0000000	2.2023E+02	7.4610E+00
$\alpha_2$	4.42E-03	1.47E-02	1.33E-02	2.97E-02	0.00E+00	3.3447E+00	2.2435E+02
$\alpha_3$	1.13E-03	7.63E-03	6.25E-03	1.89E-02	0.00E+00	1.7384E+00	2.2595E+02
$\alpha_4$	3.57E-04	5.04E-03	3.68E-03	1.43E-02	0.00E+00	1.1465E+00	2.2654E+02
$\alpha_5$	5.66E-05	3.11E-03	1.83E-03	1.05E-02	0.00E+00	7.0833E-01	2.2698E+02
$\alpha_6$	9.12E-07	1.61E-03	5.28E-04	6.89E-03	0.00E+00	3.6696E-01	2.2732E+02
$\alpha_7$	7.15E-14	5.40E-04	9.71E-06	3.07E-03	0.00E+00	1.2297E-01	2.2757E+02
$\alpha_8$	1.34E-42	1.45E-04	2.07E-12	6.15E-04	0.00E+00	3.3124E-02	2.2766E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

DC Power Distribution Circuit Breakers

DC POWER BREAKER FAIL TO OPEN

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	1.50	1.50	1.50	1.50	1.50	1.50	1.50
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

DC Power Distribution Circuit Breakers  
DC POWER BREAKER FAIL TO CLOSE**DC POWER BREAKER FAIL TO CLOSE**

System : dc power  
 Component : Circuit Breaker  
 Failure Mode : Fail to close (reset) on demand  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 9.00

Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9116630	0.9779210	0.9909360	0.9999560	1.0000000	1.9246E+01	4.3452E-01
$\alpha_2$	4.05E-05	2.21E-02	9.06E-03	8.83E-02	0.00E+00	4.3452E-01	1.9246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9207320	0.9722390	0.9797180	0.9981670	1.0000000	3.8555E+01	1.1009E+00
$\alpha_2$	6.69E-04	2.10E-02	1.37E-02	6.65E-02	0.00E+00	8.3366E-01	3.8822E+01
$\alpha_3$	2.37E-07	6.74E-03	1.36E-03	3.20E-02	0.00E+00	2.6722E-01	3.9389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9220800	0.9674500	0.9727570	0.9946390	1.0000000	5.5136E+01	1.8551E+00
$\alpha_2$	1.79E-03	2.15E-02	1.63E-02	5.94E-02	0.00E+00	1.2281E+00	5.5763E+01
$\alpha_3$	8.00E-06	7.09E-03	2.63E-03	2.93E-02	0.00E+00	4.0431E-01	5.6587E+01
$\alpha_4$	1.69E-08	3.91E-03	5.36E-04	1.96E-02	0.00E+00	2.2267E-01	5.6768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9355510	0.9674490	0.9702750	0.9896710	1.0000000	1.0516E+02	3.5382E+00
$\alpha_2$	3.75E-03	1.95E-02	1.66E-02	4.50E-02	0.00E+00	2.1142E+00	1.0658E+02
$\alpha_3$	4.39E-04	8.99E-03	6.21E-03	2.70E-02	0.00E+00	9.7738E-01	1.0772E+02
$\alpha_4$	2.26E-06	3.44E-03	1.16E-03	1.46E-02	0.00E+00	3.7439E-01	1.0832E+02
$\alpha_5$	5.49E-21	6.65E-04	3.76E-07	3.85E-03	0.00E+00	7.2277E-02	1.0863E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9381170	0.9671430	0.9695070	0.9880770	1.0000000	1.2594E+02	4.2787E+00
$\alpha_2$	3.53E-03	1.72E-02	1.48E-02	3.91E-02	0.00E+00	2.2392E+00	1.2798E+02
$\alpha_3$	6.17E-04	8.77E-03	6.41E-03	2.50E-02	0.00E+00	1.1418E+00	1.2908E+02
$\alpha_4$	4.07E-05	4.55E-03	2.38E-03	1.64E-02	0.00E+00	5.9222E-01	1.2963E+02
$\alpha_5$	7.13E-09	1.71E-03	2.31E-04	8.55E-03	0.00E+00	2.2220E-01	1.3000E+02
$\alpha_6$	1.08E-18	6.39E-04	1.12E-06	3.73E-03	0.00E+00	8.3237E-02	1.3014E+02

DC Power Distribution Circuit Breakers  
DC POWER BREAKER FAIL TO CLOSE

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9448370	0.9676930	0.9692440	0.9852520	1.0000000	1.9305E+02	6.4450E+00
$\alpha_2$	4.36E-03	1.55E-02	1.39E-02	3.20E-02	0.00E+00	3.0878E+00	1.9641E+02
$\alpha_3$	1.10E-03	8.18E-03	6.60E-03	2.06E-02	0.00E+00	1.6312E+00	1.9786E+02
$\alpha_4$	2.48E-04	4.96E-03	3.43E-03	1.49E-02	0.00E+00	9.8887E-01	1.9851E+02
$\alpha_5$	1.29E-05	2.62E-03	1.24E-03	9.88E-03	0.00E+00	5.2177E-01	1.9897E+02
$\alpha_6$	3.37E-10	9.34E-04	7.97E-05	4.90E-03	0.00E+00	1.8628E-01	1.9931E+02
$\alpha_7$	0.00E+00	1.46E-04	1.28E-13	5.49E-04	0.00E+00	2.9071E-02	1.9947E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9475310	0.9682770	0.9695950	0.9845210	1.0000000	2.2773E+02	7.4610E+00
$\alpha_2$	4.28E-03	1.42E-02	1.29E-02	2.88E-02	0.00E+00	3.3447E+00	2.3185E+02
$\alpha_3$	1.09E-03	7.39E-03	6.05E-03	1.83E-02	0.00E+00	1.7384E+00	2.3345E+02
$\alpha_4$	3.45E-04	4.87E-03	3.56E-03	1.39E-02	0.00E+00	1.1465E+00	2.3404E+02
$\alpha_5$	5.48E-05	3.01E-03	1.77E-03	1.02E-02	0.00E+00	7.0833E-01	2.3448E+02
$\alpha_6$	8.83E-07	1.56E-03	5.11E-04	6.67E-03	0.00E+00	3.6696E-01	2.3482E+02
$\alpha_7$	6.92E-14	5.23E-04	9.40E-06	2.98E-03	0.00E+00	1.2297E-01	2.3507E+02
$\alpha_8$	1.30E-42	1.41E-04	2.01E-12	5.95E-04	0.00E+00	3.3124E-02	2.3516E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

