Reliability Study Update

High Pressure Coolant Injection System

1987–2002

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 2002, as reported in Licensee Event Reports (LERs). This is the latest update to NUREG/CR 5500 Volume 4.

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 from recirculation to injection, 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)	1.04E-02	3.10E-02	6.02E-02
8-hour Mission (Unreliability)	3.28E-02	7.59E-02	1.32E-01

1.2 Fail to Start Model Results

Individual plant result unavailability has been calculated for the FTS model. The estimates of HPCI system unavailability using operating experience from LERs and fault tree analyses are plotted in Figure 1 (FTS model). Table 2 shows the data points for Figure 1.

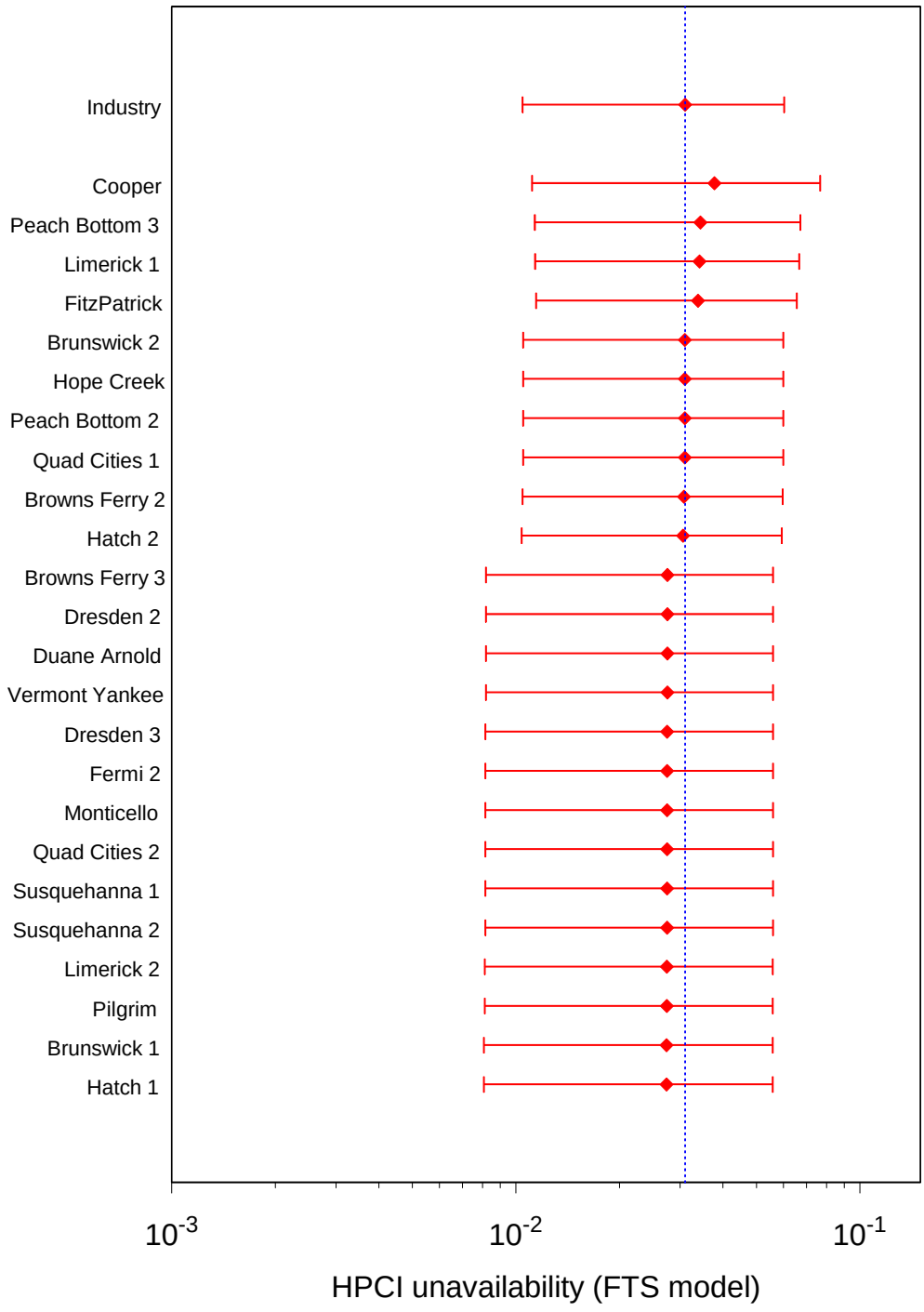

Figure 1. Plant-specific estimates of HPCI system unavailability for FTS model.

Table 2. HPCI plant unavailability FTS model.

Plant	Lower (5%)	Mean	Upper (95%)
Industry	1.04E-02	3.10E-02	6.02E-02
Hatch 1	8.07E-03	2.74E-02	5.57E-02
Brunswick 1	8.07E-03	2.74E-02	5.57E-02
Pilgrim	8.11E-03	2.75E-02	5.58E-02
Limerick 2	8.11E-03	2.75E-02	5.58E-02
Susquehanna 2	8.14E-03	2.75E-02	5.59E-02
Susquehanna 1	8.14E-03	2.75E-02	5.59E-02
Quad Cities 2	8.14E-03	2.75E-02	5.59E-02
Monticello	8.14E-03	2.75E-02	5.59E-02
Fermi 2	8.14E-03	2.75E-02	5.59E-02
Dresden 3	8.14E-03	2.75E-02	5.59E-02
Vermont Yankee	8.18E-03	2.76E-02	5.59E-02
Duane Arnold	8.18E-03	2.76E-02	5.59E-02
Dresden 2	8.18E-03	2.76E-02	5.59E-02
Browns Ferry 3	8.18E-03	2.76E-02	5.59E-02
Hatch 2	1.04E-02	3.06E-02	5.92E-02
Browns Ferry 2	1.05E-02	3.08E-02	5.96E-02
Quad Cities 1	1.05E-02	3.10E-02	5.99E-02
Peach Bottom 2	1.05E-02	3.10E-02	5.99E-02
Hope Creek	1.05E-02	3.10E-02	5.99E-02
Brunswick 2	1.05E-02	3.10E-02	5.99E-02
Fitzpatrick	1.14E-02	3.38E-02	6.55E-02
Limerick 1	1.14E-02	3.42E-02	6.65E-02
Peach Bottom 3	1.13E-02	3.44E-02	6.71E-02
Cooper	1.11E-02	3.78E-02	7.66E-02

