

# Reliability Study Update

## High Pressure Coolant Injection System

### 1987–2004

This report presents a performance evaluation of the high-pressure coolant injection (HPCI) system at 24 U.S. commercial boiling water reactors (BWRs). The evaluation is based on the operating experience from 1987 through 2004, as reported in Licensee Event Reports (LERs). This is the latest update to NUREG/CR 5500 Volume 4, updating data, availability and reliability estimates, trends, and figures.

This report calculates two basic models for the HPCI system. The FTS model includes the start and recovery of the pump and the initial opening of the injection valve. The 8-hour mission model includes the HPCI system start and operation for 8 hours. Restart of the HPCI turbine, multiple injections, transfer of the suction from the condensate storage tank (CST) to the suppression pool, and recovery actions are included. Both models include failures due to the unavailability while in maintenance. See the HPCI Fault Tree Description document for more detail.

## 1 LATEST VALUES AND TRENDS

### 1.1 Industry-Wide Unavailability and Unreliability

The industry-wide unavailability and unreliability of the HPCI system have been estimated from operating experience. A failure to start (FTS) unavailability and an 8-hour mission unreliability were evaluated, see [Table 1](#). The estimates are based on failures that occurred during unplanned demands, and cyclic and quarterly surveillance tests.

**Table 1. Industry-wide values.**

Model	Lower (5%)	Mean	Upper (95%)
Failure-to-Start (Unavailability)	6.11E-03	2.28E-02	4.78E-02
8-hour Mission (Unreliability)	2.50E-02	6.25E-02	1.13E-01

### 1.2 Fail to Start Model Results

The estimates of HPCI system unavailability using operating experience from LERs and fault tree analyses show no statistically significant difference between plants. Plant system differences are computed based on plant differences seen in the segment failure data. When there are no statistically significant differences observed in the segment failure data, any update to show system unavailability results in the same values for all plants. Therefore, no data are plotted.

An extremely statistically significant<sup>1</sup> decreasing trend within the industry estimates of HPCI system unavailability (FTS) on a per fiscal year basis was identified. Figure 1 shows the trend in the FTS model unavailability. Table 5 shows the data points for Figure 1.

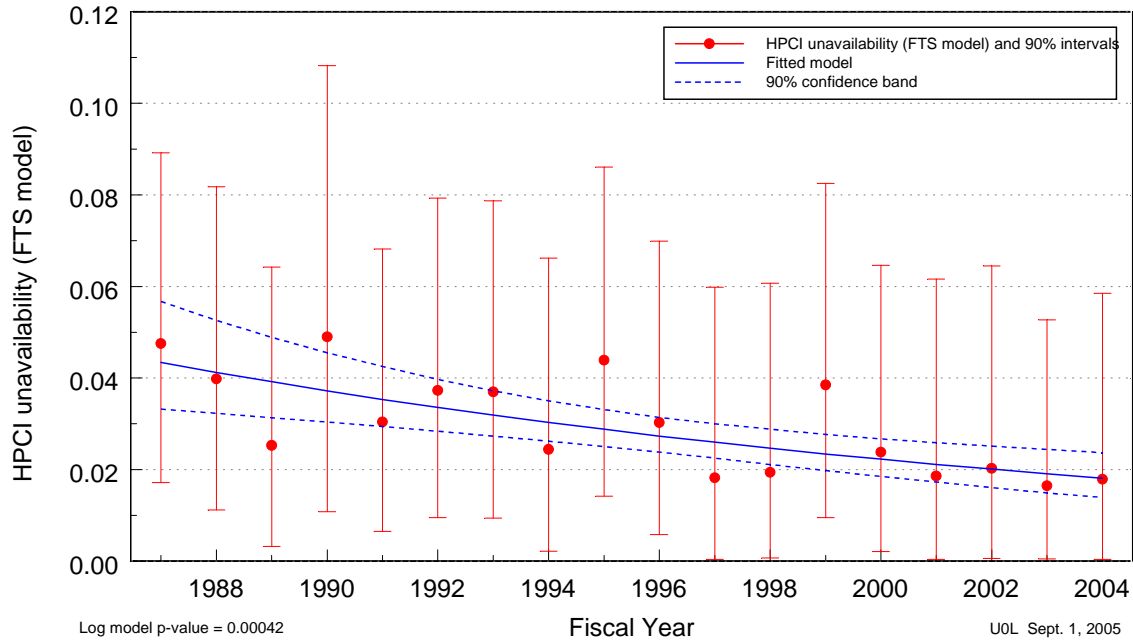


Figure 1. Trend of HPCI system unavailability (FTS model), as a function of fiscal year.

<sup>1</sup> Statistically significant 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).

The leading contributor to HPCI system short-term unavailability, after maintenance out of service, is the failure of the turbine to start. Figure 2 shows the distribution of segment failure contributions for the FTS model.

