

Reliability Study Update

Auxiliary Feedwater

1987–2002

This report presents a performance evaluation of the auxiliary feedwater (AFW) system at 69 operating United States commercial pressurized-water reactors (PWRs). The evaluation is based on the operating experience from 1987 through 2002, from 74 PWRs, as reported in Licensee Event Reports (LERs). This is the latest update to NUREG/CR 5500 Volume 1.

This report calculates two basic models for the AFW system. The first model, failure to start (FTS), models the AFW system start and injection. The second model, 8-hour mission, models the AFW system start, injection, and pump run for 8 hours. See the AFW Fault Tree Description document for more detail.

The AFW system has been categorized into eleven groups. The AFW design classes were categorized first by number of steam generators (SG), then by number of pump trains, and finally by number of motor (M), turbine (T), and diesel (D) trains. [Table 1](#) summarizes those groups. Information that is more detailed can be found in [Section 5](#).

Table 1. AFW design class summary.

	Design Class	Reference Plant	Number of Plants
1	1M, 1T, 2SG	Crystal River 3	8
2	1M, 2T, 2SG	Calvert Cliffs 1	2
3	2T, 2SG	Davis-Besse	1
4	2M, 1T, 2SG	St. Lucie 1	17
5	2M, 1T, 3SG	Farley 1	12
6	3T, 3SG	Turkey Point 3	2
7	1M, 1D, 4SG	Braidwood 1	4
8	1M, 1T, 4SG	Seabrook	1
9	2T, 4SG	Haddam Neck	1
10	2M, 1T, 4SG	Salem 1	24
11	3M, 1T, 4SG	South Texas 1	2

1 LATEST VALUES AND TRENDS

1.1 Industry-Wide Unavailability and Unreliability

The industry-wide unreliability and unavailability of the AFW system has been calculated from the operating experience for an 8-hour mission and for the failure to start (FTS) and are shown in [Table 2](#). The estimates are based on failures that occurred during unplanned demands, and cyclic and quarterly surveillance tests.

Table 2. AFW Industry values.

Model	Lower (5%)	Mean	Upper (95%)
Failure-to-Start (Unavailability)	2.44E-05	2.60E-04	8.58E-04
8-hour Mission (Unreliability)	4.97E-05	5.15E-04	1.69E-03

1.2 Fail to Start Model Results

The unavailability of the AFW system for each design class has been calculated from the operating experience for the failure to start (FTS) mission. A waterfall plot is shown in [Figure 1](#) and the data table is shown in [Table 3](#).

Unavailability's, for currently operating plants, have been calculated for the FTS model. The estimates of AFW system unavailability using operating experience from LERs and fault tree analyses are plotted in [Figure 2](#) (FTS model) and the data table is shown in [Table 4](#).

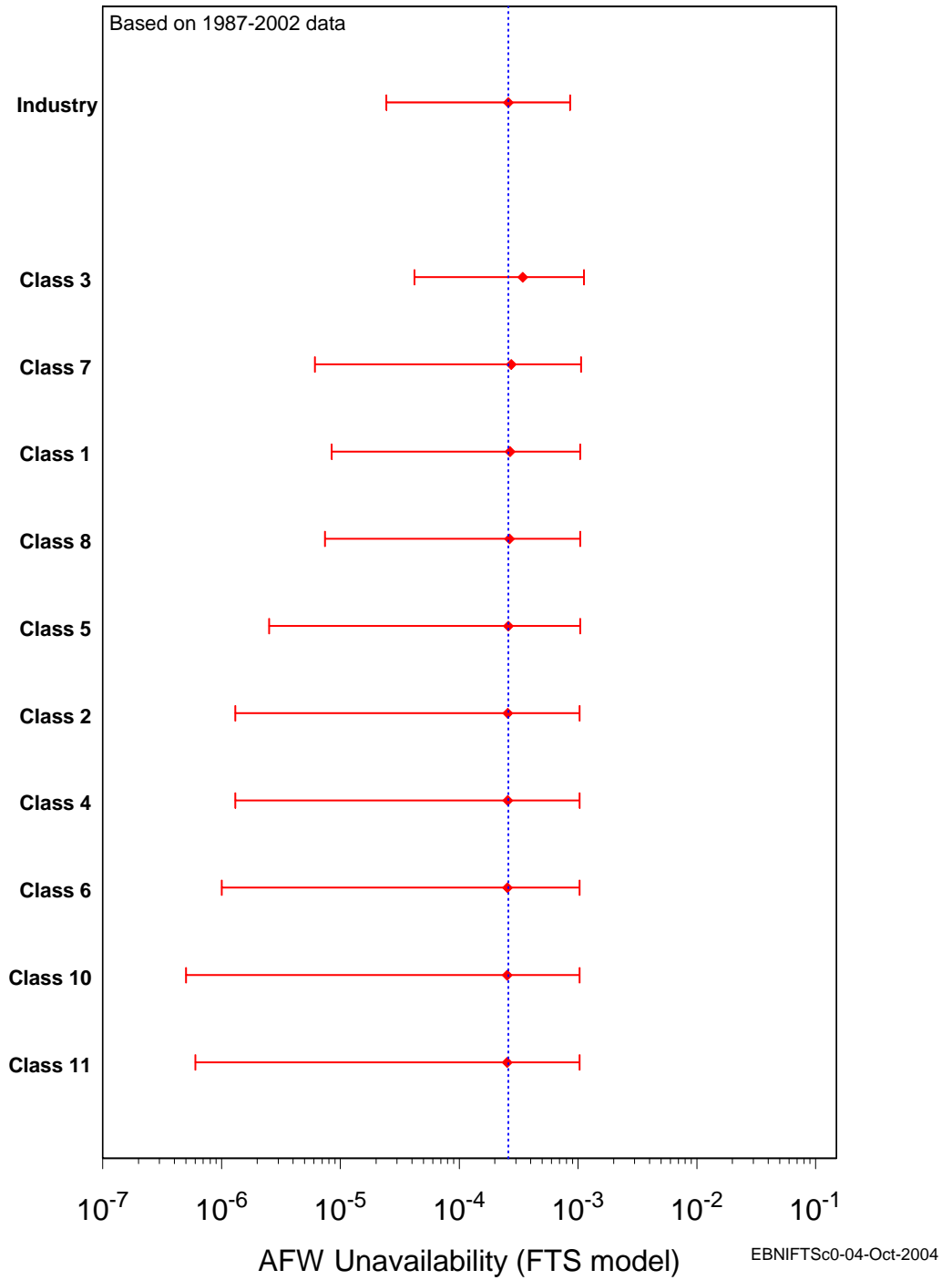


Figure 1. AFW design class unavailability (FTS model).