A statistically significant[1] decreasing trend within the industry estimates of HPCI system unavailability (FTS) on a per fiscal year basis was identified. Figure 2 shows the trend in the FTS model unavailability. Table 7 shows the data points for Figure 2.

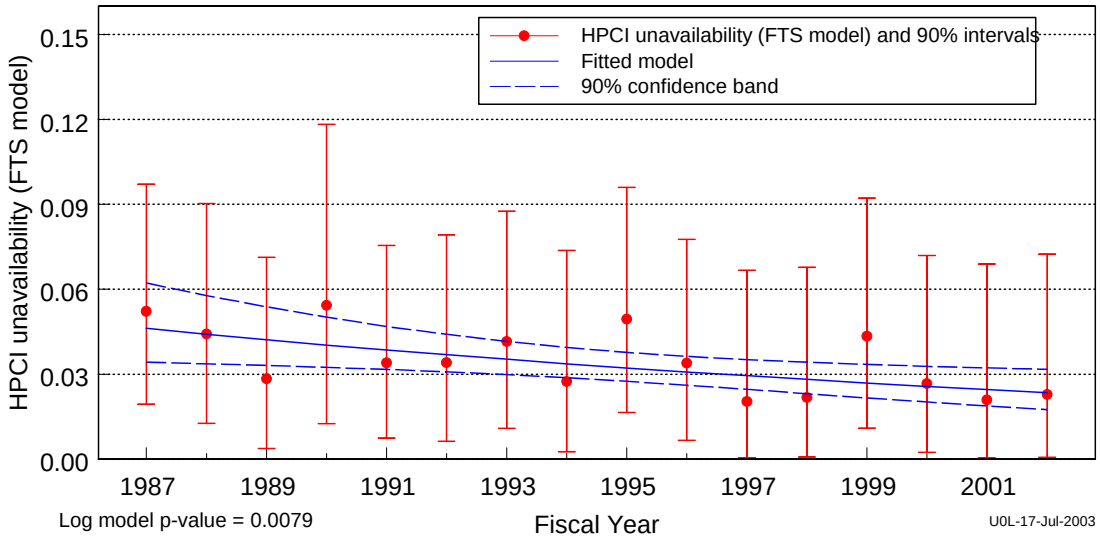

Figure 2. Trend of HPCI system unavailability (FTS model), as a function of fiscal year.

[1] The term "statistically significant" means that the data are too closely correlated to be attributed to chances and the data consequently have a systematic relationship. A p-value of less than 0.05 is generally considered 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 3 shows the distribution of segment failure contributions for the FTS model.

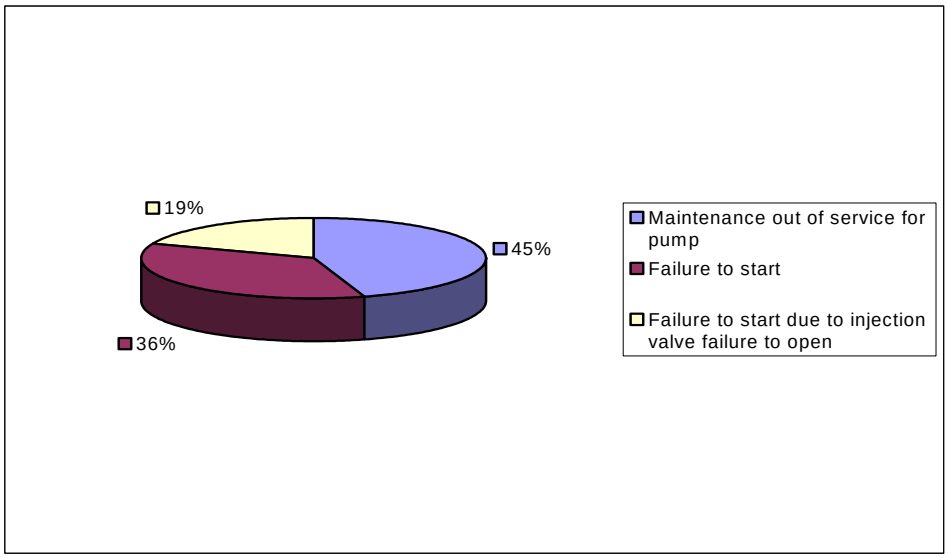

Figure 3. Segment failure distribution, FTS model.

1.3 Fail to Operate for 8-Hour Model Results

Individual plant result unreliability has been calculated for the 8-hour mission. The estimates of HPCI system unreliability using operating experience from LERs and fault tree analyses are plotted in Figure 4 (8-hour mission model). Table 3 shows the data points used in Figure 4.