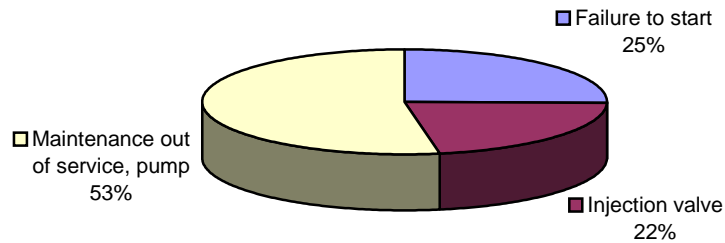


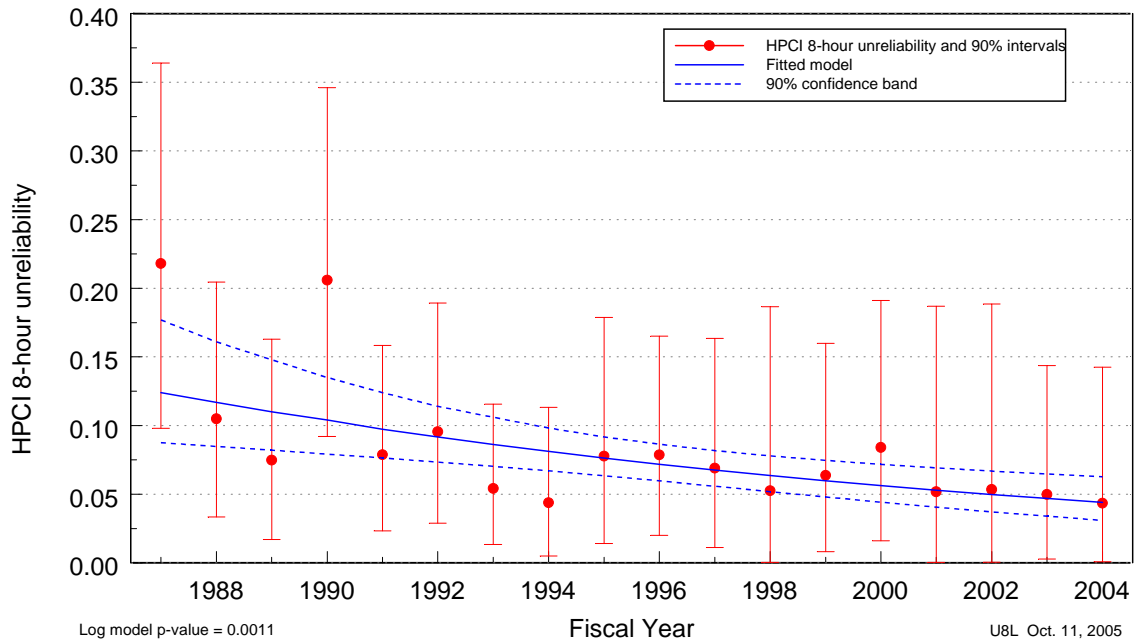
Figure 2. Segment failure distribution, FTS model.

### 1.3 Fail to Operate for 8-Hour Model Results

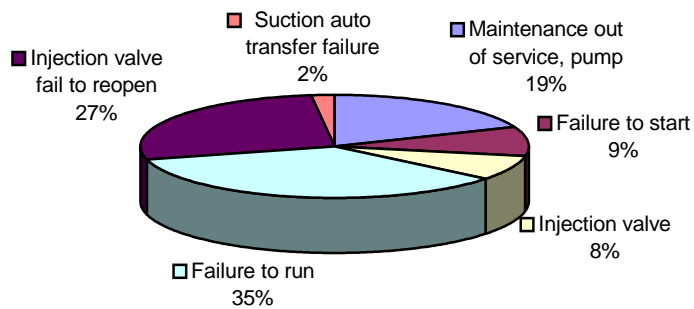
The estimates of HPCI system unreliability using operating experience from LERs and fault tree analyses show no statistically significant difference between plants. Plant system differences are computed based on plant differences seen in the segment failure data. When there are no statistically significant differences observed in the segment failure data, any update to show system unreliability results in the same values for all plants. Therefore, no data are plotted.

A highly statistically significant trend within the industry estimates of HPCI system unreliability (8-hour mission) on a per fiscal year basis was identified. Figure 3 displays the trend by fiscal year of the HPCI system unreliability calculated from the 1987–2004 experience. Table 6 shows the data points for Figure 3.

The leading contributors to HPCI system long-term unreliability are the failure to run and the failure of the injection valve to reopen. Figure 4 shows the distribution of segment failures for the 8-hour mission.



**Figure 3. Trend of HPCI system unreliability (8-hour mission), as a function of fiscal year.**



**Figure 4. Segment failure distribution, 8-hour mission.**

## 2 DATA TRENDS

The raw actuation and failure data were trended for event counts over time.

### 2.1 Unplanned Demand Trend

Trends were identified in the frequency of HPCI unplanned demands (Figure 5). When modeled as a function of fiscal year, the unplanned demand frequency exhibited an extremely statistically significant decreasing trend. Table 7 shows the LERs that are represented in the figure.