DC Power Distribution Circuit Breakers

DC POWER BREAKER FAIL TO CLOSE

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	9.00	9.00	9.00	9.00	9.00	9.00	9.00
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000



## DC Power Distribution Circuit Breakers

## DC POWER BREAKER SPURIOUS ACTUATION

**DC POWER BREAKER SPURIOUS ACTUATION**

System : dc power  
 Component : Circuit Breaker  
 Failure Mode : Spurious operation open or close  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 14.00

Total Number of Common-Cause Failure Events: 0

*ALPHA FACTOR DISTRIBUTIONS***CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9294220	0.9823940	0.9928250	0.9999650	1.0000000	2.4246E+01	4.3452E-01
$\alpha_2$	3.20E-05	1.76E-02	7.18E-03	7.06E-02	0.00E+00	4.3452E-01	2.4246E+01

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9294880	0.9753470	0.9820230	0.9983720	1.0000000	4.3555E+01	1.1009E+00
$\alpha_2$	5.92E-04	1.87E-02	1.21E-02	5.91E-02	0.00E+00	8.3366E-01	4.3822E+01
$\alpha_3$	2.10E-07	5.98E-03	1.21E-03	2.84E-02	0.00E+00	2.6722E-01	4.4389E+01

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9282810	0.9700750	0.9749830	0.9950760	1.0000000	6.0136E+01	1.8551E+00
$\alpha_2$	1.64E-03	1.98E-02	1.49E-02	5.47E-02	0.00E+00	1.2281E+00	6.0763E+01
$\alpha_3$	7.35E-06	6.52E-03	2.42E-03	2.69E-02	0.00E+00	4.0431E-01	6.1587E+01
$\alpha_4$	1.55E-08	3.59E-03	4.92E-04	1.80E-02	0.00E+00	2.2267E-01	6.1768E+01

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9383530	0.9688800	0.9715890	0.9901320	1.0000000	1.1016E+02	3.5382E+00
$\alpha_2$	3.58E-03	1.86E-02	1.59E-02	4.30E-02	0.00E+00	2.1142E+00	1.1158E+02
$\alpha_3$	4.20E-04	8.60E-03	5.94E-03	2.58E-02	0.00E+00	9.7738E-01	1.1272E+02
$\alpha_4$	2.16E-06	3.29E-03	1.11E-03	1.40E-02	0.00E+00	3.7439E-01	1.1332E+02
$\alpha_5$	5.25E-21	6.36E-04	3.59E-07	3.68E-03	0.00E+00	7.2277E-02	1.1363E+02

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9403810	0.9683580	0.9706390	0.9885240	1.0000000	1.3094E+02	4.2787E+00
$\alpha_2$	3.40E-03	1.66E-02	1.42E-02	3.77E-02	0.00E+00	2.2392E+00	1.3298E+02
$\alpha_3$	5.94E-04	8.44E-03	6.18E-03	2.40E-02	0.00E+00	1.1418E+00	1.3408E+02
$\alpha_4$	3.92E-05	4.38E-03	2.29E-03	1.58E-02	0.00E+00	5.9222E-01	1.3463E+02
$\alpha_5$	6.87E-09	1.64E-03	2.23E-04	8.23E-03	0.00E+00	2.2220E-01	1.3500E+02
$\alpha_6$	1.04E-18	6.16E-04	1.08E-06	3.59E-03	0.00E+00	8.3237E-02	1.3514E+02

DC Power Distribution Circuit Breakers

DC POWER BREAKER SPURIOUS ACTUATION

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9461730	0.9684830	0.9699980	0.9856130	1.0000000	1.9805E+02	6.4450E+00
$\alpha_2$	4.25E-03	1.51E-02	1.35E-02	3.12E-02	0.00E+00	3.0878E+00	2.0141E+02
$\alpha_3$	1.07E-03	7.98E-03	6.44E-03	2.01E-02	0.00E+00	1.6312E+00	2.0286E+02
$\alpha_4$	2.42E-04	4.84E-03	3.35E-03	1.45E-02	0.00E+00	9.8887E-01	2.0351E+02
$\alpha_5$	1.25E-05	2.55E-03	1.21E-03	9.64E-03	0.00E+00	5.2177E-01	2.0397E+02
$\alpha_6$	3.29E-10	9.11E-04	7.78E-05	4.78E-03	0.00E+00	1.8628E-01	2.0431E+02
$\alpha_7$	0.00E+00	1.42E-04	1.24E-13	5.35E-04	0.00E+00	2.9071E-02	2.0447E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9486090	0.9689370	0.9702290	0.9848460	1.0000000	2.3273E+02	7.4610E+00
$\alpha_2$	4.19E-03	1.39E-02	1.26E-02	2.82E-02	0.00E+00	3.3447E+00	2.3685E+02
$\alpha_3$	1.07E-03	7.24E-03	5.92E-03	1.79E-02	0.00E+00	1.7384E+00	2.3845E+02
$\alpha_4$	3.38E-04	4.77E-03	3.49E-03	1.36E-02	0.00E+00	1.1465E+00	2.3904E+02
$\alpha_5$	5.37E-05	2.95E-03	1.73E-03	9.98E-03	0.00E+00	7.0833E-01	2.3948E+02
$\alpha_6$	8.65E-07	1.53E-03	5.00E-04	6.54E-03	0.00E+00	3.6696E-01	2.3982E+02
$\alpha_7$	6.78E-14	5.12E-04	9.21E-06	2.91E-03	0.00E+00	1.2297E-01	2.4007E+02
$\alpha_8$	1.27E-42	1.38E-04	1.97E-12	5.83E-04	0.00E+00	3.3124E-02	2.4016E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