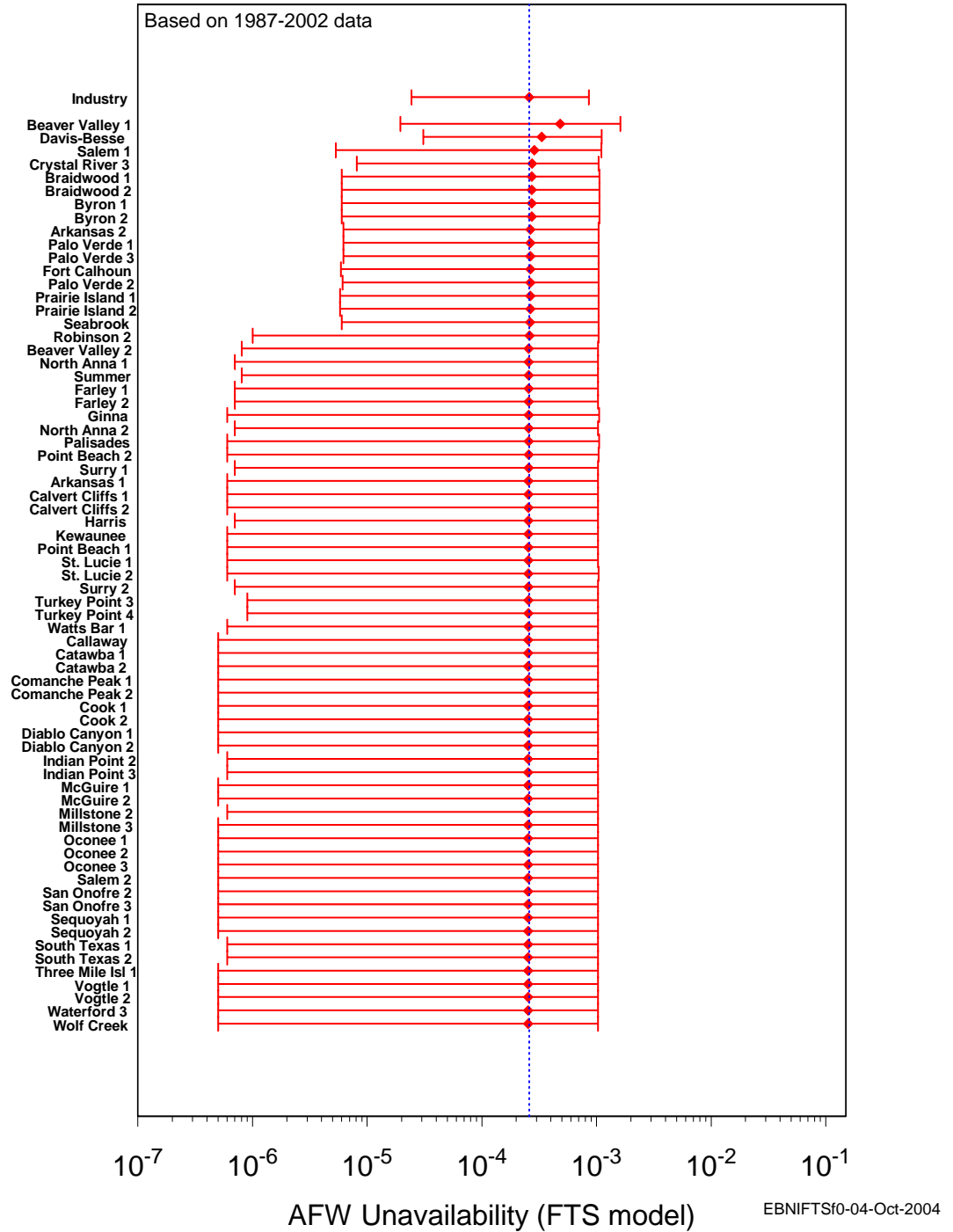


Figure 2. Plant-specific estimates of AFW system unavailability for FTS model.

Table 3. AFW unavailability (start only model) by design class.

Design Class	Lower (5%)	Mean	Upper (95%)
Industry	2.44E-05	2.60E-04	8.58E-04
Class 11	5.77E-07	2.54E-04	1.03E-03
Class 10	4.96E-07	2.54E-04	1.03E-03
Class 6	9.98E-07	2.55E-04	1.03E-03
Class 4	1.33E-06	2.56E-04	1.03E-03
Class 2	1.28E-06	2.56E-04	1.03E-03
Class 5	2.55E-06	2.60E-04	1.04E-03
Class 8	7.45E-06	2.66E-04	1.04E-03
Class 1	8.37E-06	2.68E-04	1.04E-03
Class 7	6.08E-06	2.74E-04	1.06E-03
Class 3	4.19E-05	3.42E-04	1.12E-03

Table 4. AFW plant unavailability FTS model.

Plant	Lower (5%)	Mean	Upper (95%)
Industry	2.44E-05	2.60E-04	8.58E-04
Wolf Creek	4.96E-07	2.54E-04	1.03E-03
Waterford 3	4.96E-07	2.54E-04	1.03E-03
Vogtle 2	4.96E-07	2.54E-04	1.03E-03
Vogtle 1	4.96E-07	2.54E-04	1.03E-03
Three Mile Isl 1	4.96E-07	2.54E-04	1.03E-03
South Texas 2	5.77E-07	2.54E-04	1.03E-03
South Texas 1	5.77E-07	2.54E-04	1.03E-03
Sequoyah 2	4.96E-07	2.54E-04	1.03E-03
Sequoyah 1	4.96E-07	2.54E-04	1.03E-03
San Onofre 3	4.96E-07	2.54E-04	1.03E-03
San Onofre 2	4.96E-07	2.54E-04	1.03E-03
Salem 2	4.96E-07	2.54E-04	1.03E-03
Oconee 3	4.96E-07	2.54E-04	1.03E-03
Oconee 2	4.96E-07	2.54E-04	1.03E-03
Oconee 1	4.96E-07	2.54E-04	1.03E-03
Millstone 3	4.96E-07	2.54E-04	1.03E-03
Millstone 2	5.77E-07	2.54E-04	1.03E-03
McGuire 2	4.96E-07	2.54E-04	1.03E-03
McGuire 1	4.96E-07	2.54E-04	1.03E-03
Indian Point 3	6.40E-07	2.54E-04	1.03E-03
Indian Point 2	5.77E-07	2.54E-04	1.03E-03
Diablo Canyon 2	4.96E-07	2.54E-04	1.03E-03
Diablo Canyon 1	4.96E-07	2.54E-04	1.03E-03
Cook 2	4.96E-07	2.54E-04	1.03E-03
Cook 1	4.96E-07	2.54E-04	1.03E-03
Comanche Peak 2	4.96E-07	2.54E-04	1.03E-03
Comanche Peak 1	4.96E-07	2.54E-04	1.03E-03
Catawba 2	4.96E-07	2.54E-04	1.03E-03

Plant	Lower (5%)	Mean	Upper (95%)
Catawba 1	4.96E-07	2.54E-04	1.03E-03
Callaway	4.96E-07	2.54E-04	1.03E-03
Watts Bar 1	6.49E-07	2.55E-04	1.03E-03
Turkey Point 4	9.22E-07	2.55E-04	1.03E-03
Turkey Point 3	9.22E-07	2.55E-04	1.03E-03
Surry 2	7.27E-07	2.55E-04	1.03E-03
St. Lucie 2	5.81E-07	2.55E-04	1.04E-03
St. Lucie 1	5.65E-07	2.55E-04	1.03E-03
Point Beach 1	5.81E-07	2.55E-04	1.03E-03
Kewaunee	5.81E-07	2.55E-04	1.03E-03
Harris	7.18E-07	2.55E-04	1.03E-03
Calvert Cliffs 2	6.00E-07	2.55E-04	1.03E-03
Calvert Cliffs 1	6.00E-07	2.55E-04	1.03E-03
Arkansas 1	5.75E-07	2.55E-04	1.03E-03
Surry 1	7.27E-07	2.56E-04	1.03E-03
Point Beach 2	5.82E-07	2.56E-04	1.04E-03
Palisades	5.95E-07	2.56E-04	1.05E-03
North Anna 2	7.34E-07	2.56E-04	1.03E-03
Ginna	5.95E-07	2.56E-04	1.05E-03
Farley 2	7.34E-07	2.56E-04	1.03E-03
Farley 1	7.41E-07	2.56E-04	1.03E-03
Summer	7.63E-07	2.57E-04	1.03E-03
North Anna 1	7.41E-07	2.57E-04	1.03E-03
Beaver Valley 2	7.63E-07	2.57E-04	1.03E-03
Industry	2.44E-05	2.60E-04	8.58E-04
Wolf Creek	4.96E-07	2.54E-04	1.03E-03
Waterford 3	4.96E-07	2.54E-04	1.03E-03
Vogtle 2	4.96E-07	2.54E-04	1.03E-03
Vogtle 1	4.96E-07	2.54E-04	1.03E-03
Three Mile Isl 1	4.96E-07	2.54E-04	1.03E-03
South Texas 2	5.77E-07	2.54E-04	1.03E-03
South Texas 1	5.77E-07	2.54E-04	1.03E-03
Sequoyah 2	4.96E-07	2.54E-04	1.03E-03
Sequoyah 1	4.96E-07	2.54E-04	1.03E-03
San Onofre 3	4.96E-07	2.54E-04	1.03E-03
San Onofre 2	4.96E-07	2.54E-04	1.03E-03
Salem 2	4.96E-07	2.54E-04	1.03E-03
Oconee 3	4.96E-07	2.54E-04	1.03E-03
Oconee 2	4.96E-07	2.54E-04	1.03E-03
Oconee 1	4.96E-07	2.54E-04	1.03E-03
Millstone 3	4.96E-07	2.54E-04	1.03E-03

Figure 3 displays the trend by fiscal year of the AFW system FTS unavailability calculated from the 1987–2002 experience. Table 10 shows the data points for Figure 3. The trend is not statistically significant.¹

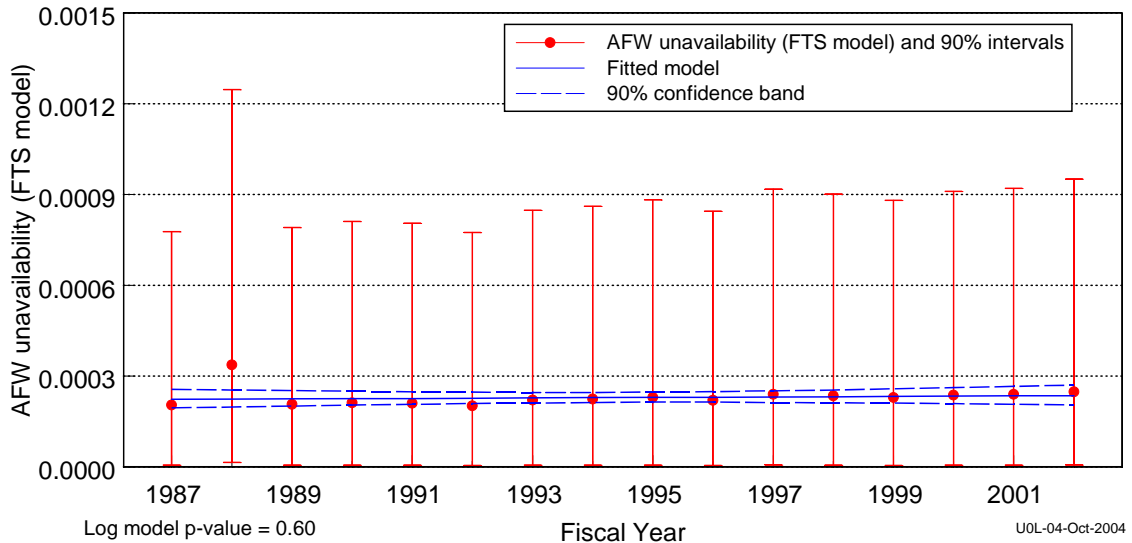


Figure 3. Trend of AFW system unavailability (FTS model), as a function of fiscal year.