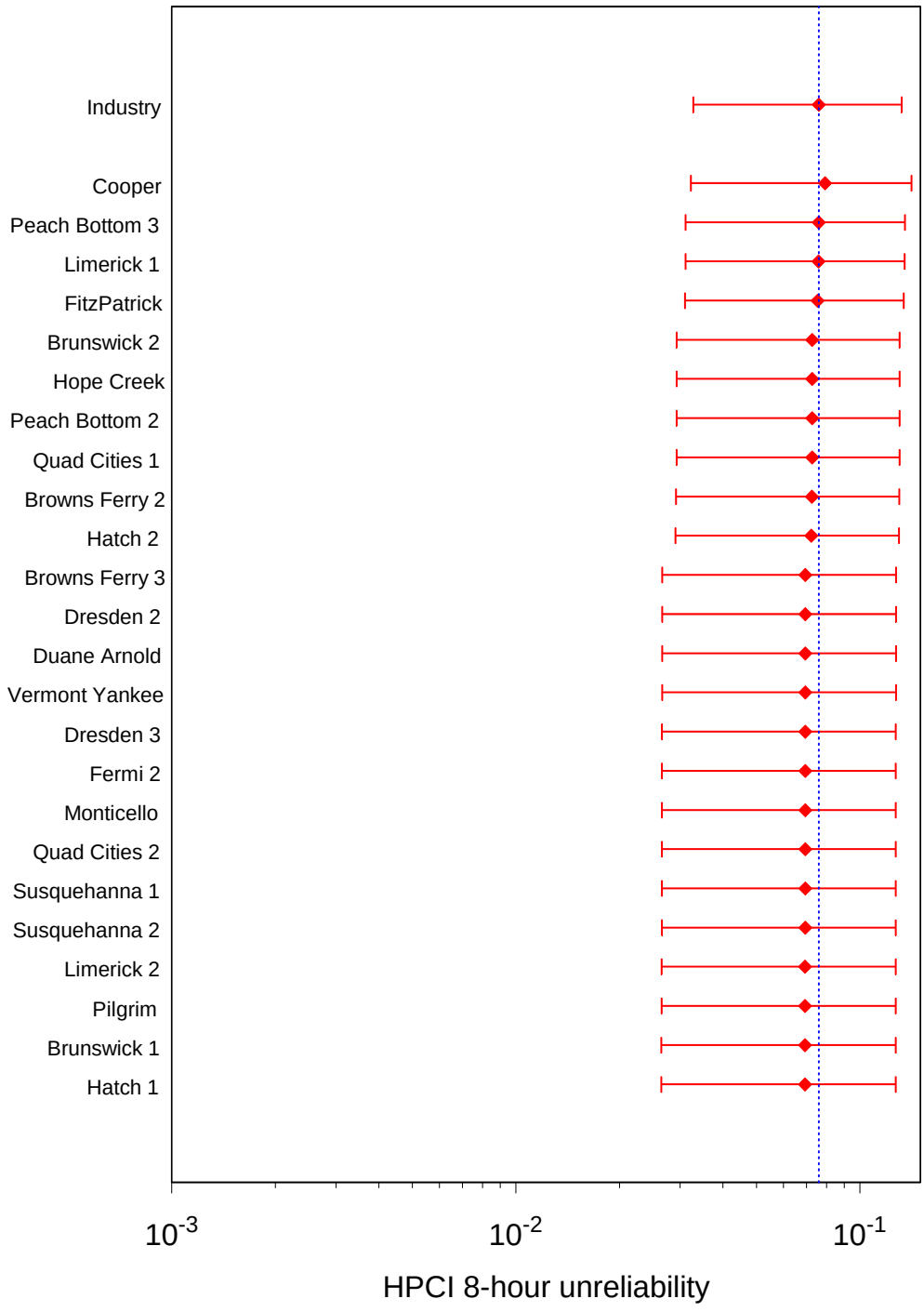

Figure 4. Plant-specific estimates of HPCI system unreliability for an 8-hour mission.

Table 3. HPCI plant unreliability data.

Plant	Lower (5%)	Mean	Upper (95%)
Industry	3.28E-02	7.59E-02	1.32E-01
Hatch 1	2.65E-02	6.92E-02	1.27E-01
Brunswick 1	2.65E-02	6.92E-02	1.27E-01
Pilgrim	2.65E-02	6.93E-02	1.27E-01
Limerick 2	2.65E-02	6.93E-02	1.27E-01
Susquehanna 2	2.65E-02	6.93E-02	1.27E-01
Susquehanna 1	2.65E-02	6.93E-02	1.27E-01
Quad Cities 2	2.65E-02	6.93E-02	1.27E-01
Monticello	2.65E-02	6.93E-02	1.27E-01
Fermi 2	2.65E-02	6.93E-02	1.27E-01
Dresden 3	2.65E-02	6.93E-02	1.27E-01
Vermont Yankee	2.66E-02	6.94E-02	1.27E-01
Duane Arnold	2.66E-02	6.94E-02	1.27E-01
Dresden 2	2.66E-02	6.94E-02	1.27E-01
Browns Ferry 3	2.66E-02	6.94E-02	1.27E-01
Hatch 2	2.91E-02	7.23E-02	1.30E-01
Browns Ferry 2	2.92E-02	7.25E-02	1.30E-01
Quad Cities 1	2.93E-02	7.27E-02	1.30E-01
Peach Bottom 2	2.93E-02	7.27E-02	1.30E-01
Hope Creek	2.93E-02	7.27E-02	1.30E-01
Brunswick 2	2.93E-02	7.27E-02	1.30E-01
Fitzpatrick	3.10E-02	7.54E-02	1.34E-01
Limerick 1	3.11E-02	7.57E-02	1.35E-01
Peach Bottom 3	3.11E-02	7.59E-02	1.35E-01
Cooper	3.22E-02	7.92E-02	1.41E-01

A statistically significant trend within the industry estimates of HPCI system unreliability (8-hour mission) on a per fiscal year basis was identified. Figure 5 displays the trend by fiscal year of the HPCI system unreliability calculated from the 1987–2002 experience. Table 8 shows the data points for Figure 5.