DC Power Distribution Circuit Breakers

DC POWER BREAKER SPURIOUS ACTUATION

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	14.00	14.00	14.00	14.00	14.00	14.00	14.00
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

# Reactor Protection System, Reactor Trip Breakers

## Reactor Trip Breakers

### REACTOR TRIP BREAKERS FAIL TO OPEN

System : Reactor protection  
 Component : Circuit Breaker  
 Failure Mode : Fail to open on demand  
 Component Group : Reactor Trip Breaker  
 Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 4.50  
 Total Number of Common-Cause Failure Events: 0

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8858260	0.9713760	0.9881340	0.9999430	1.0000000	1.4746E+01	4.3452E-01
$\alpha_2$	5.30E-05	2.86E-02	1.19E-02	1.14E-01	0.00E+00	4.3452E-01	1.4746E+01

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9107480	0.9686860	0.9770720	0.9979200	1.0000000	3.4055E+01	1.1009E+00
$\alpha_2$	7.57E-04	2.37E-02	1.55E-02	7.49E-02	0.00E+00	8.3366E-01	3.4322E+01
$\alpha_3$	2.68E-07	7.60E-03	1.54E-03	3.61E-02	0.00E+00	2.6722E-01	3.4889E+01

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9155110	0.9646590	0.9703930	0.9941670	1.0000000	5.0636E+01	1.8551E+00
$\alpha_2$	1.94E-03	2.34E-02	1.77E-02	6.45E-02	0.00E+00	1.2281E+00	5.1263E+01
$\alpha_3$	8.69E-06	7.70E-03	2.86E-03	3.18E-02	0.00E+00	4.0431E-01	5.2087E+01
$\alpha_4$	1.83E-08	4.24E-03	5.82E-04	2.13E-02	0.00E+00	2.2267E-01	5.2268E+01

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9328030	0.9660430	0.9689890	0.9892170	1.0000000	1.0066E+02	3.5382E+00
$\alpha_2$	3.91E-03	2.03E-02	1.73E-02	4.69E-02	0.00E+00	2.1142E+00	1.0208E+02
$\alpha_3$	4.58E-04	9.38E-03	6.48E-03	2.82E-02	0.00E+00	9.7738E-01	1.0322E+02
$\alpha_4$	2.36E-06	3.59E-03	1.21E-03	1.53E-02	0.00E+00	3.7439E-01	1.0382E+02
$\alpha_5$	5.73E-21	6.94E-04	3.92E-07	4.02E-03	0.00E+00	7.2277E-02	1.0413E+02

Reactor Trip Breakers

REACTOR TRIP BREAKERS FAIL TO OPEN

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9359280	0.9659660	0.9684130	0.9876440	1.0000000	1.2144E+02	4.2787E+00
$\alpha_2$	3.66E-03	1.78E-02	1.53E-02	4.05E-02	0.00E+00	2.2392E+00	1.2348E+02
$\alpha_3$	6.40E-04	9.08E-03	6.64E-03	2.59E-02	0.00E+00	1.1418E+00	1.2458E+02
$\alpha_4$	4.21E-05	4.71E-03	2.47E-03	1.70E-02	0.00E+00	5.9222E-01	1.2513E+02
$\alpha_5$	7.39E-09	1.77E-03	2.40E-04	8.86E-03	0.00E+00	2.2220E-01	1.2550E+02
$\alpha_6$	1.12E-18	6.62E-04	1.16E-06	3.86E-03	0.00E+00	8.3237E-02	1.2564E+02

CCCG = 7

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9435720	0.9669480	0.9685360	0.9849040	1.0000000	1.8855E+02	6.4450E+00
$\alpha_2$	4.46E-03	1.58E-02	1.42E-02	3.28E-02	0.00E+00	3.0878E+00	1.9191E+02
$\alpha_3$	1.13E-03	8.37E-03	6.75E-03	2.11E-02	0.00E+00	1.6312E+00	1.9336E+02
$\alpha_4$	2.54E-04	5.07E-03	3.51E-03	1.52E-02	0.00E+00	9.8887E-01	1.9401E+02
$\alpha_5$	1.32E-05	2.68E-03	1.27E-03	1.01E-02	0.00E+00	5.2177E-01	1.9447E+02
$\alpha_6$	3.45E-10	9.55E-04	8.16E-05	5.01E-03	0.00E+00	1.8628E-01	1.9481E+02
$\alpha_7$	0.00E+00	1.49E-04	1.31E-13	5.61E-04	0.00E+00	2.9071E-02	1.9497E+02

CCCG = 8

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9465160	0.9676580	0.9690050	0.9842160	1.0000000	2.2323E+02	7.4610E+00
$\alpha_2$	4.36E-03	1.45E-02	1.31E-02	2.93E-02	0.00E+00	3.3447E+00	2.2735E+02
$\alpha_3$	1.12E-03	7.54E-03	6.17E-03	1.86E-02	0.00E+00	1.7384E+00	2.2895E+02
$\alpha_4$	3.52E-04	4.97E-03	3.63E-03	1.42E-02	0.00E+00	1.1465E+00	2.2954E+02
$\alpha_5$	5.59E-05	3.07E-03	1.80E-03	1.04E-02	0.00E+00	7.0833E-01	2.2998E+02
$\alpha_6$	9.00E-07	1.59E-03	5.21E-04	6.80E-03	0.00E+00	3.6696E-01	2.3032E+02
$\alpha_7$	7.06E-14	5.33E-04	9.59E-06	3.03E-03	0.00E+00	1.2297E-01	2.3057E+02
$\alpha_8$	1.32E-42	1.44E-04	2.05E-12	6.07E-04	0.00E+00	3.3124E-02	2.3066E+02

ALPHA FACTOR and MGL PARAMETERS

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

Reactor Trip Breakers

REACTOR TRIP BREAKERS FAIL TO OPEN

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
Adj. Ind. Events	4.50	4.50	4.50	4.50	4.50	4.50	4.50
N <sub>1</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>2</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>3</sub>		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>4</sub>			0.0000	0.0000	0.0000	0.0000	0.0000
N <sub>5</sub>				0.0000	0.0000	0.0000	0.0000
N <sub>6</sub>					0.0000	0.0000	0.0000
N <sub>7</sub>						0.0000	0.0000
N <sub>8</sub>							0.0000