1.3 Fail to Operate for 8-Hour Model

The unreliability of the AFW system for each design class has been calculated from the operating experience for the 8-hour mission. Waterfall plots are shown in Figure 4 and the data table is shown in Table 5.

Individual plant unreliability, for currently operating plants, has been calculated for the 8-hour mission. The estimates of AFW system unreliability using operating experience from LERs and fault tree analyses are plotted in Figure 5 (8-hour mission) and the data table is shown in Table 6.

¹ 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).

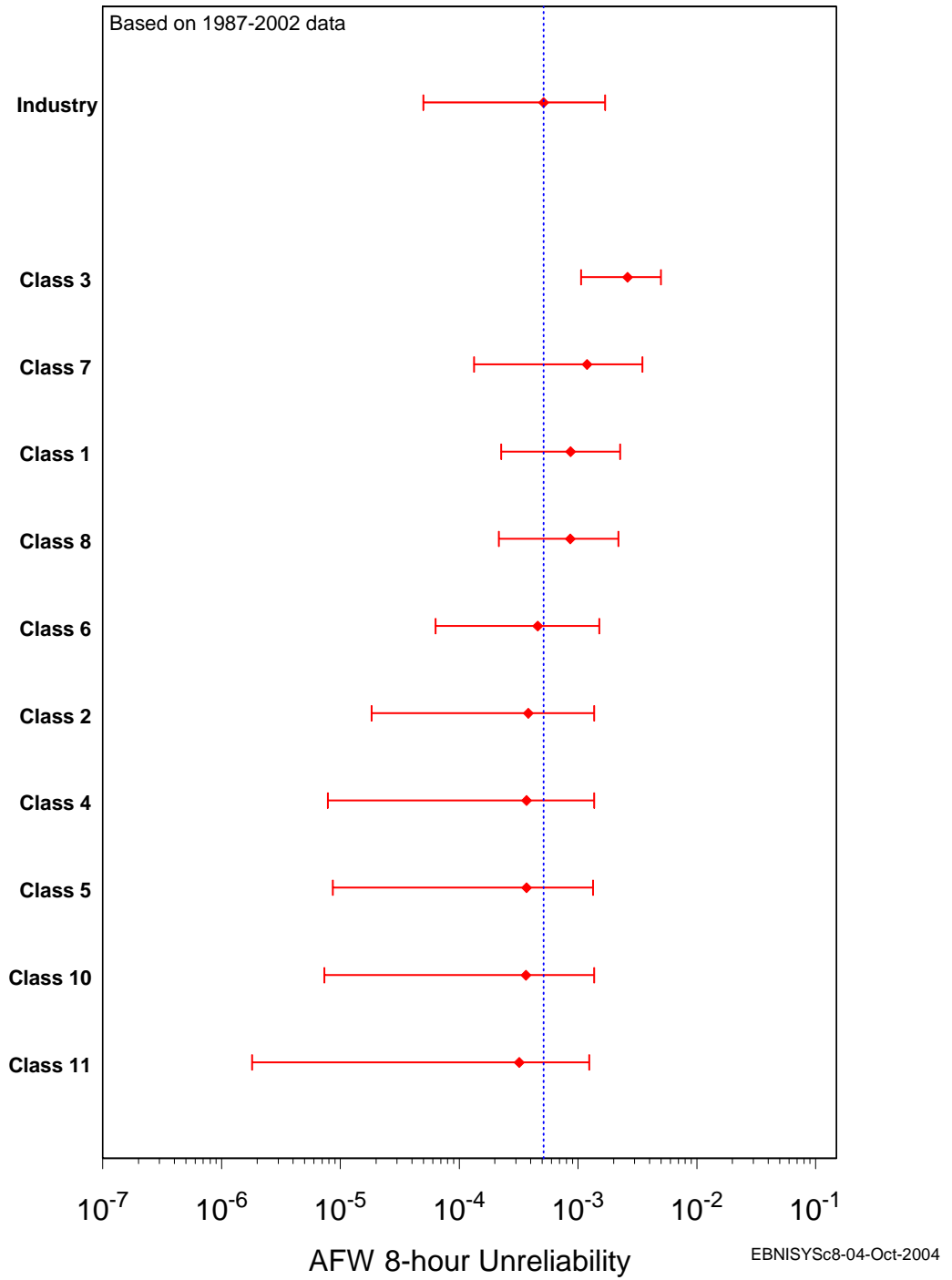


Figure 4. AFW design class unreliability (8-hour model).

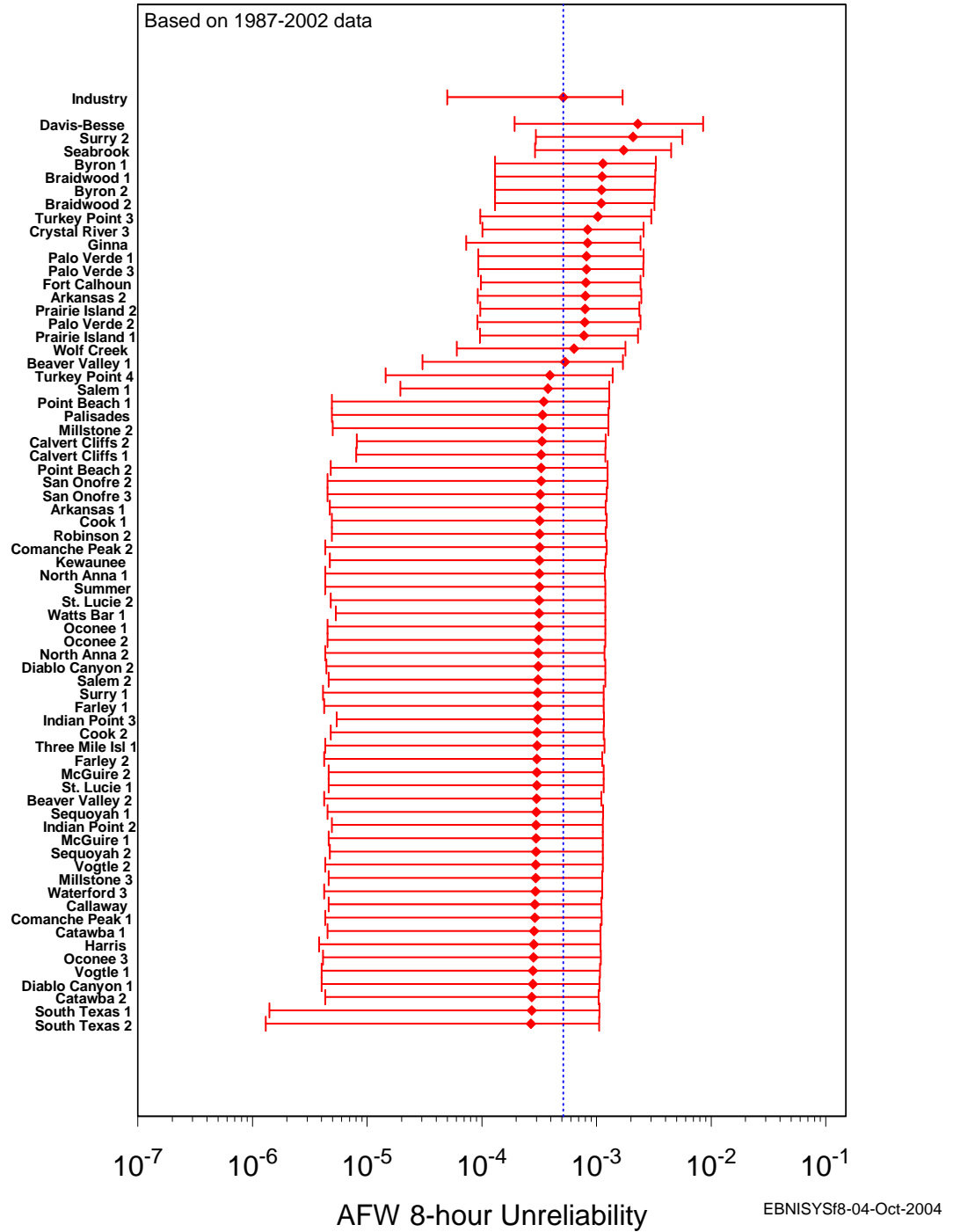


Figure 5. Plant-specific estimates of AFW system unreliability for an 8-hour mission.