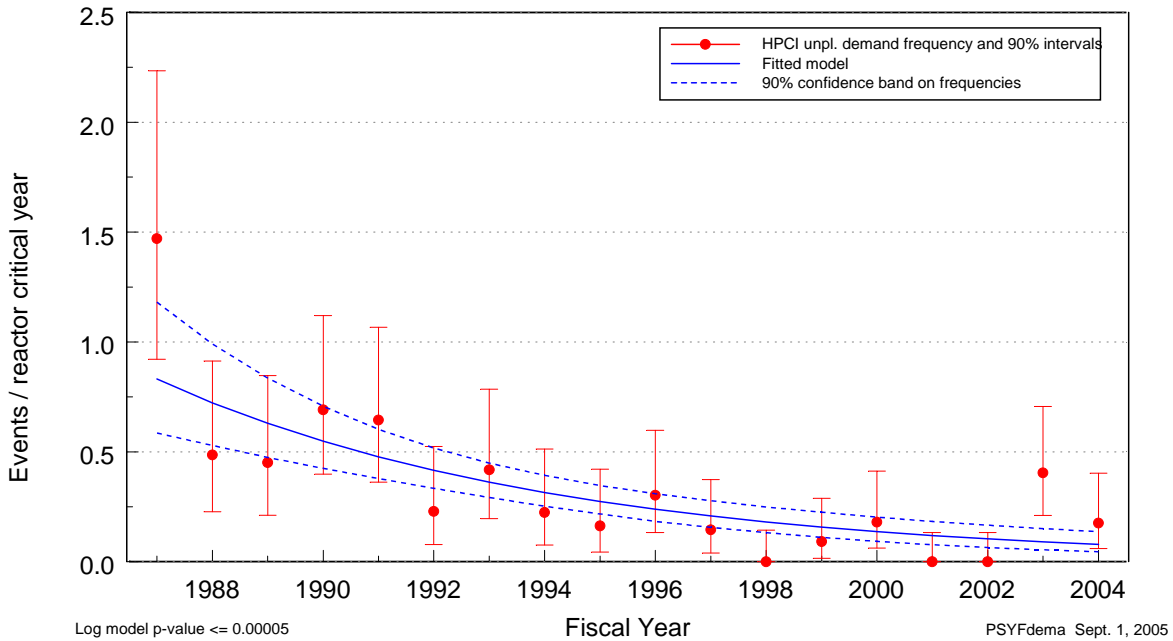
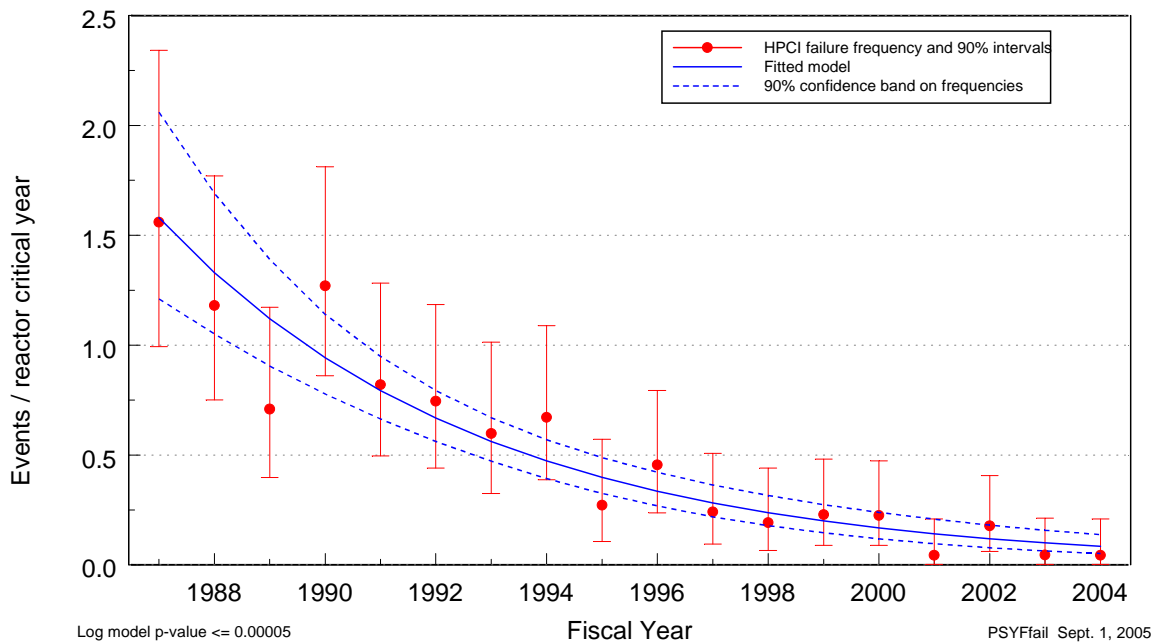


Figure 5. Frequency (events per operating year) of unplanned demands, as a function of fiscal year.

### 2.2 Failure Trend

The frequency of all failures (unplanned demands, surveillance tests, inspections, etc.) resulting in train unavailability identified in the experience was analyzed to determine trends. When modeled as a function of fiscal year, an extremely statistically significant decreasing trend was identified. The fitted frequency is plotted against fiscal year in Figure 6. Trends for HPCI failures are plotted without regard to method of detection (the trend excludes maintenance out of service and support system failures). Table 8 shows the LERs that are represented in the figure.



**Figure 6. Frequency (events per operating year) of failures, as a function of fiscal year.**

## 2.3 Failure Cause and Discovery Method Summary

The raw failure data were sliced to show the distribution of the failure causes and the discovery methods by the affected segment.

### 2.3.1 Leading Segment Failures.

The turbine (48%) and the instrumentation and control (15%) were the leading segment failures identified in the database. See [Table 2](#).

### 2.3.2 Leading Discovery Methods

Periodic surveillance (52%) and alarms and indication (22%) were the leading methods of discovery. See [Table 2](#).

### 2.3.3 Leading Causes of Failure.

Seventy-two percent of the HPCI system failures that were observed in the experience are attributed to hardware-related problems. Personnel errors caused 13% of all HPCI system failures. See [Table 4](#)

**Table 2. Comparison of failed segment with the method of discovery.<sup>2</sup>**

Segment	Actual/ unplanned demand	Alarm/ indicator	I&C functional test	Inspection/ review	Maintenance on system	Periodic surveillance on system	Post-maintenance testing	Total	Percent
I&C		9	3	2		10		24	15%
Injection	4			3		8	1	16	10%
Pump	1	4		2	1	13	1	22	14%
Support	1	12		4		2		19	12%
Turbine	3	10	2	7		48	5	75	48%
Total	9	35	5	18	1	81	7	156	100%
Percent	6%	22%	3%	12%	1%	52%	4%	100%	

