Results and Databases Trend Summary

2012

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 2012 as they are collected in the Integrated Data Collection and Calculation System (IDCCS). The loss of offsite power (LOOP, calendar year 1986 to 2012) and initiating event (IE, FY 1988 to FY 2012) 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 in the next few years.*
- *The EPS EDG FTR>1H trend is highly statistically significant and increasing. This trend shows no sign of changing in the next few years.*

2.1 Air-Operated Valves

The results of air-operated valves (AOVs) are summarized in this section. Of particular interest is the existence of any statistically significant increasing trends.

The results of this study are summarized in this section. Of particular interest is the existence of any statistically significant increasing trends. In this update, no statistically significant increasing trends were identified in the AOV results.

Statistically significant decreasing trends were identified in the AOV results for the following:

[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).

- Frequency (demands per reactor year) of AOV operation demands, ≤ 20 demands per year. (see Figure 7)

- Frequency (demands per reactor year) of AOV operation demands, > 20 demands per year. (see Figure 8)

2.2 Emergency Diesel Generators

The results of emergency diesel generators (EDGs) are summarized in this section. Of particular interest is the existence of any statistically significant increasing trends.

In this update, the following extremely statistically significant increasing trends were identified in the EDG results:

- EPS, industry-wide EDG unreliability trend (8-hour mission). (see Figure 9)

Highly statistically significant increasing trends were identified in the EDG results:

- Failure rate estimate trend for EPS EDGs, industry-wide EDG FTR>1H trend. (see Figure 3)

Statistically significant increasing trends were identified in the EDG results:

- EPS EDG UA trend. (see Figure 7).

The increasing trend in the EPS EDG unreliability (Figure 9) is primarily due to the increasing trend in the greater than 1 hour failure to run events (reflected in Figure 3). The increasing trend in the EPS EDG unavailability (Figure 7) only varies from 1.35E-02 to 1.69E-02, which indicates only a small increase in unavailability for the EDG over the last ten years.

Highly statistically significant decreasing trends were identified in the EDG results for the following:

- Frequency (events per reactor year) of start demands, EPS and HPCS EDGs.. (see Figure 11)

- Frequency (events per reactor year) of load and run ≤ 1 hour demands, EPS and HPCS EDGs (see Figure 12)

- EPS and HPCS EDG run hours per reactor year. (see Figure 13)

2.3 Motor-Driven Pumps

The results of motor-driven pumps (MDPs) are summarized in this section. Of particular interest is the existence of any statistically significant increasing trends.

In this update, the following extremely statistically significant increasing trends were identified in the MDP results.

- Standby MDP run hours per reactor critical year. (see Figure 11)

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 2012 period. Statistically significant decreasing trends were identified in the MDP results for the following:

- Standby systems, industry-wide MDP unreliability trend (8-hour mission). (see Figure 7)
- Normally running systems (MFW), industry-wide MDP unreliability trend (8-hour mission). (see Figure 8)

Highly statistically significant decreasing trends in the MDP results were identified for the following:

- Frequency (failures per reactor year) of FTS events, standby MDPs. (see Figure 12)
- Failure probability estimate trend for standby systems, industry-wide MDP FTS trend. (see Figure 1)

2.4 Motor-Operated Valves

The results of motor-operated valves (MOVs) are summarized in this section. Of particular interest is the existence of any statistically significant increasing trends.

In this update, no statistically significant increasing trends were identified in the MOV results. Statistically significant decreasing trends were identified in the MOV results for the following:

- Failure probability estimate trend for MOV FTOC, all systems, industry-wide trend of MOVs with > 20 demands per year. (see Figure 2)
- Frequency (failures per reactor year) of MOV FTOC events > 20 demands per year. (see Figure 10)

Highly statistically significant decreasing trends were identified in the MOV results for the following:

- Frequency (demands per reactor year) of MOV operation demands, ≤ 20 demands per year. (see Figure 7)

2.5 Turbine-Driven Pumps

The results of turbine-driven pumps (TDPs) are summarized in this section. Of particular interest is the existence of any statistically significant increasing trends.

In this update, no statistically significant increasing trends were identified in the TDP results.

Highly statistically significant decreasing trends were identified in the TDP results for the following:

- Normally running TDP run hours per reactor critical year. (see Figure 16)

Statistically significant decreasing trends were identified in the TDP results for the following:

- Frequency (events per reactor year) of start demands, normally running TDPs. (see Figure 15)

Both of these decreasing trends are only significant because of the consistent (lack of variation) values year-to-year. The actual decrease is less than 5% for both trends over the most recent 10-year period.