Table 5. AFW unreliability (8-hour model) by design class.

Design Class	Lower (5%)	Mean	Upper (95%)
Industry	4.97E-05	5.15E-04	1.69E-03
Class 11	1.81E-06	3.21E-04	1.24E-03
Class 10	7.27E-06	3.64E-04	1.37E-03
Class 4	7.76E-06	3.70E-04	1.37E-03
Class 5	8.62E-06	3.70E-04	1.34E-03
Class 2	1.83E-05	3.81E-04	1.37E-03
Class 6	6.31E-05	4.59E-04	1.51E-03
Class 8	2.15E-04	8.63E-04	2.18E-03
Class 1	2.25E-04	8.68E-04	2.26E-03
Class 7	1.33E-04	1.19E-03	3.47E-03
Class 3	1.06E-03	2.62E-03	4.99E-03

Table 6. AFW plant unreliability data.

Plant	Lower (5%)	Mean	Upper (95%)
Industry	4.97E-05	5.15E-04	1.69E-03
South Texas 2	1.32E-06	2.69E-04	1.05E-03
Catawba 2	4.34E-06	2.73E-04	1.04E-03
South Texas 1	1.41E-06	2.73E-04	1.06E-03
Diablo Canyon 1	3.98E-06	2.79E-04	1.06E-03
Vogtle 1	4.03E-06	2.80E-04	1.07E-03
Oconee 3	4.11E-06	2.83E-04	1.09E-03
Harris	3.76E-06	2.84E-04	1.08E-03
Catawba 1	4.55E-06	2.86E-04	1.08E-03
Callaway	4.63E-06	2.91E-04	1.10E-03
Comanche Peak 1	4.26E-06	2.91E-04	1.11E-03
Waterford 3	4.25E-06	2.94E-04	1.12E-03
Millstone 3	4.63E-06	2.95E-04	1.12E-03
Vogtle 2	4.30E-06	2.96E-04	1.13E-03
McGuire 1	4.64E-06	2.97E-04	1.13E-03
Sequoyah 2	4.68E-06	2.97E-04	1.13E-03
Indian Point 2	4.93E-06	2.98E-04	1.13E-03
Sequoyah 1	4.51E-06	2.99E-04	1.14E-03
Beaver Valley 2	4.21E-06	3.00E-04	1.10E-03
Farley 2	4.17E-06	3.02E-04	1.12E-03
McGuire 2	4.65E-06	3.02E-04	1.15E-03
St. Lucie 1	4.58E-06	3.02E-04	1.15E-03
Cook 2	4.79E-06	3.05E-04	1.15E-03
Three Mile Isl 1	4.34E-06	3.05E-04	1.17E-03
Farley 1	4.22E-06	3.07E-04	1.15E-03
Indian Point 3	5.41E-06	3.07E-04	1.16E-03
Surry 1	4.13E-06	3.08E-04	1.15E-03
Salem 2	4.61E-06	3.10E-04	1.19E-03
Diablo Canyon 2	4.36E-06	3.11E-04	1.19E-03
North Anna 2	4.26E-06	3.12E-04	1.17E-03

Plant	Lower (5%)	Mean	Upper (95%)
Oconee 2	4.46E-06	3.13E-04	1.19E-03
Oconee 1	4.46E-06	3.14E-04	1.19E-03
St. Lucie 2	4.77E-06	3.16E-04	1.19E-03
Watts Bar 1	5.28E-06	3.16E-04	1.19E-03
Kewaunee	4.73E-06	3.18E-04	1.20E-03
North Anna 1	4.35E-06	3.18E-04	1.18E-03
Summer	4.35E-06	3.18E-04	1.19E-03
Comanche Peak 2	4.27E-06	3.20E-04	1.23E-03
Cook 1	4.93E-06	3.21E-04	1.23E-03
Robinson 2	4.95E-06	3.21E-04	1.20E-03
Arkansas 1	4.67E-06	3.22E-04	1.20E-03
San Onofre 3	4.48E-06	3.24E-04	1.23E-03
San Onofre 2	4.53E-06	3.29E-04	1.25E-03
Calvert Cliffs 1	7.96E-06	3.30E-04	1.19E-03
Point Beach 2	4.81E-06	3.30E-04	1.25E-03
Calvert Cliffs 2	8.12E-06	3.36E-04	1.20E-03
Millstone 2	5.05E-06	3.37E-04	1.27E-03
Palisades	4.95E-06	3.38E-04	1.27E-03
Point Beach 1	4.94E-06	3.47E-04	1.29E-03
Salem 1	1.94E-05	3.78E-04	1.29E-03
Turkey Point 4	1.45E-05	3.93E-04	1.38E-03
Beaver Valley 1	3.03E-05	5.30E-04	1.70E-03
Wolf Creek	6.03E-05	6.39E-04	1.79E-03
Prairie Island 1	9.65E-05	7.77E-04	2.29E-03
Palo Verde 2	9.13E-05	7.93E-04	2.42E-03
Prairie Island 2	9.70E-05	7.95E-04	2.36E-03
Arkansas 2	9.22E-05	7.99E-04	2.46E-03
Fort Calhoun	9.78E-05	8.08E-04	2.42E-03
Palo Verde 1	9.31E-05	8.19E-04	2.57E-03
Palo Verde 3	9.32E-05	8.19E-04	2.56E-03
GINNA	7.27E-05	8.39E-04	2.41E-03
Crystal River 3	1.01E-04	8.40E-04	2.57E-03
Turkey Point 3	9.68E-05	1.03E-03	3.00E-03
Braidwood 2	1.30E-04	1.10E-03	3.19E-03
Byron 2	1.30E-04	1.11E-03	3.22E-03
Braidwood 1	1.30E-04	1.12E-03	3.25E-03
Byron 1	1.30E-04	1.14E-03	3.28E-03
Seabrook	2.91E-04	1.73E-03	4.48E-03
Surry 2	2.96E-04	2.08E-03	5.60E-03
Davis-Besse	1.93E-04	2.30E-03	8.52E-03

No statistically significant trend within the industry estimates of AFW system unreliability (8-hour mission) on a per fiscal year basis was identified. Figure 6 displays the trend by fiscal year of the AFW system unreliability calculated from the 1987–2002 experience. Table 11 shows the data points for Figure 6.

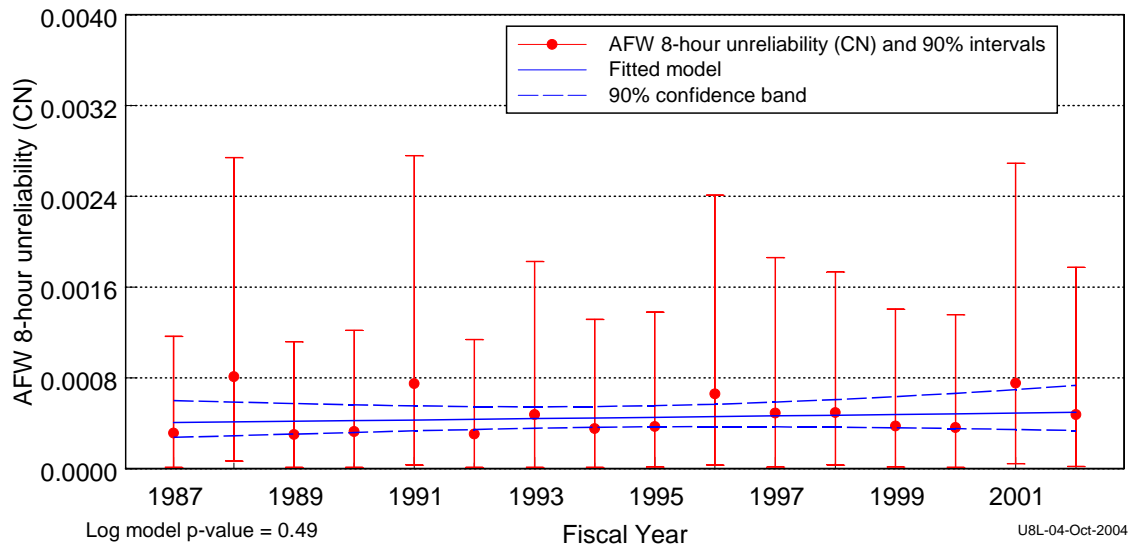


Figure 6. Trend of AFW system unreliability (8-hour mission), as a function of fiscal year.

2 DATA TRENDS

2.1 Unplanned Demand Trend

Trends were identified in the frequency of AFW unplanned demands (Figure 7). When modeled as a function of fiscal year, the unplanned demand frequency exhibited a highly statistically significant decreasing trend. Table 12 shows the LERs that are represented in the figure.