# Air Compressors

## Motor-Driven Air Compressors

### MOTOR DRIVEN AIR COMPRESSOR FAIL TO START

Component : Compressor  
 Failure Mode : Fail to start  
 Component Group : Motor Driven  
 Start Date : 1998/01/01  
 Data Version : 2010/12/31

**Total Number of Independent Failure Events: 217.60**

**Total Number of Common-Cause Failure Events: 2**

#### ALPHA FACTOR DISTRIBUTIONS

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9791990	0.9936620	0.9960890	0.9998490	0.9969830	1.2038E+02	7.6782E-01
$\alpha_2$	1.53E-04	6.34E-03	3.91E-03	2.08E-02	3.02E-03	7.6782E-01	1.2038E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9750620	0.9892730	0.9908910	0.9979580	0.9939470	1.9376E+02	2.1009E+00
$\alpha_2$	1.49E-03	9.36E-03	7.75E-03	2.27E-02	6.05E-03	1.8337E+00	1.9403E+02
$\alpha_3$	4.73E-08	1.36E-03	2.72E-04	6.47E-03	0.00E+00	2.6722E-01	1.9559E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9719390	0.9855940	0.9867890	0.9951750	0.9908930	2.6374E+02	3.8551E+00
$\alpha_2$	3.52E-03	1.21E-02	1.09E-02	2.47E-02	9.11E-03	3.2281E+00	2.6437E+02
$\alpha_3$	1.69E-06	1.51E-03	5.56E-04	6.25E-03	0.00E+00	4.0431E-01	2.6719E+02
$\alpha_4$	3.56E-09	8.32E-04	1.13E-04	4.17E-03	0.00E+00	2.2267E-01	2.6737E+02

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9736570	0.9851800	0.9860350	0.9937800	0.9927010	3.6816E+02	5.5383E+00
$\alpha_2$	2.84E-03	9.23E-03	8.37E-03	1.86E-02	4.87E-03	3.4475E+00	3.7025E+02
$\alpha_3$	5.98E-04	4.40E-03	3.55E-03	1.11E-02	2.43E-03	1.6441E+00	3.7205E+02
$\alpha_4$	6.56E-07	1.00E-03	3.36E-04	4.26E-03	0.00E+00	3.7439E-01	3.7332E+02
$\alpha_5$	1.59E-21	1.93E-04	1.09E-07	1.12E-03	0.00E+00	7.2277E-02	3.7363E+02

Air Compressors  
 Motor-Driven Air Compressors  
 MOTOR DRIVEN AIR COMPRESSOR FAIL TO START  
 CCGG = 6

2010

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9758880	0.9860360	0.9867480	0.9937490	0.9939100	4.4334E+02	6.2787E+00
$\alpha_2$	1.97E-03	6.96E-03	6.24E-03	1.44E-02	2.71E-03	3.1281E+00	4.4649E+02
$\alpha_3$	8.20E-04	4.52E-03	3.81E-03	1.06E-02	2.71E-03	2.0307E+00	4.4759E+02
$\alpha_4$	5.25E-05	1.81E-03	1.15E-03	5.83E-03	6.77E-04	8.1442E-01	4.4880E+02
$\alpha_5$	2.06E-09	4.94E-04	6.68E-05	2.48E-03	0.00E+00	2.2220E-01	4.4940E+02
$\alpha_6$	3.13E-19	1.85E-04	3.23E-07	1.08E-03	0.00E+00	8.3237E-02	4.4954E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9969830	0.9939470	0.9908930	0.9927010	0.9939100
$\alpha_2$	3.02E-03	6.05E-03	9.11E-03	4.87E-03	2.71E-03
$\alpha_3$		0.00E+00	0.00E+00	2.43E-03	2.71E-03
$\alpha_4$			0.00E+00	0.00E+00	6.77E-04
$\alpha_5$				0.00E+00	0.00E+00
$\alpha_6$					0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.97E-01	9.94E-01	9.91E-01	9.93E-01	9.94E-01
Beta	3.02E-03	6.05E-03	9.11E-03	7.30E-03	6.09E-03
Gamma		0.00E+00	0.00E+00	3.33E-01	5.56E-01
Delta			0.00E+00	0.00E+00	2.00E-01
Epsilon				0.00E+00	0.00E+00
Mu					0.00E+00

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	108.80	163.20	217.60	272.00	326.40
$N_1$	1.3333	1.0000	0.0000	0.0000	0.0000
$N_2$	0.3333	1.0000	2.0000	1.3333	0.8889
$N_3$		0.0000	0.0000	0.6667	0.8889
$N_4$			0.0000	0.0000	0.2222
$N_5$				0.0000	0.0000
$N_6$					0.0000



Air Compressors  
 Motor-Driven Air Compressors  
 MOTOR DRIVEN AIR COMPRESSOR FAIL TO RUN  
**MOTOR DRIVEN AIR COMPRESSOR FAIL TO RUN**

2010

Component : Compressor  
 Failure Mode : Fail to Run (Normally running equipment)  
 Component Group : Motor Driven  
 Start Date : 1998/01/01  
 Data Version : 2010/12/31

**Total Number of Independent Failure Events: 580.00**  
**Total Number of Common-Cause Failure Events: 3**

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9883980	0.9945890	0.9952160	0.9986240	0.9953410	5.0876E+02	2.7678E+00
$\alpha_2$	1.37E-03	5.41E-03	4.78E-03	1.16E-02	4.66E-03	2.7678E+00	5.0876E+02

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9899010	0.9947450	0.9951640	0.9981680	0.9959990	7.7634E+02	4.1009E+00
$\alpha_2$	9.42E-04	3.63E-03	3.22E-03	7.74E-03	2.67E-03	2.8337E+00	7.7761E+02
$\alpha_3$	1.41E-04	1.62E-03	1.22E-03	4.48E-03	1.33E-03	1.2672E+00	7.7917E+02