3 LOSS OF OFFSITE POWER EVENTS

None of the loss of offsite power (LOOP, also referred to as LOSP) trend plots show statistically significant increasing or decreasing trends.

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.

Table 1. Summary of initiating event trend figures.

Figure	Description	p-value	Trend Direction	Trend Significance[2]
1	LOOP - Loss of Offsite Power	0.174	--	
2	LOAC - Loss of AC Power	0.388	--	
3	LODC - Loss of DC Power	1.000	--	
4	SLOCA - Small Loss of Coolant Accident	0.428	--	
5	PLOCCW - Partial Loss of Component Cooling Water	0.222	--	
6	LOMFW - Loss of Main Feedwater	0.001	decreasing	High
7	PLOSWS - Partial Loss of Service Water System	-(Note a)	decreasing	Extreme
8	LOIA (BWR) - Loss of Instrument Air (BWR)	0.605	--	
9	SORV (BWR) - Stuck Open Relief Valve (BWR)	0.216	--	
10	LOCHS (BWR) - Loss of Condensed Heat Sink (BWR)	0.012	decreasing	High
11	TRANS (BWR) - Transients (BWR)	0.012	decreasing	High
12	LOIA (PWR) - Loss of Instrument Air (PWR)	0.503	--	
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)	0.137	--	
16	TRANS (PWR) - Transients (PWR)	0.007	decreasing	High

a. The PLOSWS p-value was essentially zero (highly significant) because the data had 2 occurrences in the first year of the 10-year period and none in the rest.

[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

The results of the auxiliary feedwater system (AFW) unreliability study are summarized in this section. Of particular interest is the existence of any statistically significant increasing trends. In this update, no statistically significant increasing trends were identified in the AFW unreliability trend results. In addition, this update identified no statistically significant decreasing trends in the AFW results.

5.2 Emergency Power System

The results of the emergency power system (EPS) system unreliability study are summarized in this section. Of particular interest is the existence of any statistically significant increasing trends. In this update, two statistically significant increasing trends were identified in the EPS unreliability trend results.

- Trend of EPS system unreliability (8-hour model), as a function of fiscal year. (see Figure 4)

The absolute change in the EPS reliability is small; however, the statistical significance of the trend is below the threshold of statistical significance. The increasing trend reflects the increasing trend in the Emergency Diesel Generator (EDG) unreliability as noted in the component performance study for EDGs.

This update identified no statistically significant decreasing trends in the EPS results.

5.3 High Pressure Coolant Injection

The results of the high pressure coolant injection (HPCI) system unreliability study are summarized in this section. Of particular interest is the existence of any statistically significant increasing trends. In this update, no statistically significant increasing trends were identified in the HPCI unreliability trend results. No statistically significant decreasing trends within the industry-wide estimates of HPCI system unreliability on a per fiscal year basis were identified.

5.4 High Pressure Core Spray

The results of the high pressure core spray (HPCS) system unreliability study are summarized in this section. Of particular interest is the existence of any statistically significant increasing trends. In this update, no statistically significant increasing trends were identified in the HPCS unreliability trend results. In addition, this update identified no statistically significant decreasing trends in the HPCS results.

5.5 High Pressure Safety Injection

The results of the high-pressure safety injection system (HPSI) unreliability study are summarized in this section. Of particular interest is the existence of any statistically significant increasing trends. In this update, no statistically significant increasing trends were identified in the HPSI unreliability trend results. In addition, this update identified no statistically significant decreasing trends in the HPSI results.

5.6 Isolation Condenser

The results of the isolation condenser (ISO) system unreliability study are summarized in this section. Of particular interest is the existence of any statistically significant increasing trends. In this

update, no statistically significant increasing trends were identified in the ISO unreliability trend results. In addition, this update identified no statistically significant decreasing trends in the ISO results.

5.7 Reactor Core Isolation Cooling

The results of reactor core isolation cooling (RCIC) system unreliability study are summarized in this section. Of particular interest is the existence of any statistically significant increasing trends. In this update, no statistically significant increasing trends were identified in the RCIC unreliability trend results. In addition, this update identified no statistically significant decreasing trends in the RCIC results.

5.8 Residual Heat Removal System

The results of the residual heat removal (RHR) system unreliability study are summarized in this section. Of particular interest is the existence of any statistically significant increasing trends. In this update, no statistically significant increasing trends were identified in the RHR unreliability trend results.

Statistically significant decreasing trends in the RHR LPI results were identified for:

- Trend of RHR (injection mode) system unreliability (8-hour model), as a function of fiscal year. (see Figure 6)

No statistically significant decreasing trends in the RHR SDC results were identified.