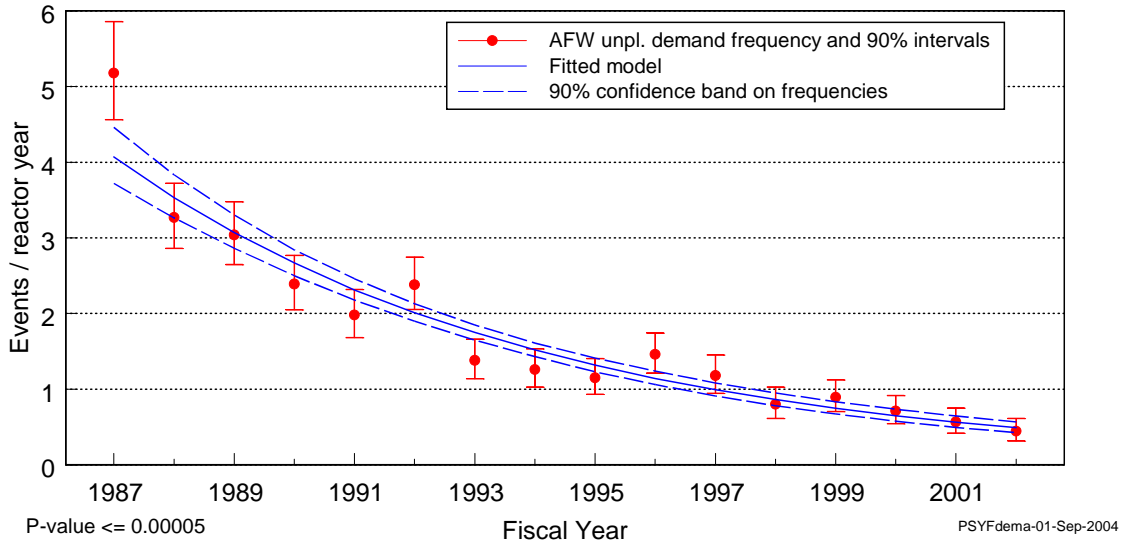


Figure 7. Frequency (events per reactor year) of unplanned demands, as a function of fiscal year.

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 AFW failures are plotted without regard to method of detection (the trend excludes maintenance out of service and support system failures). Table 13 shows the LERs that are represented in the figure.

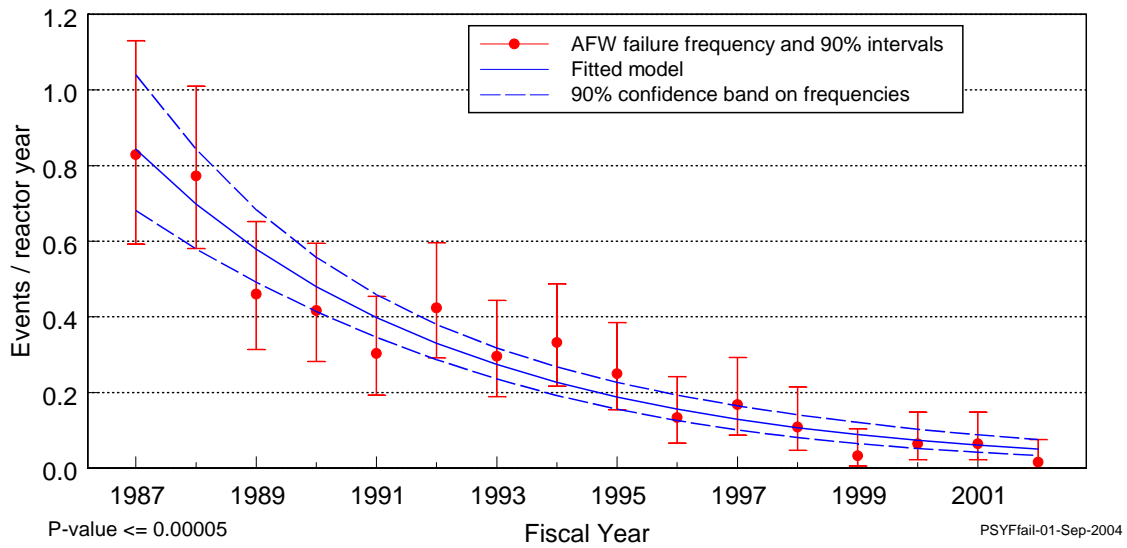


Figure 8. Frequency (events per reactor year) of failures, as a function of fiscal year.

3 MAJOR CONTRIBUTORS TO SYSTEM UNRELIABILITY AND UNAVAILABILITY

3.1 Segment Failure Contribution to Design Class Models

The segment failure contribution has been calculated by adding up the components of each cut-set for each design class fault tree model. Only the top five segments are shown.

3.1.1 Fail to Start Model

Figure 9 through Figure 19 show the distributions of segment failures for the FTS model.

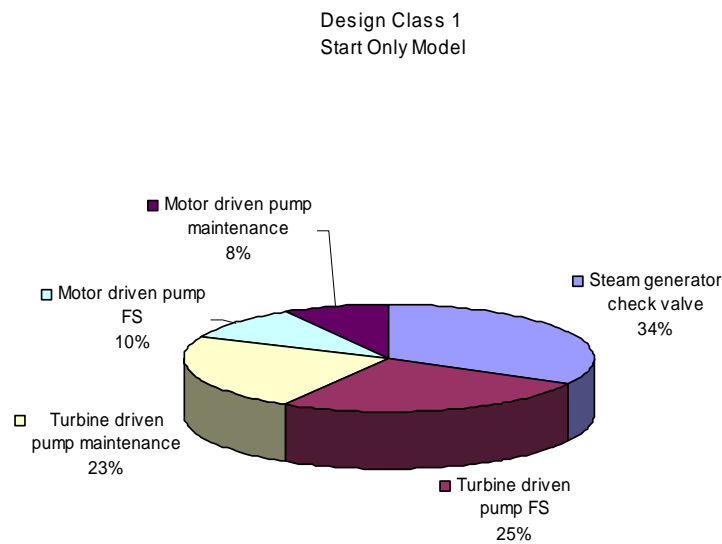


Figure 9. Segment failure distribution, FTS model Design Class 1.

Design Class 2
Start Only Model

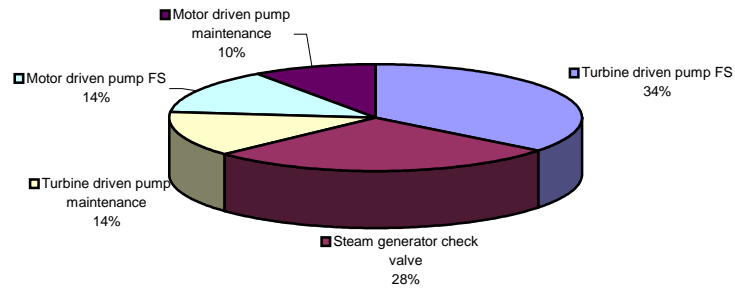


Figure 10. Segment failure distribution, FTS model Design Class 2.

Design Class 3
Start Only Model

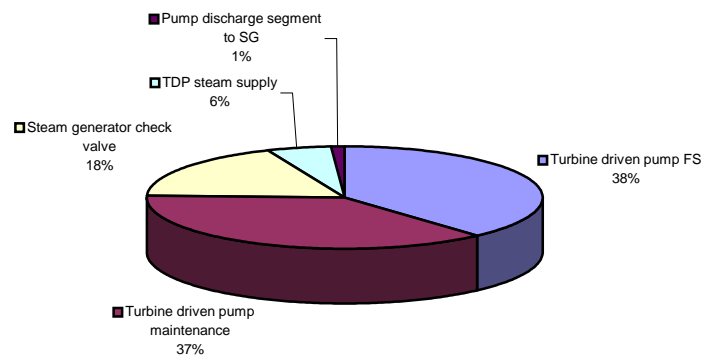


Figure 11. Segment failure distribution, FTS model Design Class 3.

Design Class 4
Start Only Model

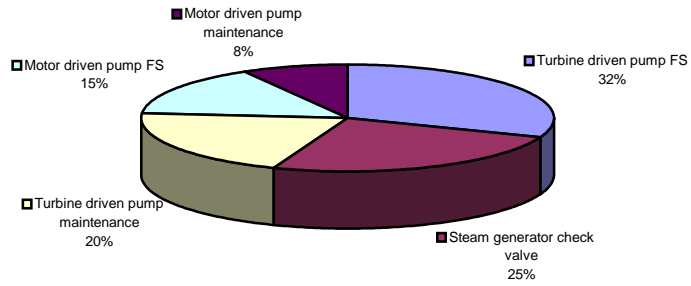


Figure 12. Segment failure distribution, FTS model Design Class 4.

Design Class 5
Start Only Model

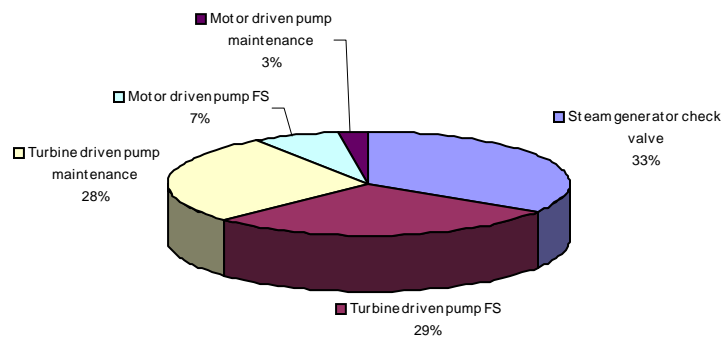


Figure 13. Segment failure distribution, FTS model Design Class 5.