**Table 3. Discovery method description.**

Discovery Method	Description	Used in the Failure Calculations
Actual/unplanned demand	The demand for the system was ESF, inadvertent. If the demand was inadvertent, the demand should mimic an ESF demand.	✓
Design review	Because of a design review, a deficiency was noted in the system.	
Periodic surveillance on subject system	Normally scheduled surveillance. These surveillances are to satisfy scheduled Technical Specification requirements.	✓
Maintenance on subject system	The failed condition was discovered during maintenance on the system. These include latent failures as well as maintenance-induced failures.	
Inspection/review	The failure was discovered during operator duties such as walk downs, inspections, etc.	
Alarm/indicator	The failure was evidenced by an alarm or by other indications.	
I&C functional test	The failure was discovered during testing of the instrumentation and control system for the subject system or another system.	
Post-maintenance testing	Failed condition was discovered during post-maintenance testing. The technical specification surveillance tests can be used for this testing, but cannot be counted.	

<sup>2</sup> The discovery method is the activity that is ongoing at the time of the failure.

Discovery Method	Description	Used in the Failure Calculations
Unscheduled TS required surveillance	Failed condition was discovered during technical specification required testing. Tests are performed to show system operability per the technical specifications and are not scheduled. The technical specification surveillance tests can be used for this testing, but cannot be counted.	
Other (not counted) surveillance test	All others discovered by testing.	

**Table 4. Comparison of failed segment and failure cause.<sup>3</sup>**

Segment	Contamination	Design	Hardware	Personnel	Procedure	Total	Percent
I&C			17	4	3	24	15%
Injection		2	12	1	1	16	10%
Pump	4	1	11	5	1	22	14%
Support			13	5	1	19	12%
Turbine	1	4	60	6	4	75	48%
Total	5	7	113	21	10	156	100%
Percent	3%	4%	72%	13%	6%	100%	

- Contamination–The failure was the result of foreign material affecting the component.
- Design–The failure was the result of a flawed design.
- Hardware–The failure was the result of some aspect of the equipment. Typically, this is used for normal wear of the component.
- Personnel–The failure was the result of personnel error, by either commission or omission.
- Procedure–The failure was the result of an incorrect procedure.

<sup>3</sup> The cause of the failure is assigned to a broadly defined cause classification. The cause classifications are design, environment, hardware (e.g., aging, wear, manufacturing defects), personnel, and procedure. The cause classification assigned is based on the immediate cause of the failure and not the root cause. Generally, root cause is only determined through a detailed investigation and analysis of the failure. Specifically, the mechanism that actually resulted in the failure of the segment or component is captured as the cause.



### 3 DATA TABLES

#### 3.1 Data Tables for Unreliability and Unavailability Trends

**Table 5. Plot data table for HPCI system unavailability, FTS model. Figure 1.**

Fiscal Year	Plot Trend Error Bar Points			Regression Curve Data Points		
	Lower (5%)	Mean	Upper (95%)	Lower (5%)	Mean	Upper (95%)
1987	1.73E-02	4.75E-02	8.92E-02	3.32E-02	4.34E-02	5.67E-02
1988	1.13E-02	3.98E-02	8.19E-02	3.23E-02	4.12E-02	5.26E-02
1989	3.23E-03	2.53E-02	6.42E-02	3.13E-02	3.92E-02	4.89E-02
1990	1.08E-02	4.90E-02	1.08E-01	3.04E-02	3.72E-02	4.55E-02
1991	6.46E-03	3.04E-02	6.82E-02	2.94E-02	3.53E-02	4.25E-02
1992	9.47E-03	3.73E-02	7.93E-02	2.84E-02	3.36E-02	3.97E-02
1993	9.42E-03	3.70E-02	7.86E-02	2.73E-02	3.19E-02	3.72E-02
1994	2.21E-03	2.44E-02	6.61E-02	2.62E-02	3.03E-02	3.50E-02
1995	1.42E-02	4.39E-02	8.61E-02	2.50E-02	2.88E-02	3.31E-02
1996	5.80E-03	3.03E-02	6.99E-02	2.38E-02	2.73E-02	3.14E-02
1997	4.17E-04	1.82E-02	5.98E-02	2.25E-02	2.60E-02	3.00E-02
1998	6.71E-04	1.94E-02	6.07E-02	2.11E-02	2.47E-02	2.88E-02
1999	9.54E-03	3.85E-02	8.25E-02	1.98E-02	2.34E-02	2.77E-02
2000	2.16E-03	2.38E-02	6.46E-02	1.85E-02	2.23E-02	2.67E-02
2001	4.02E-04	1.86E-02	6.16E-02	1.73E-02	2.11E-02	2.59E-02
2002	6.21E-04	2.03E-02	6.44E-02	1.61E-02	2.01E-02	2.51E-02
2003	4.84E-04	1.65E-02	5.27E-02	1.49E-02	1.91E-02	2.44E-02
2004	4.30E-04	1.79E-02	5.85E-02	1.39E-02	1.81E-02	2.37E-02