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9914600	0.9953610	0.9956700	0.9981970	0.9969960	1.0418E+03	4.8551E+00
$\alpha_2$	4.31E-04	2.13E-03	1.82E-03	4.88E-03	1.00E-03	2.2281E+00	1.0444E+03
$\alpha_3$	3.04E-04	1.82E-03	1.51E-03	4.38E-03	1.50E-03	1.9043E+00	1.0448E+03
$\alpha_4$	1.35E-05	6.90E-04	4.10E-04	2.32E-03	5.01E-04	7.2267E-01	1.0459E+03

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9916730	0.9951470	0.9953930	0.9977880	0.9975950	1.3408E+03	6.5383E+00
$\alpha_2$	4.66E-04	1.94E-03	1.70E-03	4.24E-03	4.01E-04	2.6142E+00	1.3447E+03
$\alpha_3$	3.35E-04	1.65E-03	1.41E-03	3.79E-03	1.00E-03	2.2274E+00	1.3451E+03
$\alpha_4$	1.03E-04	1.02E-03	7.87E-04	2.74E-03	8.02E-04	1.3744E+00	1.3460E+03
$\alpha_5$	4.82E-08	2.39E-04	6.53E-05	1.07E-03	2.00E-04	3.2228E-01	1.3470E+03

**CCCG = 6**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9924610	0.9955010	0.9957000	0.9978450	0.9979950	1.6105E+03	7.2786E+00
$\alpha_2$	3.51E-04	1.54E-03	1.34E-03	3.41E-03	1.67E-04	2.4892E+00	1.6153E+03
$\alpha_3$	2.24E-04	1.25E-03	1.05E-03	2.95E-03	5.85E-04	2.0168E+00	1.6158E+03
$\alpha_4$	1.54E-04	1.06E-03	8.64E-04	2.64E-03	7.52E-04	1.7172E+00	1.6161E+03
$\alpha_5$	1.71E-05	5.24E-04	3.38E-04	1.66E-03	4.18E-04	8.4720E-01	1.6169E+03
$\alpha_6$	2.29E-10	1.29E-04	1.48E-05	6.56E-04	8.35E-05	2.0824E-01	1.6176E+03

Air Compressors  
 Motor-Driven Air Compressors  
 MOTOR DRIVEN AIR COMPRESSOR FAIL TO RUN  
*ALPHA FACTOR and MGL PARAMETERS*

2010

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9953410	0.9959990	0.9969960	0.9975950	0.9979950
$\alpha_2$	4.66E-03	2.67E-03	1.00E-03	4.01E-04	1.67E-04
$\alpha_3$		1.33E-03	1.50E-03	1.00E-03	5.85E-04
$\alpha_4$			5.01E-04	8.02E-04	7.52E-04
$\alpha_5$				2.00E-04	4.18E-04
$\alpha_6$					8.35E-05

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.95E-01	9.96E-01	9.97E-01	9.98E-01	9.98E-01
Beta	4.66E-03	4.00E-03	3.00E-03	2.40E-03	2.00E-03
Gamma		3.33E-01	6.67E-01	8.33E-01	9.17E-01
Delta			2.50E-01	5.00E-01	6.82E-01
Epsilon				2.00E-01	4.00E-01
Mu					1.67E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	497.85	746.78	995.71	1244.64	1493.56
$N_1$	0.6667	0.0000	0.0000	0.0000	0.0000
$N_2$	2.3333	2.0000	1.0000	0.5000	0.2500
$N_3$		1.0000	1.5000	1.2500	0.8750
$N_4$			0.5000	1.0000	1.1250
$N_5$				0.2500	0.6250
$N_6$					0.1250

Air Compressors  
Motor-Driven Air Compressors  
No Data

2010

## **No Data (Prior Only)**

### **No Data**

The section labeled No Data (Prior Only) shows the prior used in the CCF database. This is the result of calculating an application without any data, which is the same as calculating an application with all the events in the CCF database. These CCF parameters may be used for those cases where there is no reasonable set of data to approximate the intended event.

## Generic Distributions

### Generic Demand CCF Distribution

ALL CCF DEMAND BASED EVENTS 1997 TO CURRENT SPAR: CCF-DEM

Failure Mode : Fail to close (reset) on demand  
 Fail to Open/Close Mode Unspecified (demand based)  
 Fail to open on demand  
 Fail to start  
 Fail to Load/Run  
 Fail to stop

Start Date : 1997/01/01  
 Data Version : 2010/12/31

Total Number of Independent Failure Events: 2821.80  
 Total Number of Common-Cause Failure Events: 95

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9679280	0.9760020	0.9762900	0.9830830	0.9761660	1.0674E+03	2.6245E+01
$\alpha_2$	1.69E-02	2.40E-02	2.37E-02	3.21E-02	2.38E-02	2.6245E+01	1.0674E+03

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9689110	0.9755070	0.9756980	0.9814460	0.9757250	1.5955E+03	4.0060E+01
$\alpha_2$	1.15E-02	1.62E-02	1.60E-02	2.17E-02	1.60E-02	2.6557E+01	1.6090E+03
$\alpha_3$	4.95E-03	8.26E-03	8.06E-03	1.22E-02	8.25E-03	1.3503E+01	1.6221E+03

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9689330	0.9747150	0.9748630	0.9799950	0.9750170	2.1153E+03	5.4874E+01
$\alpha_2$	1.13E-02	1.54E-02	1.53E-02	2.00E-02	1.52E-02	3.3455E+01	2.1367E+03
$\alpha_3$	3.95E-03	6.50E-03	6.35E-03	9.57E-03	6.46E-03	1.4109E+01	2.1561E+03
$\alpha_4$	1.61E-03	3.37E-03	3.22E-03	5.64E-03	3.34E-03	7.3097E+00	2.1629E+03

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9721560	0.9770540	0.9771730	0.9815520	0.9775280	2.6748E+03	6.2818E+01
$\alpha_2$	8.03E-03	1.11E-02	1.10E-02	1.46E-02	1.07E-02	3.0426E+01	2.7072E+03
$\alpha_3$	4.24E-03	6.55E-03	6.43E-03	9.28E-03	6.43E-03	1.7939E+01	2.7197E+03
$\alpha_4$	2.18E-03	3.91E-03	3.79E-03	6.06E-03	3.92E-03	1.0711E+01	2.7269E+03
$\alpha_5$	4.45E-04	1.37E-03	1.25E-03	2.70E-03	1.39E-03	3.7417E+00	2.7339E+03

