Results and Databases Trend Summary

2016

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 study was last updated using data from 1998 through 2016. The summary provided in this section is therefore the latest available information until the next update, which is scheduled for completion when the 2018 data are available.

The trending analysis in the study used data over the last 10 years, i.e., from 2007 through 2016. Important trends and observations from the analysis are presented below:

- *The HPCS, industry-wide EDG unreliability trend is statistically significant and increasing. This is a new trend that was not existing in the last component performance analysis using data from 1998 through 2014.*

- *The failure probability estimate trend for EPS EDG to load and run is statistically significant and decreasing. This is a new trend that was not existing in the last component performance analysis using data from 1998 through 2014.*

- *The failure probability estimate trend for MOVs to open or close for low-demand valves (those with less than or equal to twenty demands per reactor year) is statistically significant and decreasing. This trend shows no sign of changing.*

[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 Air-Operated Valves

2.1.1 Increasing Trends

2.1.1.1 Highly Statistically Significant

- The frequency of demands per reactor year for AOVs to open or close for low-demand valves (those with less than or equal to twenty demands per reactor year) was found to be increasing.

2.1.2 Decreasing Trends

- None.

2.2 Emergency Diesel Generators

2.2.1 Increasing Trends

2.2.1.1 Highly Statistically Significant

- The EPS EDG unreliability (8-hour mission) was found to be increasing. 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 Highly Statistically Significant

- EPS and HPCS EDG run hours per reactor year were found to be decreasing.

2.2.2.2 Statistically Significant

- The failure probability estimate for EPS EDG fail to load and run was found to be decreasing.
- The frequency (events per reactor year) of fail to load-run events for both EPS and HPCS EDGs were found to be decreasing.

2.3 Motor-Driven Pumps

2.3.1 Increasing Trends

2.3.1.1 Highly Statistically Significant

- Normally running MDP run hours per reactor critical year were found to be increasing.

2.3.2 Decreasing Trends

- None.

2.4 Motor-Operated Valves

2.4.1 Increasing Trends

2.4.1.1 Highly Statistically Significant

- The frequency of demands per reactor year for MOVs to open or close for low-demand valves (those with less than or equal to twenty demands per reactor year) was found to be increasing.

2.4.2 Decreasing Trends

2.4.2.1 Statistically Significant

- The failure probability estimate trend for MOVs to open or close for low-demand valves (those with less than or equal to twenty demands per reactor year) was found to be decreasing.
- The frequency (failures per reactor year) of MOV fail to open or close events for low-demand valves (those with less than or equal to twenty demands per reactor year) was found to be decreasing.

2.5 Turbine-Driven Pumps

2.5.1 Increasing Trends

2.5.1.1 Statistically Significant

- The start demands for standby TDPs were found to be increasing.
- Run hours for the first hour for standby TDPs were found to be increasing.

2.5.2 Decreasing Trends

2.5.2.1 Highly Statistically Significant

- Run hours per reactor year for normally running TDPs were found to be decreasing.

3 LOSS OF OFFSITE POWER EVENTS

Overall LOOP event frequency during critical operation shows a statistically significant increasing trend over the most recent ten years (from 2007 through 2016). When LOOP event frequency is examined by category, the category results show increasing trends, but only plant-centered LOOP frequency is statistically significant.

The 1997–2016 post-deregulation LOOP durations exhibit an extremely significant increasing trend, driven by the switchyard- and grid-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 (from 2007 through 2016).

Table 1. Summary of initiating event trend figures.

Figure	Description	p-value	Trend Direction	Trend Significance
1	LOOP - Loss of Offsite Power	0.097	--	
2	LOAC - Loss of AC Power	0.635	--	
3	LODC - Loss of DC Power	0.875	--	
4	VSLOCA – Very Small Loss of Coolant Accident	1.000	--	
5	PLOCCW - Partial Loss of Component Cooling Water	0.609	--	
6	LOMFW - Loss of Main Feedwater	0.260	--	
7	PLOSWS - Partial Loss of Service Water System	1.000	--	
8	LOIA (BWR) - Loss of Instrument Air (BWR)	0.593	--	
9	SORV (BWR) - Stuck Open Relief Valve (BWR)	0.176	--	
10	LOCHS (BWR) - Loss of Condensed Heat Sink (BWR)	0.032	Decreasing	Significant
11	TRANS (BWR) - Transients (BWR)	0.025	Decreasing	Significant
12	LOIA (PWR) - Loss of Instrument Air (PWR)	0.634	--	
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)	0.959	--	
16	TRANS (PWR) - Transients (PWR)	0.614	--	

5 SYSTEM STUDIES

The system performance study was last updated using data from 1998 through 2016. The summary provided in this section is therefore the latest available information until the next update, which is scheduled for completion when the 2018 data are available.

The trending analysis in the study used data over the most recent 10 years, i.e., from 2007 through 2016. 4 statistically significant decreasing trends were identified from the analysis:

- *The HPSI start-only unreliability trend is statistically significant and decreasing.*
- *The ISO system unreliability trend is statistically significant and decreasing.*
- *The RHR shutdown cooling mode start-only unreliability trend is statistically significant and decreasing.*
- *The RHR shutdown cooling mode 24-hour unreliability trend is statistically significant and decreasing*

5.1 Auxiliary Feedwater System

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

5.2 Emergency Power System

No statistically significant trends were identified in the emergency power system results.

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

5.5.1 Increasing Trends

- None.

5.5.2 Decreasing Trends

5.5.2.1 Statistically Significant

- HPSI start-only unreliability was found to be decreasing.

5.6 Isolation Condenser

5.6.1 Increasing Trends

- None.

5.6.2 Decreasing Trends

5.6.2.1 Statistically Significant

- ISO system unreliability was found to be decreasing. 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 Statistically Significant

- RHR shutdown cooling mode start-only unreliability was found to be decreasing.
- RHR shutdown cooling mode 24-hour unreliability was found to be decreasing.