**Table 6. Plot data table for HPCI system unreliability, 8-hour mission. Figure 3**

Fiscal Year	Plot Trend Error Bar Points			Regression Curve Data Points		
	Lower (5%)	Mean	Upper (95%)	Lower (5%)	Mean	Upper (95%)
1987	9.79E-02	2.18E-01	3.64E-01	8.75E-02	1.24E-01	1.77E-01
1988	3.32E-02	1.05E-01	2.04E-01	8.48E-02	1.17E-01	1.61E-01
1989	1.71E-02	7.49E-02	1.63E-01	8.21E-02	1.10E-01	1.48E-01
1990	9.22E-02	2.06E-01	3.46E-01	7.93E-02	1.04E-01	1.35E-01
1991	2.33E-02	7.89E-02	1.58E-01	7.65E-02	9.74E-02	1.24E-01
1992	2.90E-02	9.55E-02	1.89E-01	7.35E-02	9.17E-02	1.14E-01
1993	1.34E-02	5.42E-02	1.16E-01	7.04E-02	8.63E-02	1.06E-01
1994	4.94E-03	4.38E-02	1.13E-01	6.71E-02	8.12E-02	9.82E-02
1995	1.42E-02	7.78E-02	1.79E-01	6.35E-02	7.64E-02	9.18E-02
1996	2.02E-02	7.87E-02	1.65E-01	5.98E-02	7.18E-02	8.64E-02
1997	1.13E-02	6.90E-02	1.64E-01	5.59E-02	6.76E-02	8.18E-02
1998	4.38E-04	5.26E-02	1.87E-01	5.19E-02	6.36E-02	7.79E-02
1999	8.14E-03	6.38E-02	1.60E-01	4.80E-02	5.98E-02	7.46E-02
2000	1.62E-02	8.41E-02	1.91E-01	4.42E-02	5.63E-02	7.17E-02
2001	3.61E-04	5.18E-02	1.87E-01	4.06E-02	5.30E-02	6.92E-02
2002	4.90E-04	5.35E-02	1.89E-01	3.72E-02	4.98E-02	6.68E-02
2003	2.91E-03	4.98E-02	1.44E-01	3.40E-02	4.69E-02	6.47E-02
2004	9.39E-04	4.35E-02	1.42E-01	3.10E-02	4.41E-02	6.27E-02

## 3.2 Data Tables for Failure and Demand Trends

**Table 7. LER listing for demand trend figure. Figure 5**

FY	Plant Name	LER	Event Date
1996	Browns Ferry 2	<a href="#">2601996005</a>	5/10/1996
1997	Browns Ferry 2	<a href="#">2601997001</a>	4/24/1997
1996	Browns Ferry 3	<a href="#">2961996002</a>	4/21/1996
1996	Browns Ferry 3	<a href="#">2961996003</a>	5/1/1996
2000	Browns Ferry 3	<a href="#">2962000001</a>	4/15/2000
2000	Browns Ferry 3	<a href="#">2962000005</a>	5/24/2000
1991	Brunswick 1	<a href="#">3251991018</a>	7/18/1991
1992	Brunswick 1	<a href="#">3251992003</a>	1/17/1992
1995	Brunswick 1	<a href="#">3251995015</a>	7/13/1995
2004	Brunswick 1	<a href="#">3252004002</a>	8/14/2004
1987	Brunswick 2	<a href="#">3241987001</a>	1/5/1987
1987	Brunswick 2	<a href="#">3241987004</a>	3/11/1987
1989	Brunswick 2	<a href="#">3241988018</a>	11/16/1988
1990	Brunswick 2	<a href="#">3241990008</a>	8/16/1990
1990	Brunswick 2	<a href="#">3241990009</a>	8/19/1990
1990	Brunswick 2	<a href="#">3241990015</a>	9/27/1990
1991	Brunswick 2	<a href="#">3241990016</a>	10/12/1990
1991	Brunswick 2	<a href="#">3241991001</a>	1/25/1991
1992	Brunswick 2	<a href="#">3241991021</a>	12/17/1991
2004	Brunswick 2	<a href="#">3242003004</a>	11/4/2003
1987	Cooper	<a href="#">2981987003</a>	1/7/1987
1987	Cooper	<a href="#">2981987009</a>	2/18/1987
1988	Cooper	<a href="#">2981988021</a>	8/25/1988
1990	Cooper	<a href="#">2981989026</a>	11/25/1989
1991	Cooper	<a href="#">2981990011</a>	10/17/1990
1994	Cooper	<a href="#">2981993038</a>	12/14/1993
1994	Cooper	<a href="#">2981994004</a>	3/2/1994
2003	Cooper	<a href="#">2982003004</a>	5/26/2003
2004	Cooper	<a href="#">2982003007</a>	11/26/2003
1989	Dresden 3	<a href="#">2491989001</a>	3/25/1989
1996	Dresden 3	<a href="#">2491996004</a>	5/15/1996
2004	Dresden 3	<a href="#">2492004003</a>	5/5/2004
1989	Duane Arnold	<a href="#">3311989008</a>	3/5/1989
1989	Duane Arnold	<a href="#">3311989011</a>	8/26/1989
1988	Fermi 2	<a href="#">3411988004</a>	1/10/1988
1993	Fermi 2	<a href="#">3411992012</a>	11/18/1992
1993	Fermi 2	<a href="#">3411993010</a>	8/13/1993
2003	Fermi 2	<a href="#">3412003002</a>	8/14/2003
1990	FitzPatrick	<a href="#">3331990009</a>	3/19/1990
1993	FitzPatrick	<a href="#">3331993009</a>	4/20/1993
1995	FitzPatrick	<a href="#">3331995013</a>	9/5/1995
1996	FitzPatrick	<a href="#">3331996010</a>	9/16/1996
2003	FitzPatrick	<a href="#">3332003001</a>	8/14/2003
1987	Hatch 1	<a href="#">3211987011</a>	7/23/1987
1987	Hatch 1	<a href="#">3211987013</a>	8/3/1987
1988	Hatch 1	<a href="#">3211988013</a>	9/4/1988
1989	Hatch 1	<a href="#">3211988018</a>	12/17/1988
1990	Hatch 1	<a href="#">3211990013</a>	6/20/1990
1991	Hatch 1	<a href="#">3211991001</a>	1/18/1991
1991	Hatch 1	<a href="#">3211991007</a>	2/27/1991
1991	Hatch 1	<a href="#">3211991017</a>	9/11/1991
1992	Hatch 1	<a href="#">3211992021</a>	8/27/1992
1994	Hatch 1	<a href="#">3211993013</a>	10/22/1993
2000	Hatch 1	<a href="#">3212000002</a>	1/26/2000
2000	Hatch 1	<a href="#">3212000011</a>	9/29/2000
1987	Hatch 2	<a href="#">3661987003</a>	1/26/1987