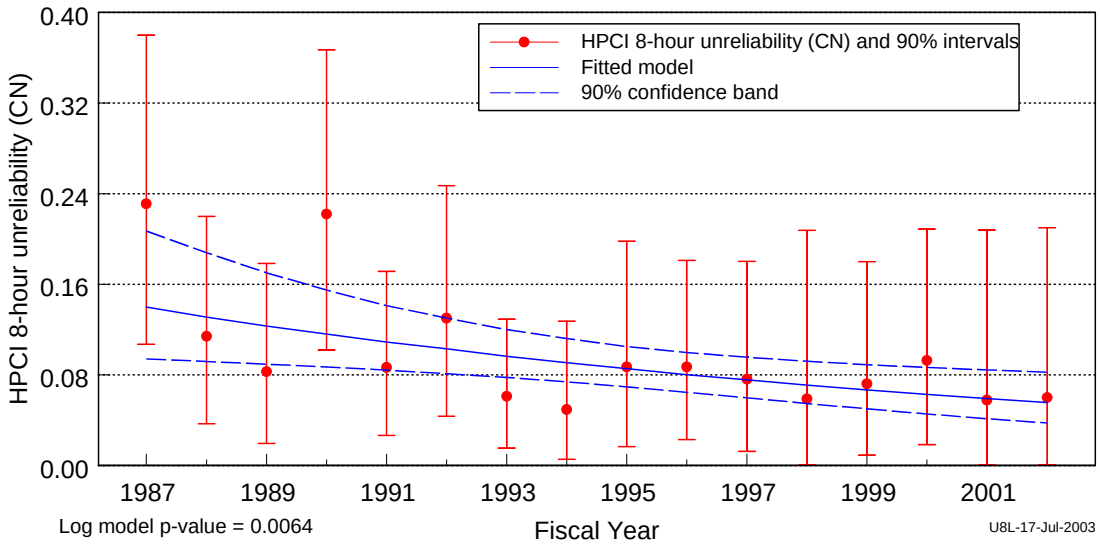

Figure 5. Trend of HPCI system unreliability (8-hour mission), as a function of fiscal year.

The leading contributor to HPCI system long-term unreliability, after maintenance out of service, is the failure of the turbine to start. Figure 6 shows the distribution of segment failures for the 8-hour mission.

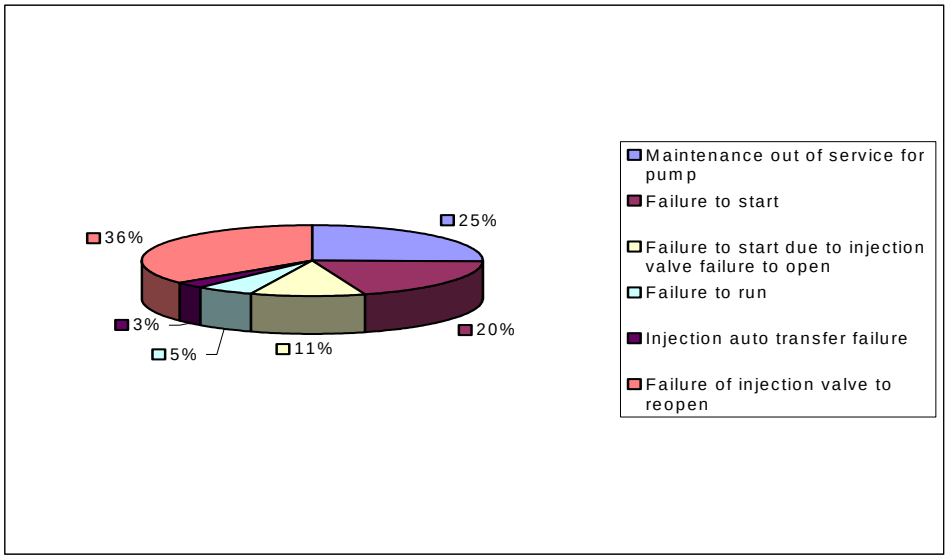

Figure 6. Segment failure distribution, 8-hour mission.

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 7). When modeled as a function of fiscal year, the unplanned demand frequency exhibited a highly statistically significant decreasing trend. Table 9 shows the LERs that are represented in the figure.