Design Class 6
Start Only Model

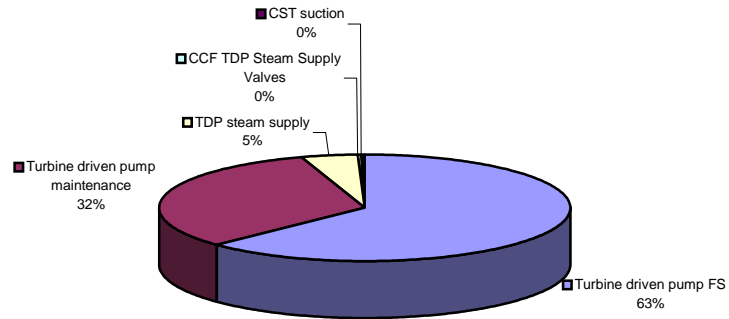


Figure 14. Segment failure distribution, FTS model Design Class 6.

Design Class 7
Start Only Model

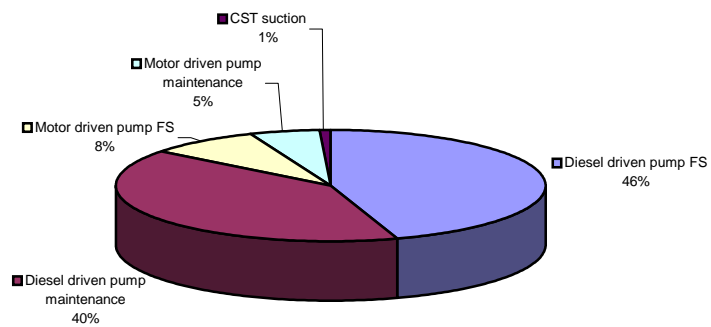


Figure 15. Segment failure distribution, FTS model Design Class 7.

Design Class 8
Start Only Model

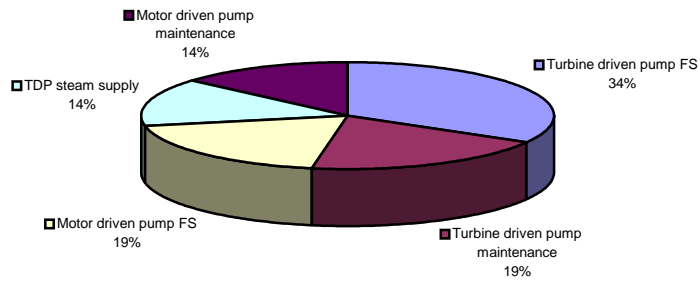


Figure 16. Segment failure distribution, FTS model Design Class 8.

Design Class 9
Start Only Model

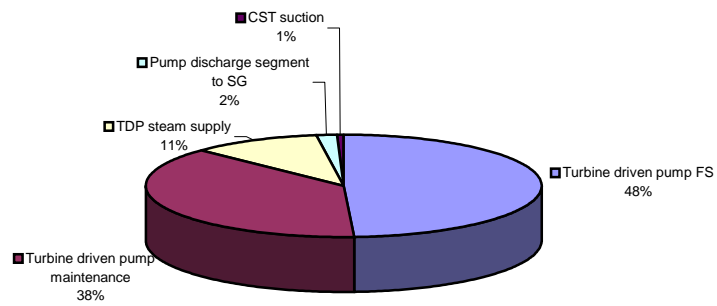


Figure 17. Segment failure distribution, FTS model Design Class 9.

Design Class 10
Start Only Model

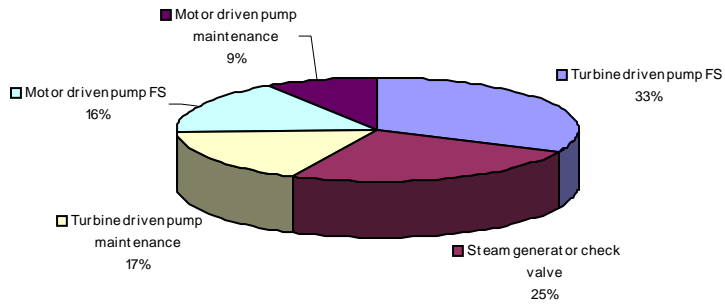


Figure 18. Segment failure distribution, FTS model Design Class 10.

Design Class 11
Start Only Model

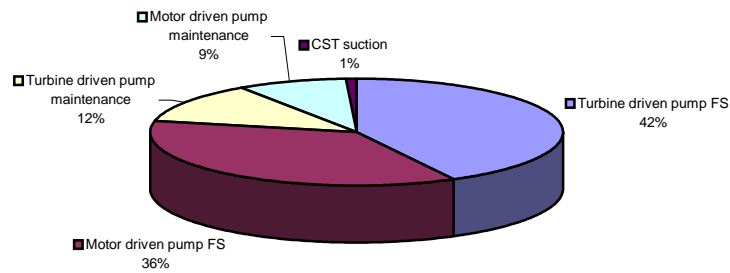


Figure 19. Segment failure distribution, FTS model Design Class 11.

3.1.2 Fail to Operate for 8 –hour Model

Figure 20 through Figure 30 show the distributions of segment failures for the 8-hour model.

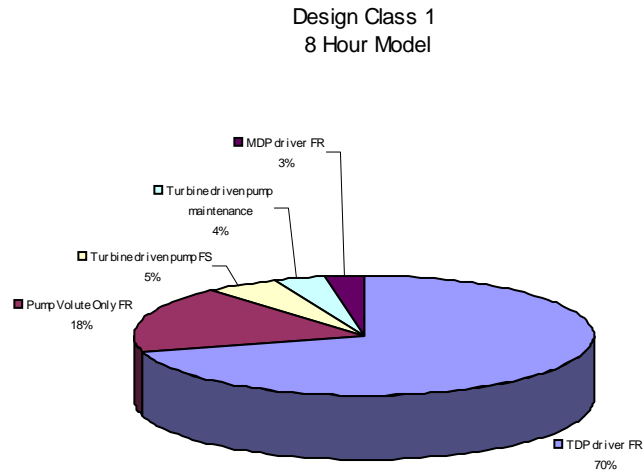


Figure 20. Segment failure distribution, 8-hour mission Design Class 1.

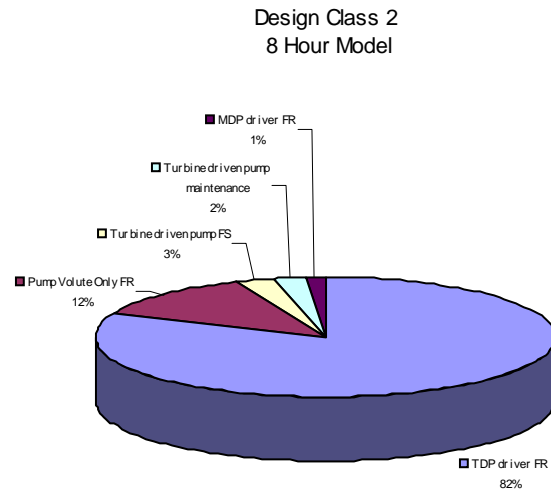


Figure 21. Segment failure distribution, 8-hour mission Design Class 2.

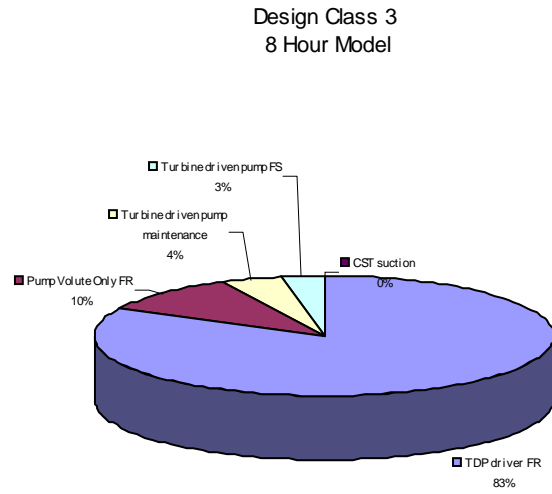


Figure 22. Segment failure distribution, 8-hour mission Design Class 3.

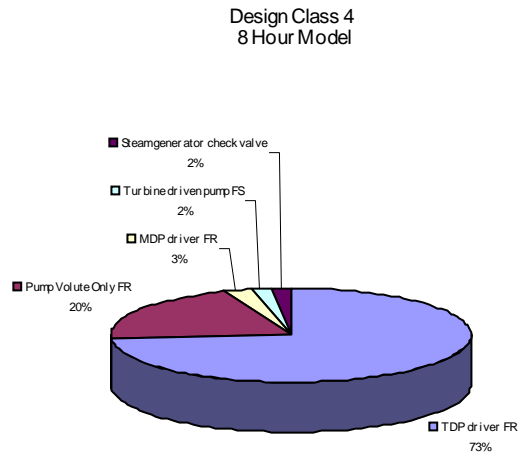


Figure 23. Segment failure distribution, 8-hour mission Design Class 4.