FY	Plant Name	LER	Event Date
1987	Hatch 2	<a href="#">3661987008</a>	4/22/1987
1987	Hatch 2	<a href="#">3661987006</a>	7/26/1987
1987	Hatch 2	<a href="#">3661987009</a>	8/3/1987
1988	Hatch 2	<a href="#">3661988017</a>	5/27/1988
1988	Hatch 2	<a href="#">3661988020</a>	8/5/1988
1990	Hatch 2	<a href="#">3661990001</a>	1/12/1990
1992	Hatch 2	<a href="#">3661992009</a>	6/25/1992
1994	Hatch 2	<a href="#">3661994007</a>	8/30/1994
1995	Hatch 2	<a href="#">3661995001</a>	4/11/1995
1997	Hatch 2	<a href="#">3661997007</a>	4/22/1997
1987	Hope Creek	<a href="#">3541987017</a>	2/24/1987
1987	Hope Creek	<a href="#">3541987034</a>	7/30/1987
1987	Hope Creek	<a href="#">3541987037</a>	8/16/1987
1987	Hope Creek	<a href="#">3541987039</a>	8/29/1987
1988	Hope Creek	<a href="#">3541988012</a>	4/30/1988
1988	Hope Creek	<a href="#">3541988022</a>	8/26/1988
1989	Hope Creek	<a href="#">3541988027</a>	10/15/1988
1989	Hope Creek	<a href="#">3541988029</a>	11/1/1988
1990	Hope Creek	<a href="#">3541990003</a>	3/19/1990
1991	Hope Creek	<a href="#">3541990029</a>	11/26/1990
1999	Limerick 1	<a href="#">3521999003</a>	4/20/1999
2003	Limerick 1	<a href="#">3522003003</a>	4/23/2003
1987	Monticello	<a href="#">2631987009</a>	4/3/1987
1991	Monticello	<a href="#">2631991019</a>	8/25/1991
1990	Peach Bottom 2	<a href="#">2771989033</a>	12/20/1989
1993	Peach Bottom 2	<a href="#">2771993004</a>	3/2/1993
2003	Peach Bottom 2	<a href="#">2772002001</a>	12/21/2002
2003	Peach Bottom 2	<a href="#">2772003003</a>	7/22/2003
2003	Peach Bottom 2	<a href="#">2772003004</a>	9/15/2003
1990	Peach Bottom 3	<a href="#">2781990002</a>	1/28/1990
1990	Peach Bottom 3	<a href="#">2781990008</a>	7/27/1990
1993	Peach Bottom 3	<a href="#">2781992008</a>	10/15/1992
1993	Peach Bottom 3	<a href="#">2781993004</a>	7/30/1993
2003	Peach Bottom 3	<a href="#">2772003004</a>	9/15/2003
1990	Pilgrim	<a href="#">2931990013</a>	9/2/1990
1997	Quad Cities 2	<a href="#">2651997001</a>	2/27/1997
1991	Susquehanna 1	<a href="#">3871991008</a>	7/31/1991
1999	Susquehanna 1	<a href="#">3871999003</a>	7/1/1999
2003	Susquehanna 1	<a href="#">3872003006</a>	9/24/2003
1987	Susquehanna 2	<a href="#">3881987006</a>	4/16/1987
1996	Susquehanna 2	<a href="#">3881996004</a>	7/14/1996
1991	Vermont Yankee	<a href="#">2711991009</a>	4/23/1991

**Table 8. LER listing for failure trend figure. Figure 6**

FY	Plant Name	LER	Event Date
1991	Browns Ferry 2	<a href="#">2601991015</a>	7/31/1991
1994	Browns Ferry 2	<a href="#">2601994001</a>	2/14/1994
1995	Browns Ferry 2	<a href="#">2601995005</a>	6/7/1995
2000	Browns Ferry 2	<a href="#">2601999011</a>	11/18/1999
2003	Browns Ferry 3	<a href="#">2962002004</a>	10/22/2002
1987	Brunswick 1	<a href="#">3251987001</a>	1/26/1987
1988	Brunswick 1	<a href="#">3251987023</a>	12/31/1987
1988	Brunswick 1	<a href="#">3251988011</a>	4/20/1988
1988	Brunswick 1	<a href="#">3251988012</a>	5/28/1988