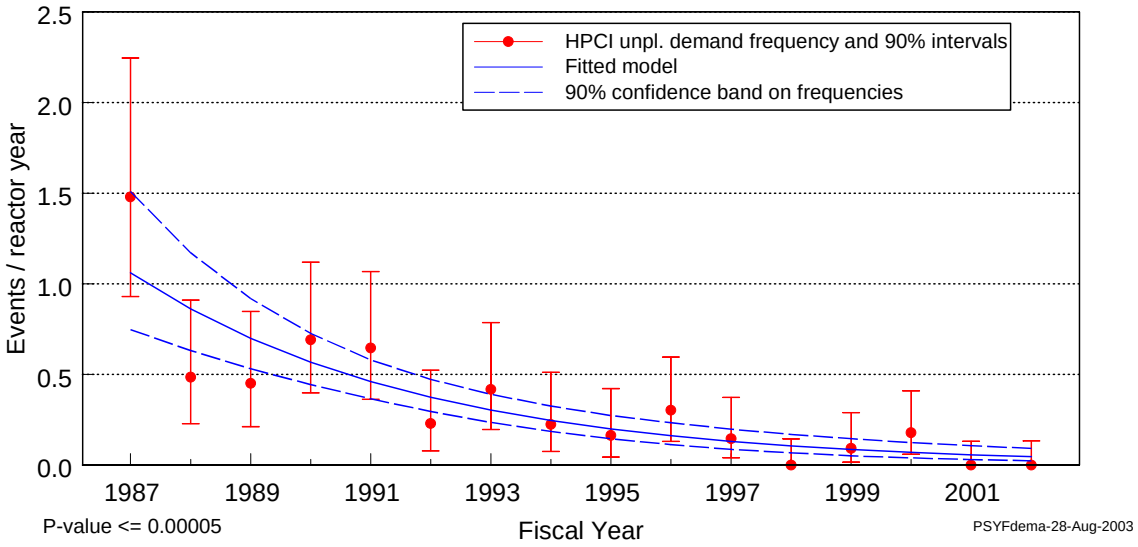

Figure 7. Frequency (events per operating year) of unplanned demands, as a function of fiscal year.

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, a highly statistically significant decreasing trend was identified. The fitted frequency is plotted against fiscal year in Figure 8. Trends for HPCI failures are plotted without regard to method of detection (the trend excludes maintenance out of service and support system failures). Table 10 shows the LERs that are represented in the figure.

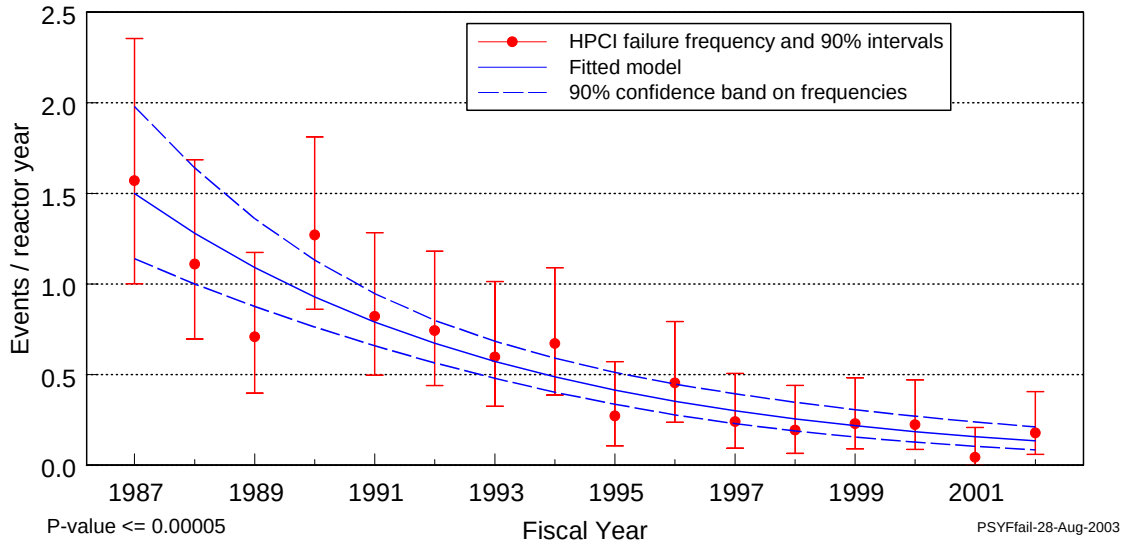

Figure 8. Frequency (events per operating year) of failures, as a function of fiscal year.

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 (16%) were the leading segment failures identified in the database. See Table 4.

2.3.2 Leading Discovery Methods

Periodic surveillance (53%) and alarms and indication (22%) were the leading methods of discovery. See Table 4.

2.3.3 Leading Causes of Failure.

Seventy-three percent of the HPCI system observed in the experience were attributed to hardware-related problems. Personnel errors caused 13% of all HPCI system failures. See Table 6

Table 4. Comparison of failed segment with the method of discovery.[2]

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		11		25	16%
Injection	4			3		8	1	16	10%
Pump	1	4		2	1	13	1	22	14%
Support	1	12		4		2		19	12%
Turbine	2	10	2	8		49	5	76	48%
Total	8	35	5	19	1	83	7	158	100%
Percent	5%	22%	3%	12%	1%	53%	4%	100%	

Table 5. 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.	

[2] 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 6. Comparison of failed segment and failure cause.[3]

Segment	Contamination	Design	Hardware	Personnel	Procedure	Total	Percent
I&C			18	4	3	25	16%
Injection		2	12	1	1	16	10%
Pump	4	1	11	5	1	22	14%
Support			13	5	1	19	12%
Turbine	1	4	61	6	4	76	48%
Total	5	7	115	21	10	158	100%
Percent	3%	4%	73%	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.

[3] 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 7. Plot data table for HPCI system unavailability, FTS model. Figure 2.

	Plot Trend Error Bar Points			Regression Curve Data Points		
FY	Lower (5%)	Mean	Upper (95%)	Lower (5%)	Mean	Upper (95%)
1987	1.94E-02	5.22E-02	9.71E-02	3.43E-02	4.62E-02	6.22E-02
1988	1.27E-02	4.42E-02	9.03E-02	3.37E-02	4.41E-02	5.78E-02
1989	3.81E-03	2.84E-02	7.14E-02	3.31E-02	4.22E-02	5.38E-02
1990	1.26E-02	5.43E-02	1.18E-01	3.24E-02	4.03E-02	5.02E-02
1991	7.51E-03	3.40E-02	7.55E-02	3.17E-02	3.86E-02	4.69E-02
1992	6.35E-03	3.41E-02	7.92E-02	3.09E-02	3.69E-02	4.41E-02
1993	1.09E-02	4.16E-02	8.76E-02	2.99E-02	3.53E-02	4.16E-02
1994	2.56E-03	2.74E-02	7.37E-02	2.88E-02	3.37E-02	3.95E-02
1995	1.64E-02	4.95E-02	9.60E-02	2.75E-02	3.22E-02	3.77E-02
1996	6.70E-03	3.39E-02	7.76E-02	2.61E-02	3.08E-02	3.63E-02
1997	4.77E-04	2.04E-02	6.67E-02	2.47E-02	2.95E-02	3.52E-02
1998	7.82E-04	2.18E-02	6.78E-02	2.31E-02	2.82E-02	3.43E-02
1999	1.10E-02	4.34E-02	9.23E-02	2.16E-02	2.69E-02	3.35E-02
2000	2.49E-03	2.67E-02	7.19E-02	2.02E-02	2.57E-02	3.28E-02
2001	4.58E-04	2.09E-02	6.90E-02	1.88E-02	2.46E-02	3.23E-02
2002	7.22E-04	2.29E-02	7.24E-02	1.75E-02	2.35E-02	3.17E-02