Generic Demand CCF Distribution

ALL CCF DEMAND BASED EVENTS 1997 TO CURRENT SPAR: CCF-DEM

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9745600	0.9788530	0.9789530	0.9828180	0.9793970	3.2045E+03	6.9231E+01
$\alpha_2$	6.15E-03	8.63E-03	8.53E-03	1.14E-02	8.25E-03	2.8242E+01	3.2455E+03
$\alpha_3$	3.83E-03	5.84E-03	5.74E-03	8.19E-03	5.70E-03	1.9120E+01	3.2546E+03
$\alpha_4$	2.22E-03	3.80E-03	3.70E-03	5.72E-03	3.76E-03	1.2439E+01	3.2613E+03
$\alpha_5$	1.09E-03	2.27E-03	2.16E-03	3.78E-03	2.28E-03	7.4165E+00	3.2663E+03
$\alpha_6$	1.10E-04	6.15E-04	5.17E-04	1.46E-03	6.12E-04	2.0134E+00	3.2717E+03

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9761660	0.9757250	0.9750170	0.9775280	0.9793970
$\alpha_2$	2.38E-02	1.60E-02	1.52E-02	1.07E-02	8.25E-03
$\alpha_3$		8.25E-03	6.46E-03	6.43E-03	5.70E-03
$\alpha_4$			3.34E-03	3.92E-03	3.76E-03
$\alpha_5$				1.39E-03	2.28E-03
$\alpha_6$					6.12E-04

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.76E-01	9.76E-01	9.75E-01	9.78E-01	9.79E-01
Beta	2.38E-02	2.43E-02	2.50E-02	2.25E-02	2.06E-02
Gamma		3.40E-01	3.92E-01	5.22E-01	6.00E-01
Delta			3.41E-01	4.52E-01	5.38E-01
Epsilon				2.62E-01	4.35E-01
Mu					2.12E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	1015.04	1522.55	2030.07	2537.59	3045.11
$N_1$	42.0650	43.3744	39.0866	41.0323	42.4318
$N_2$	25.8106	25.7231	32.2268	28.3118	26.0027
$N_3$		13.2362	13.7050	16.9613	17.9781
$N_4$			7.0870	10.3371	11.8469
$N_5$				3.6694	7.1943
$N_6$					1.9302

**Generic Rate CCF Distribution**

**ALL CCF RATE BASED EVENTS 1997 TO CURRENT SPAR: CCF-RATE**

**Failure Mode :** Spurious operation open or close  
 Fail to Run (Normally running equipment)  
 Filter media allows the pass through of debris  
 Failure of Control Function Only  
 High dP across filter  
 Fail to Run >1 Hour (Standby equipment)  
 Fail to control flow  
 Fail to Run less than 1 Hour  
 Fail to Operate (General operation failure, rate based)

Loss of heat transfer capabilities in heat exchangers

No flow/plugged

**Start Date :** 1997/01/01  
**Data Version :** 2010/12/31

Total Number of Independent Failure Events: 2433.50

Total Number of Common-Cause Failure Events: 99

*ALPHA FACTOR DISTRIBUTIONS*

**CCCG = 2**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9546190	0.9640470	0.9643150	0.9725600	0.9640900	1.1169E+03	4.1654E+01
$\alpha_2$	2.74E-02	3.60E-02	3.57E-02	4.54E-02	3.59E-02	4.1654E+01	1.1169E+03

**CCCG = 3**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9582460	0.9657470	0.9659280	0.9726330	0.9657760	1.6645E+03	5.9037E+01
$\alpha_2$	1.45E-02	1.97E-02	1.95E-02	2.55E-02	1.95E-02	3.3908E+01	1.6896E+03
$\alpha_3$	1.02E-02	1.46E-02	1.44E-02	1.96E-02	1.47E-02	2.5129E+01	1.6984E+03

**CCCG = 4**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9618670	0.9681350	0.9682740	0.9739420	0.9682810	2.2088E+03	7.2699E+01
$\alpha_2$	1.10E-02	1.50E-02	1.48E-02	1.94E-02	1.47E-02	3.4148E+01	2.2474E+03
$\alpha_3$	6.89E-03	1.01E-02	9.92E-03	1.37E-02	1.01E-02	2.2953E+01	2.2585E+03
$\alpha_4$	4.27E-03	6.84E-03	6.69E-03	9.90E-03	6.88E-03	1.5598E+01	2.2659E+03

**CCCG = 5**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9665110	0.9717760	0.9718820	0.9766630	0.9720370	2.7911E+03	8.1064E+01
$\alpha_2$	7.42E-03	1.03E-02	1.02E-02	1.36E-02	9.92E-03	2.9626E+01	2.8425E+03
$\alpha_3$	5.93E-03	8.55E-03	8.44E-03	1.16E-02	8.51E-03	2.4566E+01	2.8476E+03
$\alpha_4$	3.54E-03	5.62E-03	5.50E-03	8.09E-03	5.69E-03	1.6139E+01	2.8560E+03
$\alpha_5$	2.08E-03	3.74E-03	3.62E-03	5.78E-03	3.85E-03	1.0733E+01	2.8614E+03

## Generic Rate CCF Distribution

ALL CCF RATE BASED EVENTS 1997 TO CURRENT SPAR: CCF-RATE

CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9701220	0.9746820	0.9747770	0.9789330	0.9750480	3.3448E+03	8.6882E+01
$\alpha_2$	5.07E-03	7.29E-03	7.19E-03	9.83E-03	6.88E-03	2.5014E+01	3.4067E+03
$\alpha_3$	4.91E-03	7.10E-03	7.00E-03	9.60E-03	7.01E-03	2.4348E+01	3.4073E+03
$\alpha_4$	3.55E-03	5.44E-03	5.34E-03	7.65E-03	5.46E-03	1.8666E+01	3.4130E+03
$\alpha_5$	1.67E-03	3.03E-03	2.94E-03	4.72E-03	3.08E-03	1.0408E+01	3.4213E+03
$\alpha_6$	1.25E-03	2.46E-03	2.37E-03	4.00E-03	2.53E-03	8.4458E+00	3.4232E+03