FY	Plant Name	LER	Event Date
1988	Brunswick 1	<a href="#">3251988017</a>	7/1/1988
1988	Brunswick 1	<a href="#">3251988018</a>	7/13/1988
1990	Brunswick 1	<a href="#">3251989020</a>	10/11/1989
1990	Brunswick 1	<a href="#">3251990001</a>	1/2/1990
1990	Brunswick 1	<a href="#">3251990003</a>	3/2/1990
1991	Brunswick 1	<a href="#">3251991018</a>	7/18/1991
1994	Brunswick 1	<a href="#">3251994009</a>	5/13/1994
1994	Brunswick 1	<a href="#">3251994012</a>	9/22/1994
1996	Brunswick 1	<a href="#">3251996007</a>	5/9/1996
1987	Brunswick 2	<a href="#">3241987001</a>	1/5/1987
1987	Brunswick 2	<a href="#">3241987004</a>	3/11/1987
1989	Brunswick 2	<a href="#">3241988018</a>	11/16/1988
1989	Brunswick 2	<a href="#">3241989013</a>	9/9/1989
1990	Brunswick 2	<a href="#">3241990008</a>	8/16/1990
1990	Brunswick 2	<a href="#">3241990013</a>	9/6/1990
1992	Brunswick 2	<a href="#">3241991020</a>	12/14/1991
1995	Brunswick 2	<a href="#">3241995002</a>	5/10/1995
1992	Cooper	<a href="#">2981992014</a>	7/31/1992
1993	Cooper	<a href="#">2981993031</a>	8/30/1993
1999	Cooper	<a href="#">2981998012</a>	12/17/1998
1999	Cooper	<a href="#">2981998011</a>	12/18/1998
2002	Cooper	<a href="#">2982001005</a>	10/17/2001
2002	Cooper	<a href="#">2982002001</a>	9/18/2002
1987	Dresden 2	<a href="#">2371987012</a>	4/22/1987
1987	Dresden 2	<a href="#">2371987018</a>	6/6/1987
1988	Dresden 2	<a href="#">2371988013</a>	7/8/1988
1994	Dresden 2	<a href="#">2371994020</a>	7/15/1994
1994	Dresden 2	<a href="#">2371994021</a>	8/4/1994
1998	Dresden 2	<a href="#">2371998003</a>	1/28/1998
1987	Dresden 3	<a href="#">2491987002</a>	2/25/1987
1993	Dresden 3	<a href="#">2491993013</a>	8/9/1993
1994	Dresden 3	<a href="#">2491993019</a>	12/14/1993
1987	Duane Arnold	<a href="#">3311987023</a>	7/14/1987
1988	Duane Arnold	<a href="#">3311988002</a>	4/11/1988
1989	Duane Arnold	<a href="#">3311989002</a>	1/26/1989
1996	Duane Arnold	<a href="#">3311995012</a>	12/12/1995
2001	Duane Arnold	<a href="#">3312001004</a>	9/2/2001
1988	Fermi 2	<a href="#">3411988028</a>	7/26/1988
1990	Fermi 2	<a href="#">3411990008</a>	9/5/1990
1991	Fermi 2	<a href="#">3411990012</a>	10/16/1990
1992	Fermi 2	<a href="#">3411991020</a>	11/20/1991
1993	Fermi 2	<a href="#">3411993001</a>	1/4/1993
1993	Fermi 2	<a href="#">3411993002</a>	1/14/1993
1997	Fermi 2	<a href="#">3411997002</a>	2/16/1997
1987	FitzPatrick	<a href="#">3331987010</a>	7/23/1987
1988	FitzPatrick	<a href="#">3331988001</a>	3/10/1988
1989	FitzPatrick	<a href="#">3331989005</a>	4/12/1989
1990	FitzPatrick	<a href="#">3331989018</a>	10/8/1989
1990	FitzPatrick	<a href="#">3331989025</a>	11/30/1989
1991	FitzPatrick	<a href="#">3331991019</a>	9/17/1991
1995	FitzPatrick	<a href="#">3331995008</a>	3/26/1995
1996	FitzPatrick	<a href="#">3331996008</a>	9/6/1996
1998	FitzPatrick	<a href="#">3331997013</a>	12/16/1997
1998	FitzPatrick	<a href="#">3331998007</a>	7/31/1998
2000	FitzPatrick	<a href="#">3331999010</a>	10/14/1999
1988	Hatch 1	<a href="#">3211988012</a>	8/26/1988
1988	Hatch 1	<a href="#">3211988013</a>	9/4/1988
1989	Hatch 1	<a href="#">3211989006</a>	3/29/1989
1990	Hatch 1	<a href="#">3211990001</a>	1/4/1990
1990	Hatch 1	<a href="#">3211990015</a>	7/30/1990
1991	Hatch 1	<a href="#">3211991001</a>	1/18/1991