Table 8. Plot data table for HPCI system unreliability, 8-hour mission. Figure 5

	Plot Trend Error Bar Points			Regression Curve Data Points		
FY	Lower (5%)	Mean	Upper (95%)	Lower (5%)	Mean	Upper (95%)
1987	1.08E-01	2.31E-01	3.81E-01	9.41E-02	1.40E-01	2.07E-01
1988	3.72E-02	1.14E-01	2.20E-01	9.18E-02	1.31E-01	1.88E-01
1989	1.95E-02	8.29E-02	1.78E-01	8.95E-02	1.23E-01	1.70E-01
1990	1.02E-01	2.22E-01	3.67E-01	8.70E-02	1.16E-01	1.55E-01
1991	2.66E-02	8.66E-02	1.71E-01	8.42E-02	1.09E-01	1.41E-01
1992	4.35E-02	1.30E-01	2.47E-01	8.12E-02	1.03E-01	1.30E-01
1993	1.55E-02	6.10E-02	1.29E-01	7.77E-02	9.65E-02	1.20E-01
1994	5.60E-03	4.94E-02	1.27E-01	7.38E-02	9.08E-02	1.12E-01
1995	1.67E-02	8.71E-02	1.98E-01	6.94E-02	8.54E-02	1.05E-01
1996	2.29E-02	8.70E-02	1.81E-01	6.46E-02	8.03E-02	9.98E-02
1997	1.26E-02	7.63E-02	1.80E-01	5.97E-02	7.55E-02	9.55E-02
1998	5.03E-04	5.88E-02	2.08E-01	5.48E-02	7.10E-02	9.20E-02
1999	9.23E-03	7.21E-02	1.80E-01	5.00E-02	6.68E-02	8.91E-02
2000	1.84E-02	9.27E-02	2.08E-01	4.55E-02	6.28E-02	8.66E-02
2001	4.10E-04	5.79E-02	2.08E-01	4.13E-02	5.91E-02	8.44E-02
2002	5.69E-04	5.99E-02	2.10E-01	3.75E-02	5.56E-02	8.24E-02

3.2 Data Tables for Failure and Demand Trends

Table 9. LER listing for demand trend figure. Figure 7

FY	Plant	Date	LER
1996	Browns Ferry 2	5/10/1996	2601996005
1997	Browns Ferry 2	4/24/1997	2601997001
1996	Browns Ferry 3	4/21/1996	2961996002
1996	Browns Ferry 3	5/1/1996	2961996003
2000	Browns Ferry 3	4/15/2000	2962000001
2000	Browns Ferry 3	5/24/2000	2962000005
1991	Brunswick 1	7/18/1991	3251991018
1992	Brunswick 1	1/17/1992	3251992003
1995	Brunswick 1	7/13/1995	3251995015
1987	Brunswick 2	1/5/1987	3241987001
1987	Brunswick 2	3/11/1987	3241987004
1989	Brunswick 2	11/16/1988	3241988018
1990	Brunswick 2	8/16/1990	3241990008
1990	Brunswick 2	8/19/1990	3241990009
1990	Brunswick 2	9/27/1990	3241990015
1991	Brunswick 2	10/12/1990	3241990016
1991	Brunswick 2	1/25/1991	3241991001
1992	Brunswick 2	12/17/1991	3241991021
1987	Cooper	1/7/1987	2981987003
1987	Cooper	2/18/1987	2981987009
1988	Cooper	8/25/1988	2981988021
1990	Cooper	11/25/1989	2981989026
1991	Cooper	10/17/1990	2981990011
1994	Cooper	12/14/1993	2981993038
1994	Cooper	3/2/1994	2981994004
1989	Dresden 3	3/25/1989	2491989001
1996	Dresden 3	5/15/1996	2491996004
1989	Duane Arnold	3/5/1989	3311989008
1989	Duane Arnold	8/26/1989	3311989011
1988	Fermi 2	1/10/1988	3411988004
1993	Fermi 2	11/18/1992	3411992012
1993	Fermi 2	8/13/1993	3411993010
1990	Fitzpatrick	3/19/1990	3331990009
1993	Fitzpatrick	4/20/1993	3331993009
1995	Fitzpatrick	9/5/1995	3331995013
1996	Fitzpatrick	9/16/1996	3331996010
1987	Hatch 1	7/23/1987	3211987011
1987	Hatch 1	8/3/1987	3211987013
1988	Hatch 1	9/4/1988	3211988013
1989	Hatch 1	12/17/1988	3211988018
1990	Hatch 1	6/20/1990	3211990013
1991	Hatch 1	1/18/1991	3211991001
1991	Hatch 1	2/27/1991	3211991007
1991	Hatch 1	9/11/1991	3211991017
1992	Hatch 1	8/27/1992	3211992021
1994	Hatch 1	10/22/1993	3211993013
2000	Hatch 1	1/26/2000	3212000002
2000	Hatch 1	9/29/2000	3212000011
1987	Hatch 2	1/26/1987	3661987003
1987	Hatch 2	4/22/1987	3661987008
1987	Hatch 2	7/26/1987	3661987006
1987	Hatch 2	8/3/1987	3661987009
1988	Hatch 2	5/27/1988	3661988017
1988	Hatch 2	8/5/1988	3661988020
1990	Hatch 2	1/12/1990	3661990001
1992	Hatch 2	6/25/1992	3661992009
1994	Hatch 2	8/30/1994	3661994007
1995	Hatch 2	4/11/1995	3661995001
1997	Hatch 2	4/22/1997	3661997007
1987	Hope Creek	2/24/1987	3541987017
1987	Hope Creek	7/30/1987	3541987034
1987	Hope Creek	8/16/1987	3541987037
1987	Hope Creek	8/29/1987	3541987039
1988	Hope Creek	4/30/1988	3541988012
1988	Hope Creek	8/26/1988	3541988022
1989	Hope Creek	10/15/1988	3541988027
1989	Hope Creek	11/1/1988	3541988029
1990	Hope Creek	3/19/1990	3541990003
1991	Hope Creek	11/26/1990	3541990029
1999	Limerick 1	4/20/1999	3521999003
1987	Monticello	4/3/1987	2631987009
1991	Monticello	8/25/1991	2631991019
1990	Peach Bottom 2	12/20/1989	2771989033
1993	Peach Bottom 2	3/2/1993	2771993004
2003	Peach Bottom 2	12/21/2002	2772002001
1990	Peach Bottom 3	1/28/1990	2781990002
1990	Peach Bottom 3	7/27/1990	2781990008
1993	Peach Bottom 3	10/15/1992	2781992008
1993	Peach Bottom 3	7/30/1993	2781993004
1990	Pilgrim	9/2/1990	2931990013
1997	Quad Cities 2	2/27/1997	2651997001
1991	Susquehanna 1	7/31/1991	3871991008
1999	Susquehanna 1	7/1/1999	3871999003
1987	Susquehanna 2	4/16/1987	3881987006
1996	Susquehanna 2	7/14/1996	3881996004
1991	Vermont Yankee	4/23/1991	2711991009