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
$\alpha_1$	0.9640900	0.9657760	0.9682810	0.9720370	0.9750480
$\alpha_2$	3.59E-02	1.95E-02	1.47E-02	9.92E-03	6.88E-03
$\alpha_3$		1.47E-02	1.01E-02	8.51E-03	7.01E-03
$\alpha_4$			6.88E-03	5.69E-03	5.46E-03
$\alpha_5$				3.85E-03	3.08E-03
$\alpha_6$					2.53E-03

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
1-Beta	9.64E-01	9.66E-01	9.68E-01	9.72E-01	9.75E-01
Beta	3.59E-02	3.42E-02	3.17E-02	2.80E-02	2.50E-02
Gamma		4.29E-01	5.35E-01	6.45E-01	7.24E-01
Delta			4.05E-01	5.28E-01	6.12E-01
Epsilon				4.03E-01	5.06E-01
Mu					4.51E-01

Avg. Impact Vector	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6
Adj. Ind. Events	1064.99	1597.48	2129.98	2662.47	3194.97
$N_1$	41.6641	37.4219	32.6854	32.5040	32.9120
$N_2$	41.2199	33.0742	32.9199	27.5114	22.7750
$N_3$		24.8618	22.5482	23.5890	23.2064
$N_4$			15.3758	15.7646	18.0733
$N_5$				10.6611	10.1861
$N_6$					8.3626

## CCF Prior Distribution

### No Data (Prior Only)

Data Version : 2007/12/31

Total Number of Independent Failure Events: 0  
 Total Number of Common-Cause Failure Events: 0

#### ALPHA FACTOR DISTRIBUTIONS

##### CCCG = 2

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.8993200	0.9742690	0.9887700	0.9999290	----	1.7418E+01	4.6002E-01
$\alpha_2$	6.65E-05	2.57E-02	1.12E-02	1.00E-01	----	4.6002E-01	1.7418E+01

##### CCCG = 3

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9306240	0.9755060	0.9819700	0.9982830	----	4.5105E+01	1.1325E+00
$\alpha_2$	6.61E-04	1.87E-02	1.23E-02	5.84E-02	----	8.6476E-01	4.5372E+01
$\alpha_3$	2.07E-07	5.79E-03	1.17E-03	2.74E-02	----	2.6776E-01	4.5969E+01

##### CCCG = 4

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9380870	0.9740820	0.9782970	0.9956540	----	7.0868E+01	1.8856E+00
$\alpha_2$	1.43E-03	1.70E-02	1.28E-02	4.69E-02	----	1.2400E+00	7.1513E+01
$\alpha_3$	9.66E-06	5.89E-03	2.32E-03	2.38E-02	----	4.2870E-01	7.2324E+01
$\alpha_4$	9.21E-09	2.98E-03	3.83E-04	1.50E-02	----	2.1695E-01	7.2536E+01

##### CCCG = 5

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9521790	0.9760740	0.9782400	0.9925770	----	1.4106E+02	3.4576E+00
$\alpha_2$	2.59E-03	1.41E-02	1.19E-02	3.30E-02	----	2.0400E+00	1.4247E+02
$\alpha_3$	3.01E-04	6.59E-03	4.50E-03	2.00E-02	----	9.5369E-01	1.4356E+02
$\alpha_4$	2.21E-06	2.67E-03	9.37E-04	1.12E-02	----	3.8684E-01	1.4413E+02
$\alpha_5$	5.61E-20	5.33E-04	5.18E-07	3.10E-03	----	7.7129E-02	1.4444E+02

##### CCCG = 6

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9553700	0.9762820	0.9779970	0.9913440	----	1.7893E+02	4.3470E+00
$\alpha_2$	2.60E-03	1.24E-02	1.07E-02	2.81E-02	----	2.2804E+00	1.8099E+02
$\alpha_3$	4.16E-04	6.13E-03	4.45E-03	1.75E-02	----	1.1245E+00	1.8215E+02
$\alpha_4$	3.82E-05	3.40E-03	1.85E-03	1.20E-02	----	6.2471E-01	1.8265E+02
$\alpha_5$	1.60E-08	1.32E-03	2.18E-04	6.46E-03	----	2.4272E-01	1.8303E+02
$\alpha_6$	1.26E-20	4.07E-04	3.05E-07	2.36E-03	----	7.4722E-02	1.8320E+02



Generic Distributions  
 CCF Prior Distribution  
 No Data (Prior Only)  
**CCCG = 7**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9603690	0.9769760	0.9781320	0.9896440	----	2.6720E+02	6.2971E+00
$\alpha_2$	3.14E-03	1.12E-02	1.00E-02	2.33E-02	----	3.0721E+00	2.7042E+02
$\alpha_3$	6.66E-04	5.55E-03	4.40E-03	1.43E-02	----	1.5182E+00	2.7197E+02
$\alpha_4$	1.58E-04	3.48E-03	2.37E-03	1.06E-02	----	9.5310E-01	2.7254E+02
$\alpha_5$	1.00E-05	1.93E-03	9.22E-04	7.26E-03	----	5.2795E-01	2.7296E+02
$\alpha_6$	4.58E-10	7.08E-04	6.75E-05	3.68E-03	----	1.9373E-01	2.7330E+02
$\alpha_7$	5.03E-44	1.17E-04	8.41E-13	4.81E-04	----	3.2027E-02	2.7346E+02

**CCCG = 8**

Alpha Factor	5th%	Mean	Median	95th%	MLE	a	b
$\alpha_1$	0.9622170	0.9773660	0.9783580	0.9891370	----	3.1221E+02	7.2302E+00
$\alpha_2$	3.13E-03	1.04E-02	9.45E-03	2.12E-02	----	3.3414E+00	3.1609E+02
$\alpha_3$	6.67E-04	5.04E-03	4.06E-03	1.28E-02	----	1.6130E+00	3.1782E+02
$\alpha_4$	1.86E-04	3.26E-03	2.30E-03	9.62E-03	----	1.0438E+00	3.1839E+02
$\alpha_5$	3.88E-05	2.20E-03	1.28E-03	7.47E-03	----	7.0280E-01	3.1873E+02
$\alpha_6$	5.77E-07	1.13E-03	3.63E-04	4.86E-03	----	3.6184E-01	3.1907E+02
$\alpha_7$	1.19E-13	3.98E-04	8.44E-06	2.25E-03	----	1.2739E-01	3.1931E+02
$\alpha_8$	5.47E-36	1.25E-04	5.43E-11	6.01E-04	----	4.0005E-02	3.1940E+02