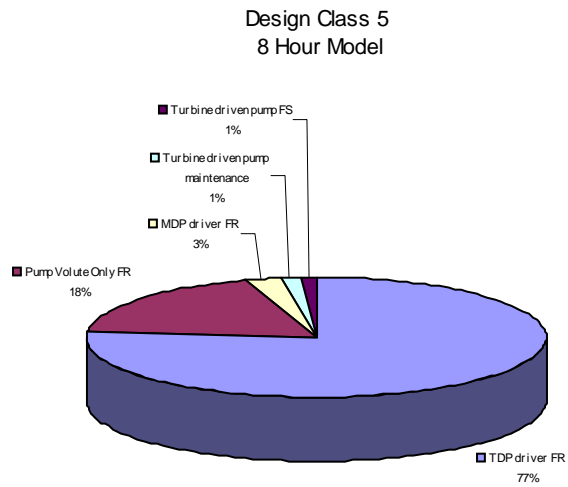


Figure 24. Segment failure distribution, 8-hour mission Design Class 5.

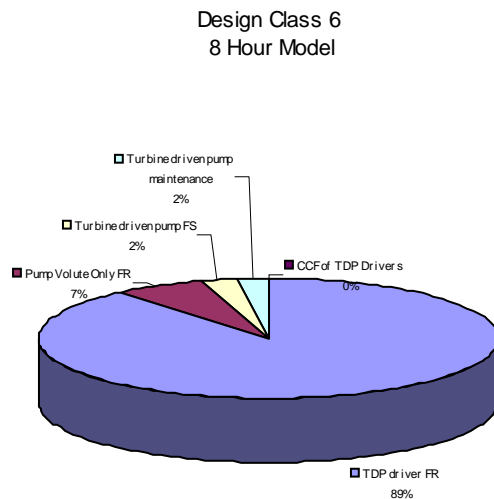


Figure 25. Segment failure distribution, 8-hour mission Design Class 6.

Design Class 7
8 Hour Model

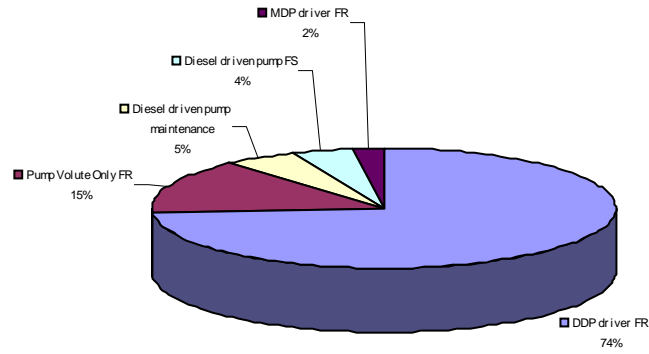


Figure 26. Segment failure distribution, 8-hour mission Design Class 7.

Design Class 8
8 Hour Model

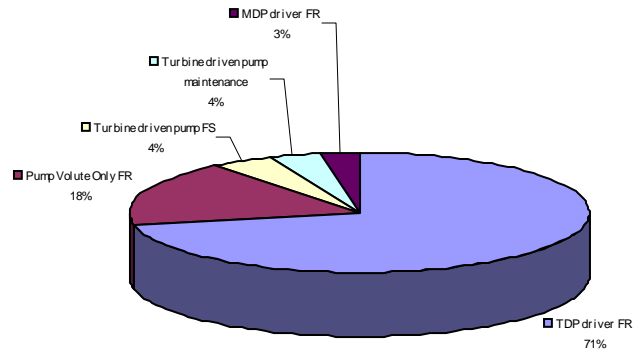


Figure 27. Segment failure distribution, 8-hour mission Design Class 8.

Design Class 9
8 Hour Model

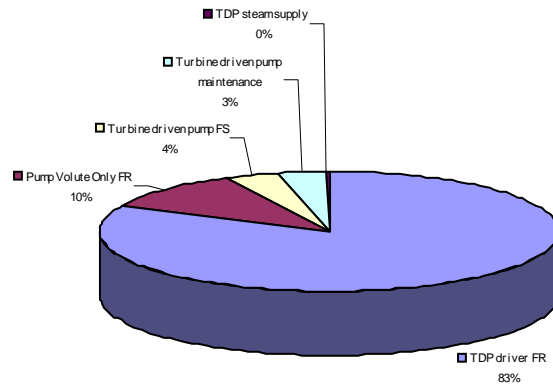


Figure 28. Segment failure distribution, 8-hour mission Design Class 9.

Design Class 10
8 Hour Model

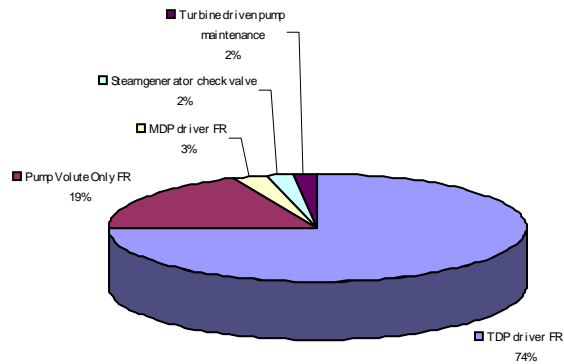


Figure 29. Segment failure distribution, 8-hour mission Design Class 10.

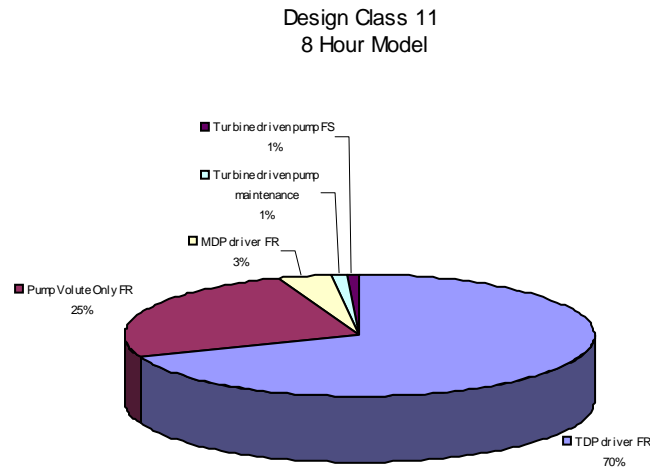


Figure 30. Segment failure distribution, 8-hour mission Design Class 11.

3.2 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.

3.2.1 Leading Segment Failures.

The turbine-driven pump (42%) and the motor-driven pump (22%) were the leading segment failures identified in the database. See [Table 7](#).

3.2.2 Leading Discovery Methods

Periodic surveillance (38%) and unplanned demand (37%) were the leading methods of discovery. See [Table 7](#).

3.2.3 Leading Causes of Failure.

Forty-two percent of the failures in the AFW system observed in the experience were attributed to hardware-related problems. Personnel errors caused 16% of all AFW system failures. However, 86% of these failures were immediately identified and either recovered or were recoverable, meaning that the failures were of the nature where plant personnel were able to respond to the failures immediately after they occurred. See [Table 9](#).

Table 7. Comparison of failed segment with the method of discovery.²

Segments	Actual/ unplanned demand	Alarm/ indicator	Design review	Inspection/ review	Maintenance on system	Other (not counted) surveillance test	Periodic surveillance on system	Post-maintenance testing	Total	Percent
Common feed control segment	5			1			3		9	4%
Diesel-driven pump	1			2					3	1%
Instrumentation and control				4			1		5	2%
Motor-driven pump	20		2	6	3	1	19		51	22%
Motor-driven pump feed segment	20	1		9			4		34	15%
Pump suction	2			1					3	1%
Steam generator feed segment	5								5	2%
Turbine-driven pump	32		2	11	3		49	2	99	42%
Turbine-driven pump feed segment	1			4			6		11	5%
Turbine-driven pump steam supply	1			5			7		13	6%
Total	87	1	4	43	6	1	89	2	233	100%
Percent	37%	0%	2%	18%	3%	0%	38%	1%	100%	

² The discovery method is the activity that is ongoing at the time of the failure.

Table 8. 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.	
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 9. Comparison of failed segment and failure cause.³

Segments	Design	Environment	Gas binding	Hardware	Maintenance	Personnel	Procedure	Support System	Water Accumulation	Total	Percent
Common feed control segment	1			7		1				9	4%
Diesel-driven pump				1		2				3	1%
Instrumentation and control				3	1		1			5	2%
Motor-driven pump	7	3	1	16	7	8	8	1		51	22%
Motor-driven pump feed segment	3	3		15	4	9				34	15%
Pump suction				2			1			3	1%
Steam generator feed segment				5						5	2%
Turbine-driven pump	7	3		44	15	11	11		8	99	42%
Turbine-driven pump feed segment				1	6	3	1			11	5%
Turbine-driven pump steam supply	4			3	2	3			1	13	6%
Total	22	9	1	97	35	37	22	1	9	233	100%
Percent	9%	4%	0%	42%	15%	16%	9%	0%	4%	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.