Table 10. LER listing for failure trend figure.
Figure 8

FY	Plant	Date	LER
1991	Browns Ferry 2	7/31/1991	2601991015
1994	Browns Ferry 2	2/14/1994	2601994001
1995	Browns Ferry 2	6/7/1995	2601995005
2000	Browns Ferry 2	11/18/1999	2601999011
2003	Browns Ferry 3	10/22/2002	2962002004
1987	Brunswick 1	1/26/1987	3251987001
1988	Brunswick 1	12/31/1987	3251987023
1988	Brunswick 1	4/20/1988	3251988011
1988	Brunswick 1	5/28/1988	3251988012
1988	Brunswick 1	7/1/1988	3251988017
1988	Brunswick 1	7/13/1988	3251988018
1990	Brunswick 1	10/11/1989	3251989020
1990	Brunswick 1	1/2/1990	3251990001
1990	Brunswick 1	3/2/1990	3251990003
1991	Brunswick 1	7/18/1991	3251991018
1994	Brunswick 1	5/13/1994	3251994009
1994	Brunswick 1	9/22/1994	3251994012
1996	Brunswick 1	5/9/1996	3251996007
1987	Brunswick 2	1/5/1987	3241987001
1987	Brunswick 2	3/11/1987	3241987004
1989	Brunswick 2	11/16/1988	3241988018
1989	Brunswick 2	9/9/1989	3241989013
1990	Brunswick 2	8/16/1990	3241990008
1990	Brunswick 2	9/6/1990	3241990013
1992	Brunswick 2	12/14/1991	3241991020
1995	Brunswick 2	5/10/1995	3241995002
1992	Cooper	7/31/1992	2981992014
1993	Cooper	8/30/1993	2981993031
1999	Cooper	12/17/1998	2981998012
1999	Cooper	12/18/1998	2981998011
2002	Cooper	10/17/2001	2982001005
2002	Cooper	9/18/2002	2982002001
1987	Dresden 2	4/22/1987	2371987012
1987	Dresden 2	6/6/1987	2371987018
1988	Dresden 2	7/8/1988	2371988013
1994	Dresden 2	7/15/1994	2371994020
1994	Dresden 2	8/4/1994	2371994021
1998	Dresden 2	1/28/1998	2371998003
1987	Dresden 3	2/25/1987	2491987002
1993	Dresden 3	8/9/1993	2491993013
1994	Dresden 3	12/14/1993	2491993019
1987	Duane Arnold	7/14/1987	3311987023
1988	Duane Arnold	4/11/1988	3311988002
1989	Duane Arnold	1/26/1989	3311989002
1996	Duane Arnold	12/12/1995	3311995012
2001	Duane Arnold	9/2/2001	3312001004
1988	Fermi 2	7/26/1988	3411988028
1990	Fermi 2	9/5/1990	3411990008
1991	Fermi 2	10/16/1990	3411990012
1992	Fermi 2	11/20/1991	3411991020
1993	Fermi 2	1/4/1993	3411993001
1993	Fermi 2	1/14/1993	3411993002
1997	Fermi 2	2/16/1997	3411997002
1987	Fitzpatrick	7/23/1987	3331987010
1988	Fitzpatrick	3/10/1988	3331988001
1989	Fitzpatrick	4/12/1989	3331989005
1990	Fitzpatrick	10/8/1989	3331989018
1990	Fitzpatrick	11/30/1989	3331989025
1991	Fitzpatrick	9/17/1991	3331991019
1995	Fitzpatrick	3/26/1995	3331995008
1996	Fitzpatrick	9/6/1996	3331996008
1998	Fitzpatrick	12/16/1997	3331997013
1998	Fitzpatrick	7/31/1998	3331998007
2000	Fitzpatrick	10/14/1999	3331999010
1988	Hatch 1	8/26/1988	3211988012
1989	Hatch 1	3/29/1989	3211989006
1990	Hatch 1	1/4/1990	3211990001
1990	Hatch 1	7/30/1990	3211990015
1991	Hatch 1	1/18/1991	3211991001
1992	Hatch 1	12/30/1991	3211991033
1992	Hatch 1	2/26/1992	3211992006
1996	Hatch 1	6/29/1996	3211996010
2000	Hatch 1	8/16/2000	3212000005
1987	Hatch 2	6/16/1987	3661987004
1987	Hatch 2	8/3/1987	3661987009
1988	Hatch 2	11/19/1987	3661987017
1988	Hatch 2	1/6/1988	3661988001
1990	Hatch 2	1/12/1990	3661990001
1990	Hatch 2	7/19/1990	3661990005
1994	Hatch 2	11/3/1993	3661993008
1994	Hatch 2	3/1/1994	3661994002
1996	Hatch 2	6/26/1996	3661996002
1997	Hatch 2	1/25/1997	3661997001
1997	Hatch 2	8/18/1997	3661997008
2000	Hatch 2	2/27/2000	3662000001
1988	Hope Creek	4/14/1988	3541988010
1989	Hope Creek	4/14/1989	3541989009
1989	Hope Creek	6/7/1989	3541989012
1990	Hope Creek	6/7/1990	3541990009
1996	Hope Creek	10/24/1995	3541995025
1998	Hope Creek	12/5/1997	3541997032
1999	Hope Creek	9/19/1999	3541999011
1987	Limerick 1	5/14/1987	3521987015
1987	Limerick 1	5/14/1987	3521987015

