Results and Databases Trend Summary

2015

1 INTRODUCTION

The following is a summary of the reliability and frequency trends identified in the update reports provided on the NRC Operating Experience web site. The statistically significant[1], either increasing or decreasing, trends identified in each update report are provided here in a single location. The figure numbers called out for the significant trends are the figure numbers in the separate update reports. Starting with this update year the frequency of the component and system performance updates is shifting to every other year. The loss of offsite power (LOOP) and initiating event updates continue to be annual.

2 COMPONENT PERFORMANCE

The component performance data was last updated using data through 2014. The summary provided in this section is therefore the latest available information until the next update, which is scheduled for completion when the 2016 data are available.

Important Trends and Observations:

- *The EPS, industry-wide EDG unreliability trend is extremely statistically significant and increasing. This trend shows no sign of changing.*
- *The EPS EDG FTR>1H trend is extremely statistically significant and increasing. This trend shows no sign of changing.*

2.1 Air-Operated Valves

2.1.1 Increasing Trends

- None.

2.1.2 Decreasing Trends

2.1.2.1 Highly Statistically Significant

- The frequency of demands per reactor year for valves recording the fail-to-open or fail-to-close failure modes, for high-demand valves (those with greater than twenty demands per year), was found to be decreasing. The decrease was about three percent over the ten year period trended.

[1] Statistical significance is defined in terms of the 'p-value.' A p-value is a probability indicating whether to accept or reject the null hypothesis that there is no trend in the data. P-values of less than or equal to 0.05 indicate that we are 95% confident that there is a trend in the data (reject the null hypothesis of no trend.) By convention, we use the "Michelin Guide" scale: p-value < 0.05 (statistically significant), p-value < 0.01 (highly statistically significant); p-value < 0.001 (extremely statistically significant).

2.1.2.2 Statistically Significant

- None.

2.2 Emergency Diesel Generators

2.2.1 Increasing Trends

2.2.1.1 Extremely Statistically Significant

- The failure rate estimate for EPS EDG fail-to-run for greater than one hour (FTR>1H) was found to be increasing. Independent analysis using a generalized linear regression model indicates this can be considered extremely statistically significant (p-value < 0.0001).
- EPS EDG unreliability (8-hour mission) was found to be increasing. Independent analysis using a generalized linear regression model indicates this can be considered extremely statistically significant (p-value = 0.0002).The increasing trend in the EPS EDG unreliability is primarily due to the increasing trend in the greater than 1 hour failure to run events.

2.2.2 Decreasing Trends

2.2.2.1 Extremely Statistically Significant

- EPS and HPCS EDG run hours per reactor year were found to be decreasing. Independent analysis using a generalized linear regression model indicates this can be considered Extremely Statistically Significant (p-value = 0.0001).
- Frequency (events per reactor year) of start demands, EPS and HPCS EDGs, were found to be decreasing. Independent analysis using a generalized linear regression model indicates this should be considered Extremely Statistically Significant (p-value < 0.0001).

2.3 Motor-Driven Pumps

2.3.1 Increasing Trends

2.3.1.1 Statistically Significant

- Standby MDP run hours per reactor year. This trend is not an adverse trend; it only indicates an increase in run hours for standby pumps. Standby MDP run hours appear to have made a step change in the upward direction in FY 2002 and FY 2003, which coincides with the start of the MSPI program. This influences an increasing trend over the 2003 to 2014 period.
- Normally running MDP run hours per reactor critical year.

2.3.2 Decreasing Trends

2.3.2.1 Statistically Significant

- Standby systems, industry-wide MDP frequency of start demands.
- Standby systems, industry-wide MDP run hours per reactor year for runs of ≤ 1 hour.
- The frequency (demands per reactor year) of start demands for normally running MDPs.

2.4 Motor-Operated Valves

2.4.1 Increasing Trends

- None.

2.4.2 Decreasing Trends

2.4.2.1 Extremely Statistically Significant

- The frequency of ≤ 20 MOV FTOC demands per reactor year.

2.4.2.2 Highly Statistically Significant

- The frequency (failures per reactor year) of MOV FTOC events where demands ≤ 20 per year.

2.4.2.3 Statistically Significant

- The frequency of demands per reactor year for valves with fail-to-open/close failure modes, for valves with greater than twenty demands per year.
- The failure probability estimate trend for MOV FTOC, all systems, industry-wide trend of MOVs with ≤ 20 demands per year.

2.5 Turbine-Driven Pumps

2.5.1 Increasing Trends

2.5.1.1 Statistically Significant

- Start demands for standby TDPs.
- Run hours for the first hour for standby TDPs.

