Results and Databases Trend Summary

2014

1 INTRODUCTION

This report presents a summary of reliability and frequency trends reported in several separate reports available on the NRC Operating Experience web site. Each report lists the significant[1], either increasing or decreasing, trends identified in each report and this report puts those trends in a single location. The figure numbers of significant trends are the figure number in the referenced report. This report does not estimate values for use in probabilistic risk assessments (PRAs), but does evaluate performance over time.

The trend evaluations in the Component Performance and System studies are based on the operating experience reports from fiscal year (FY) 1998 through FY 2014 as they are collected in the Integrated Data Collection and Calculation System (IDCCS). The loss of offsite power (LOOP, calendar year 1986 to 2014) and initiating event (IE, FY 1988 to FY 2014) studies also use IDCCS data. An overview of the trending methods, glossary of terms, and abbreviations can be found in the Overview and Reference document on the Reactor Operational Experience Results and Databases web page.

2 COMPONENT PERFORMANCE

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.

[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 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.

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

None of the loss of offsite power (LOOP) initiating event frequency trend plots show statistically significant trends.

The 1997–2013 LOOP durations exhibit a significant increasing trend, driven by the grid- and switchyard-based events. The results of this trending analysis are presented in Figure 8. The detailed results for the grid- and switchyard-based events are present in Figures 9 and 10. No significant trends in plant-centered or weather-related durations since 1997 were found.

4 RATES OF INITIATING EVENTS

The results of occurrence rates for the categories of initiating events summarized in this section. Sixteen initiating event groupings are trended and displayed. Note that the LOOP trend presented here is the trend of all LOOP categories.

Highly statistically significant decreasing trends were identified for the following:

- Loss of main feedwater. (see Figure 6)

Table 1. Summary of initiating event trend figures.

Figure	Description	p-value	Trend Direction	Trend Significance[2]
1	LOOP - Loss of Offsite Power	0.078	--	
2	LOAC - Loss of AC Power	0.210	--	
3	LODC - Loss of DC Power	0.420	--	
4	VSLOCA – Very Small Loss of Coolant Accident	0.340	--	
5	PLOCCW - Partial Loss of Component Cooling Water	0.600	--	
6	LOMFW - Loss of Main Feedwater	0.003	decreasing	High
7	PLOSWS - Partial Loss of Service Water System	1.000	--	
8	LOIA (BWR) - Loss of Instrument Air (BWR)	0.430	--	
9	SORV (BWR) - Stuck Open Relief Valve (BWR)	0.350	--	
10	LOCHS (BWR) - Loss of Condensed Heat Sink (BWR)	0.097	--	
11	TRANS (BWR) - Transients (BWR)	0.160	--	
12	LOIA (PWR) - Loss of Instrument Air (PWR)	0.640	--	
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)	0.097	--	
16	TRANS (PWR) - Transients (PWR)	0.790	--	

[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 SYSTEM STUDIES

5.1 Auxiliary Feedwater System

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

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.