*ALPHA FACTOR and MGL PARAMETERS*

Alpha Factor	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
$\alpha_1$	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
$\alpha_2$	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_3$		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_4$			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_5$				0.00E+00	0.00E+00	0.00E+00	0.00E+00
$\alpha_6$					0.00E+00	0.00E+00	0.00E+00
$\alpha_7$						0.00E+00	0.00E+00
$\alpha_8$							0.00E+00

MGL Parameter	CCCG=2	CCCG=3	CCCG=4	CCCG=5	CCCG=6	CCCG=7	CCCG=8
1-Beta	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Delta			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epsilon				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mu					0.00E+00	0.00E+00	0.00E+00
Upsilon						0.00E+00	0.00E+00
Sigma							0.00E+00

# Glossary

## **Application**

A particular set of CCF events selected from the CCF database for use in a specific study.

## **Average Impact Vector**

An average over the impact vectors for different hypotheses regarding the number of components failed in an event.

## **Available**

The component is available if it is capable of performing its function according to a specified success criterion.

## **Basic Event**

An event in a reliability logic model that represents the state in which a component or group of components is unavailable and does not require further development in terms of contributing causes.

## **Common Cause Event**

A dependent failure in which two or more component fault states exist simultaneously, or within a short time interval, and are a direct result of a shared cause.

## **Common Cause Basic Event**

In system modeling, a basic event that represents the unavailability of a specific set of components because of shared causes that are not explicitly represented in the system logic model as other basic events.

## **Common Cause Component Group**

A group of (usually similar [in mission, manufacturer, maintenance, environment, etc.]) components that are considered to have a high potential for failure due to the same cause or causes.

## **Common Cause Failure Model**

The basis for quantifying the frequency of common cause events. Examples include the beta factor, alpha factor, and basic parameter, and the binomial failure rate models.

## **Complete Common Cause Failure**

A CCF in which all redundant components are failed simultaneously as a direct result of a shared cause; i.e., the component degradation value equals 1.0 for all components, and both the timing factor and the shared cause factor are equal to 1.0.

## **Component**

An element of plant hardware designed to provide a particular function.

## **Component Boundary**

The component boundary encompasses the set of piece parts that are considered to form the component.

## **Component Degradation Value ( $p$ )**

The assessed probability ( $0.0 = p = 1.0$ ) that a functionally or physically degraded component would fail to complete the mission.

**Component State**

Component state defines the component status in regard to its intended function. Two general categories of component states are defined as available and unavailable.

**Timing Factor (q)**

The probability ( $0.0 = q = 1.0$ ) that two or more component failures (or degraded states) separated in time represent a CCF. This can be viewed as an indication of the strength-of-coupling in synchronizing failure times.

**Unavailable**

The component is unavailable if the component is unable to perform its intended function according to a stated success criterion. Two subsets of unavailable states are failure and functionally unavailable.

**Exposed Population**

The set of components within the plant that are potentially affected by the CCF under consideration.

**Failure**

The component is not capable of performing its specified operation according to a success criterion.

**Functionally Unavailable**

The component is capable of operation, but the function normally provided by the component is unavailable due to lack of proper input, lack of support function from a source outside the component (i.e., motive power, actuation signal), maintenance, testing, the improper interference of a person, etc.

**Potentially Unavailable**

The component is capable of performing its function according to a success criterion, but an incipient or degraded condition exists. (N.B., potentially unavailable is not synonymous with hypothetical.)

**Defense**

Any operational, maintenance, and design measures taken to diminish the frequency and/or consequences of CCFs.

**Degraded**

The component is in such a state that it exhibits reduced performance but insufficient degradation to declare the component unavailable according to the specified success criterion.

**Impact Vector**

An assessment of the impact an event would have on a common cause component group. The impact is usually measured as the number of failed components out of a set of similar components in the common cause component group.

**Incipient**

The component is in a condition that, if left unremedied, could ultimately lead to a degraded or unavailable state.

**Reliability Logic Model**

A logical representation of the combinations of component states that could lead to

system failure. A fault tree is an example of a system logic model.

**Root Cause**

The most basic reason for a component failure, which, if corrected, could prevent recurrence. The identified root cause may vary depending on the particular defensive strategy adopted against the failure mechanism.

**Shared Cause Factor/Mechanism**

A set of causes and factors characterizing why and how a failure is systematically induced in several components.

**Failure Mechanism**

The history describing the events and influences leading to a given failure.

**Failure Mode**

A description of component failure in terms of the component function that was actually or potentially unavailable.

**Failure Mode Applicability**

The analyst's probability that the specified component failure mode for a given event is appropriate to the particular application.

**Mapping**

The impact vector of an event must be "mapped up" or "mapped down" when the exposed population of the target plant is higher or lower than that of the original plant that experienced the CCF. The end result of mapping an impact vector is an adjusted impact vector applicable to the target plant.

**Mapping up Factor**

A factor used to adjust the impact vector of an event when the exposed population of the target plan is higher than that of the original plant that experienced the CCF.

**Potential Common Cause Failure**

Any common cause event in which at least one component degradation value is less than 1.0.

**Proximate Cause**

A characterization of the condition that is readily identified as leading to failure of the component. It might alternatively be characterized as a symptom.

**Shared-Cause Factor (c)**

A number that reflects the analyst's uncertainty ( $0.0 = c = 1.0$ ) about the existence of coupling among the failures of two or more components, i.e., whether a shared cause of failure can be clearly identified.

**Shock**

A shock is an event that occurs at a random point in time and acts on the system; i.e., all the components in the system simultaneously. There are two kinds of shocks distinguished by the potential impact of the shock event, i.e., lethal and non-lethal.

**System**

The entity that encompasses an interacting collection of components to provide a particular function or functions.