2.5.2 Decreasing Trends

2.5.2.1 Extremely Statistically Significant

- Run hours per reactor critical year for normally running TDPs. The actual decrease is less than 5% over the most recent 10-year period.

3 LOSS OF OFFSITE POWER EVENTS

Overall LOOP event frequency during critical operation shows a statistically significant increasing trend over the last ten years. When LOOP event frequency is examined by category, the category results show increasing trends, but they are no longer statistically significant.

The 1997–2015 post-deregulation LOOP durations exhibit an extremely significant increasing trend, driven by the grid- and switchyard-based events.

4 RATES OF INITIATING EVENTS

The trend in occurrence rates for the categories of initiating events are summarized in this section. Sixteen initiating event categories are trended and displayed. Note that the LOOP trend presented here is the trend for all LOOP categories combined, and include only initiating events, whereas the events considered in the LOOP study above are all events during critical operation.

Table 1 summarizes the p-values for each initiating event category. No statistically significant trends were identified for the most recent 10 year period.

Table 1. Summary of initiating event trend figures.

Figure	Description	p-value	Trend Direction	Trend Significance[2]
1	LOOP - Loss of Offsite Power	0.071	--	
2	LOAC - Loss of AC Power	0.897	--	
3	LODC - Loss of DC Power	0.849	--	
4	VSLOCA – Very Small Loss of Coolant Accident	1.000	--	
5	PLOCCW - Partial Loss of Component Cooling Water	0.875	--	
6	LOMFW - Loss of Main Feedwater	0.462	--	
7	PLOSWS - Partial Loss of Service Water System	1.000	--	
8	LOIA (BWR) - Loss of Instrument Air (BWR)	0.621	--	
9	SORV (BWR) - Stuck Open Relief Valve (BWR)	0.363	--	
10	LOCHS (BWR) - Loss of Condensed Heat Sink (BWR)	0.185	--	
11	TRANS (BWR) - Transients (BWR)	0.113	--	
12	LOIA (PWR) - Loss of Instrument Air (PWR)	0.623	--	
13	SGTR (PWR) - Steam Generator Tube Rupture (PWR)	1.000	--	
14	SORV (PWR) - Stuck Open Relief Valve (PWR)	1.000	--	
15	LOCHS (PWR) - Loss of Condenser Heat Sink (PWR)	0.493	--	
16	TRANS (PWR) - Transients (PWR)	0.954	--	

5 SYSTEM STUDIES

The system performance data was last updated using data through 2014. The summary provided in this section is therefore the latest available information until the next update, which is scheduled for completion when the 2016 data are available.

5.1 Auxiliary Feedwater System

No statistically significant trends were identified in the auxiliary feedwater system results.

[2] Statistical significance is defined in terms of the 'p-value.' A p-value is a probability indicating whether to accept or reject the null hypothesis that there is no trend in the data. P-values of less than or equal to 0.05 indicate that we are 95% confident that there is a trend in the data (reject the null hypothesis of no trend.) By convention, we use the "Michelin Guide" scale: p-value < 0.05 (statistically significant), p-value < 0.01 (highly statistically significant); p-value < 0.001 (extremely statistically significant).

5.2 Emergency Power System

5.2.1 Increasing Trends

5.2.1.1 Extremely Statistically Significant

- EPS system unreliability for an 8-hour mission was found to be increasing.

5.2.1.2 Statistically Significant

- Start-only EPS system unreliability was found to be increasing.

5.2.2 Decreasing Trends

- None.

5.3 High Pressure Coolant Injection

No statistically significant trends were identified in the high pressure coolant injection results.

5.4 High Pressure Core Spray

No statistically significant trends were identified in the high pressure core spray results.

5.5 High Pressure Safety Injection

No statistically significant trends were identified in the high pressure safety injection results.

5.6 Isolation Condenser

A statistically significant decreasing trend was identified for ISO system unreliability. The magnitude of the trend indicates a 1.5 percent decrease in system unreliability over the most recent 10 years in the data set.

5.7 Reactor Core Isolation Cooling

No statistically significant trends were identified in the reactor core isolation cooling results.

5.8 Residual Heat Removal System

5.8.1 Increasing Trends

- None.

5.8.2 Decreasing Trends

5.8.2.1 Highly Statistically Significant

- Start-only RHR injection mode unreliability was found to be decreasing.

5.8.2.2 Statistically Significant

- Start-only RHR shutdown cooling mode unreliability was found to be decreasing.
- RHR shutdown cooling mode unreliability for a 24-hour mission was found to be decreasing.