FY	Plant	Date	LER
1988	Limerick 1	12/8/1987	3521987066
1992	Limerick 1	12/10/1991	3521991028
1992	Limerick 1	3/11/1992	3521992002
1992	Limerick 1	7/7/1992	3521992015
1996	Limerick 1	9/25/1996	3521996018
1999	Limerick 1	6/23/1999	3521999008
1990	Limerick 2	10/13/1989	3531989010
1990	Limerick 2	3/8/1990	3531990004
1991	Limerick 2	9/12/1991	3531991015
1992	Limerick 2	11/15/1991	3531991017
1992	Limerick 2	2/21/1992	3531992004
1987	Peach Bottom 2	9/4/1987	2771987020
1989	Peach Bottom 2	5/5/1989	2771989009
1990	Peach Bottom 2	7/24/1990	2771990017
1993	Peach Bottom 2	1/31/1993	2771993003
1994	Peach Bottom 2	7/18/1994	2771994004
1997	Peach Bottom 2	10/1/1996	2771996009
1997	Peach Bottom 2	6/1/1997	2771997003
1999	Peach Bottom 2	1/19/1999	2771999001
1987	Peach Bottom 3	8/29/1987	2781987007
1990	Peach Bottom 3	12/7/1989	2781989009
1990	Peach Bottom 3	8/4/1990	2781990010
1990	Peach Bottom 3	9/10/1990	2781990011
1991	Peach Bottom 3	4/10/1991	2781991005
1991	Peach Bottom 3	9/5/1991	2781991014
1993	Peach Bottom 3	11/28/1992	2781992009
1993	Peach Bottom 3	1/25/1993	2781993001
1993	Peach Bottom 3	8/9/1993	2781993005
1994	Peach Bottom 3	11/13/1993	2781993009
1994	Peach Bottom 3	9/24/1994	2781994004
1995	Peach Bottom 3	7/6/1995	2781995002

FY	Plant	Date	LER
1996	Peach Bottom 3	5/29/1996	2781996001
1989	Pilgrim	3/24/1989	2931989013
1989	Pilgrim	9/7/1989	2931989028
1991	Pilgrim	10/9/1990	2931990017
1994	Pilgrim	3/9/1994	2931994002
2002	Pilgrim	7/7/2002	2932002001
1990	Quad Cities 1	11/28/1989	2541989022
1991	Quad Cities 1	5/7/1991	2541991012
1991	Quad Cities 1	5/7/1991	2541991012
1992	Quad Cities 1	2/6/1992	2541992002
1993	Quad Cities 1	6/9/1993	2541993005
1993	Quad Cities 1	7/26/1993	2541993012
1995	Quad Cities 1	3/29/1995	2541995004
1987	Quad Cities 2	1/27/1987	2651987003
1991	Quad Cities 2	11/24/1990	2651990012
1991	Quad Cities 2	1/22/1991	2651991003
2000	Quad Cities 2	2/11/2000	2652000005
1987	Susquehanna 1	2/23/1987	3871987008
1988	Susquehanna 1	5/20/1988	3871988009
1989	Susquehanna 1	11/4/1988	3871988022
1990	Susquehanna 1	2/15/1990	3871990007
1991	Susquehanna 1	2/7/1991	3871991002
1996	Susquehanna 1	12/31/1995	3871995016
2002	Susquehanna 1	11/11/2001	3872001004
1987	Susquehanna 2	4/13/1987	3881987007
1990	Susquehanna 2	2/16/1990	3881990001
1992	Susquehanna 2	12/16/1991	3881991015
1992	Susquehanna 2	4/22/1992	3881992002
1988	Vermont Yankee	11/5/1987	2711987016