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1992	Hatch 1	<a href="#">3211991033</a>	12/30/1991
1992	Hatch 1	<a href="#">3211992006</a>	2/26/1992
1996	Hatch 1	<a href="#">3211996010</a>	6/29/1996
2000	Hatch 1	<a href="#">3212000005</a>	8/16/2000
1987	Hatch 2	<a href="#">3661987004</a>	6/16/1987
1987	Hatch 2	<a href="#">3661987009</a>	8/3/1987
1988	Hatch 2	<a href="#">3661987017</a>	11/19/1987
1988	Hatch 2	<a href="#">3661988001</a>	1/6/1988
1990	Hatch 2	<a href="#">3661990001</a>	1/12/1990
1990	Hatch 2	<a href="#">3661990005</a>	7/19/1990
1994	Hatch 2	<a href="#">3661993008</a>	11/3/1993
1994	Hatch 2	<a href="#">3661994002</a>	3/1/1994
1996	Hatch 2	<a href="#">3661996002</a>	6/26/1996
1997	Hatch 2	<a href="#">3661997001</a>	1/25/1997
1997	Hatch 2	<a href="#">3661997008</a>	8/18/1997
2000	Hatch 2	<a href="#">3662000001</a>	2/27/2000
1988	Hope Creek	<a href="#">3541988010</a>	4/14/1988
1989	Hope Creek	<a href="#">3541989009</a>	4/14/1989
1989	Hope Creek	<a href="#">3541989012</a>	6/7/1989
1990	Hope Creek	<a href="#">3541990009</a>	6/7/1990
1996	Hope Creek	<a href="#">3541995025</a>	10/24/1995
1998	Hope Creek	<a href="#">3541997032</a>	12/5/1997
1999	Hope Creek	<a href="#">3541999011</a>	9/19/1999
1987	Limerick 1	<a href="#">3521987015</a>	5/14/1987
1987	Limerick 1	<a href="#">3521987015</a>	5/14/1987
1988	Limerick 1	<a href="#">3521987066</a>	12/8/1987
1992	Limerick 1	<a href="#">3521991028</a>	12/10/1991
1992	Limerick 1	<a href="#">3521992002</a>	3/11/1992
1992	Limerick 1	<a href="#">3521992015</a>	7/7/1992
1996	Limerick 1	<a href="#">3521996018</a>	9/25/1996
1999	Limerick 1	<a href="#">3521999008</a>	6/23/1999
1990	Limerick 2	<a href="#">3531989010</a>	10/13/1989
1990	Limerick 2	<a href="#">3531990004</a>	3/8/1990
1991	Limerick 2	<a href="#">3531991015</a>	9/12/1991
1992	Limerick 2	<a href="#">3531991017</a>	11/15/1991
1992	Limerick 2	<a href="#">3531992004</a>	2/21/1992
1987	Peach Bottom 2	<a href="#">2771987020</a>	9/4/1987
1989	Peach Bottom 2	<a href="#">2771989009</a>	5/5/1989
1990	Peach Bottom 2	<a href="#">2771990017</a>	7/24/1990
1993	Peach Bottom 2	<a href="#">2771993003</a>	1/31/1993
1994	Peach Bottom 2	<a href="#">2771994004</a>	7/18/1994
1997	Peach Bottom 2	<a href="#">2771996009</a>	10/1/1996
1997	Peach Bottom 2	<a href="#">2771997003</a>	6/1/1997
1999	Peach Bottom 2	<a href="#">2771999001</a>	1/19/1999
1987	Peach Bottom 3	<a href="#">2781987007</a>	8/29/1987
1990	Peach Bottom 3	<a href="#">2781989009</a>	12/7/1989
1990	Peach Bottom 3	<a href="#">2781990010</a>	8/4/1990
1990	Peach Bottom 3	<a href="#">2781990011</a>	9/10/1990
1991	Peach Bottom 3	<a href="#">2781991005</a>	4/10/1991
1991	Peach Bottom 3	<a href="#">2781991014</a>	9/5/1991
1993	Peach Bottom 3	<a href="#">2781992009</a>	11/28/1992
1993	Peach Bottom 3	<a href="#">2781993001</a>	1/25/1993
1993	Peach Bottom 3	<a href="#">2781993005</a>	8/9/1993
1994	Peach Bottom 3	<a href="#">2781993009</a>	11/13/1993
1994	Peach Bottom 3	<a href="#">2781994004</a>	9/24/1994
1995	Peach Bottom 3	<a href="#">2781995002</a>	7/6/1995
1996	Peach Bottom 3	<a href="#">2781996001</a>	5/29/1996
2004	Peach Bottom 3	<a href="#">2782004001</a>	3/17/2004
1989	Pilgrim	<a href="#">2931989013</a>	3/24/1989
1989	Pilgrim	<a href="#">2931989028</a>	9/7/1989
1991	Pilgrim	<a href="#">2931990017</a>	10/9/1990

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1994	Pilgrim	<a href="#">2931994002</a>	3/9/1994
2002	Pilgrim	<a href="#">2932002001</a>	7/7/2002
1990	Quad Cities 1	<a href="#">2541989022</a>	11/28/1989
1991	Quad Cities 1	<a href="#">2541991012</a>	5/7/1991
1991	Quad Cities 1	<a href="#">2541991012</a>	5/7/1991
1992	Quad Cities 1	<a href="#">2541992002</a>	2/6/1992
1993	Quad Cities 1	<a href="#">2541993005</a>	6/9/1993
1993	Quad Cities 1	<a href="#">2541993012</a>	7/26/1993
1995	Quad Cities 1	<a href="#">2541995004</a>	3/29/1995
1987	Quad Cities 2	<a href="#">2651987003</a>	1/27/1987
1991	Quad Cities 2	<a href="#">2651990012</a>	11/24/1990
1991	Quad Cities 2	<a href="#">2651991003</a>	1/22/1991
2000	Quad Cities 2	<a href="#">2652000005</a>	2/11/2000
1987	Susquehanna 1	<a href="#">3871987008</a>	2/23/1987

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1988	Susquehanna 1	<a href="#">3871988009</a>	5/20/1988
1989	Susquehanna 1	<a href="#">3871988022</a>	11/4/1988
1990	Susquehanna 1	<a href="#">3871990007</a>	2/15/1990
1991	Susquehanna 1	<a href="#">3871991002</a>	2/7/1991
1996	Susquehanna 1	<a href="#">3871995016</a>	12/31/1995
2002	Susquehanna 1	<a href="#">3872001004</a>	11/11/2001
1987	Susquehanna 2	<a href="#">3881987007</a>	4/13/1987
1990	Susquehanna 2	<a href="#">3881990001</a>	2/16/1990
1992	Susquehanna 2	<a href="#">3881991015</a>	12/16/1991
1992	Susquehanna 2	<a href="#">3881992002</a>	4/22/1992
1988	Vermont Yankee	<a href="#">2711987016</a>	11/5/1987