- Gas Binding–The failure was the result of gases coming out of solution in the pump suction. This cause is used only in the AFW and HPI studies.
- Environment–The failure was the result of the environment; room cooling and contaminated water are two examples.
- Support System–The failure was the result of a support system failure. These events do not count for the failure probability. Support systems include electricity and air.
- Water Accumulation–The failure was due to water accumulation in the turbine-driven pump steam.

4 DATA TABLES

4.1 Data Tables for Unreliability and Unavailability Trends

Table 10. Plot data table for AFW system unavailability, FTS model, Figure 3.

FY	Plot Trend Error Bar Points			Regression Curve Data Points		
	Lower (5%)	Mean	Upper (95%)	Lower (5%)	Mean	Upper (95%)
1987	6.06E-06	2.04E-04	7.77E-04	1.95E-04	2.23E-04	2.56E-04
1988	1.47E-05	3.37E-04	1.25E-03	1.98E-04	2.24E-04	2.54E-04
1989	5.84E-06	2.07E-04	7.90E-04	2.01E-04	2.25E-04	2.52E-04
1990	5.76E-06	2.12E-04	8.11E-04	2.04E-04	2.26E-04	2.50E-04
1991	5.41E-06	2.10E-04	8.05E-04	2.07E-04	2.26E-04	2.48E-04
1992	5.34E-06	2.02E-04	7.75E-04	2.09E-04	2.27E-04	2.47E-04
1993	5.63E-06	2.21E-04	8.48E-04	2.11E-04	2.28E-04	2.46E-04
1994	5.70E-06	2.24E-04	8.61E-04	2.13E-04	2.29E-04	2.46E-04
1995	6.04E-06	2.30E-04	8.83E-04	2.14E-04	2.30E-04	2.47E-04
1996	5.72E-06	2.20E-04	8.45E-04	2.14E-04	2.30E-04	2.49E-04
1997	6.71E-06	2.40E-04	9.17E-04	2.13E-04	2.31E-04	2.51E-04
1998	5.88E-06	2.35E-04	9.02E-04	2.12E-04	2.32E-04	2.54E-04
1999	5.79E-06	2.29E-04	8.81E-04	2.11E-04	2.33E-04	2.58E-04
2000	6.01E-06	2.37E-04	9.11E-04	2.09E-04	2.34E-04	2.62E-04
2001	6.01E-06	2.40E-04	9.21E-04	2.07E-04	2.35E-04	2.66E-04
2002	6.37E-06	2.48E-04	9.51E-04	2.05E-04	2.35E-04	2.70E-04

Table 11. Plot data table for AFW system unreliability, 8-hour mission, Figure 6.

FY	Plot Trend Error Bar Points			Regression Curve Data Points		
	Lower (5%)	Mean	Upper (95%)	Lower (5%)	Mean	Upper (95%)
1987	1.34E-05	3.15E-04	1.17E-03	2.76E-04	4.07E-04	6.00E-04
1988	6.83E-05	8.11E-04	2.74E-03	2.90E-04	4.13E-04	5.86E-04
1989	1.25E-05	3.01E-04	1.12E-03	3.05E-04	4.18E-04	5.74E-04
1990	1.34E-05	3.27E-04	1.22E-03	3.19E-04	4.24E-04	5.63E-04
1991	3.39E-05	7.49E-04	2.76E-03	3.33E-04	4.29E-04	5.54E-04
1992	1.25E-05	3.06E-04	1.14E-03	3.45E-04	4.35E-04	5.48E-04
1993	1.29E-05	4.77E-04	1.83E-03	3.56E-04	4.41E-04	5.46E-04
1994	1.44E-05	3.53E-04	1.32E-03	3.64E-04	4.47E-04	5.48E-04
1995	1.51E-05	3.71E-04	1.38E-03	3.69E-04	4.53E-04	5.56E-04
1996	3.31E-05	6.60E-04	2.41E-03	3.71E-04	4.59E-04	5.68E-04
1997	1.63E-05	4.90E-04	1.86E-03	3.69E-04	4.65E-04	5.86E-04
1998	3.29E-05	4.95E-04	1.74E-03	3.65E-04	4.71E-04	6.08E-04
1999	1.52E-05	3.76E-04	1.40E-03	3.60E-04	4.78E-04	6.35E-04
2000	1.46E-05	3.63E-04	1.36E-03	3.53E-04	4.84E-04	6.64E-04
2001	4.42E-05	7.53E-04	2.70E-03	3.45E-04	4.91E-04	6.97E-04
2002	1.94E-05	4.76E-04	1.77E-03	3.37E-04	4.97E-04	7.33E-04

4.2 Data Tables for Failure and Demand Trends

Table 12. LER listing for demand trends, Figure 7.

FY	Plant	Date	LER
1987	Arkansas 1	5/17/1987	3131987002
1987	Arkansas 1	8/8/1987	3131987003
1987	Arkansas 1	8/15/1987	3131987004
1987	Arkansas 1	8/25/1987	3131987005
1988	Arkansas 1	2/17/1988	3131988003
1989	Arkansas 1	1/20/1989	3131989002
1989	Arkansas 1	5/30/1989	3131989020
1990	Arkansas 1	12/21/1989	3131989041
1990	Arkansas 1	12/28/1989	3131989048
1991	Arkansas 1	4/21/1991	3131991003
1991	Arkansas 1	5/21/1991	3131991005
1992	Arkansas 1	4/24/1992	3131992003
1994	Arkansas 1	4/11/1994	3131994002
1995	Arkansas 1	4/3/1995	3131995004
1996	Arkansas 1	5/19/1996	3131996005
1996	Arkansas 1	9/12/1996	3131996007
1997	Arkansas 1	7/8/1997	3131997003
1998	Arkansas 1	9/23/1998	3131998004
1999	Arkansas 1	12/25/1998	3131998005
1999	Arkansas 1	9/11/1999	3131999003
1987	Arkansas 2	9/9/1987	3681987007
1988	Arkansas 2	11/14/1987	3681987008
1988	Arkansas 2	8/1/1988	3681988011
1989	Arkansas 2	12/1/1988	3681988020
1989	Arkansas 2	4/18/1989	3681989006
1990	Arkansas 2	12/31/1989	3681989024
1990	Arkansas 2	8/21/1990	3681990019
1990	Arkansas 2	9/28/1990	3681990020
1991	Arkansas 2	2/1/1991	3681991005
1998	Arkansas 2	5/20/1998	3681998002
1987	Beaver Valley 1	2/7/1987	3341987002
1987	Beaver Valley 1	6/9/1987	3341987013
1988	Beaver Valley 1	6/7/1988	3341988007
1988	Beaver Valley 1	6/9/1988	3341988008
1988	Beaver Valley 1	6/11/1988	3341988009
1989	Beaver Valley 1	1/17/1989	3341989001
1989	Beaver Valley 1	2/13/1989	3341989002
1989	Beaver Valley 1	5/18/1989	3341989007
1990	Beaver Valley 1	3/30/1990	3341990007
1991	Beaver Valley 1	7/20/1991	3341991022
1991	Beaver Valley 1	7/27/1991	3341991023
1992	Beaver Valley 1	11/6/1991	3341991029
1993	Beaver Valley 1	10/9/1992	3341992009
1994	Beaver Valley 1	10/12/1993	3341993013
1994	Beaver Valley 1	6/1/1994	3341994005
1994	Beaver Valley 1	7/19/1994	3341994008
1996	Beaver Valley 1	3/22/1996	3341996003
1996	Beaver Valley 1	5/6/1996	3341996007
1996	Beaver Valley 1	5/31/1996	3341996008
1997	Beaver Valley 1	3/19/1997	3341997005
1997	Beaver Valley 1	8/7/1997	3341997025
1999	Beaver Valley 1	1/23/1999	3341999001
1999	Beaver Valley 1	9/6/1999	3341999010
2000	Beaver Valley 1	7/5/2000	3342000006
1987	Beaver Valley 2	7/17/1987	4121987005
1987	Beaver Valley 2	8/15/1987	4121987014
1987	Beaver Valley 2	8/15/1987	4121987015
1987	Beaver Valley 2	8/16/1987	4121987017
1987	Beaver Valley 2	8/25/1987	4121987019
1987	Beaver Valley 2	9/9/1987	4121987020
1987	Beaver Valley 2	9/28/1987	4121987023
1987	Beaver Valley 2	9/29/1987	4121987024
1987	Beaver Valley 2	9/30/1987	4121987025
1988	Beaver Valley 2	10/8/1987	4121987026
1988	Beaver Valley 2	10/14/1987	4121987028
1988	Beaver Valley 2	10/16/1987	4121987030
1988	Beaver Valley 2	10/24/1987	4121987032
1988	Beaver Valley 2	10/29/1987	4121987034
1988	Beaver Valley 2	11/10/1987	4121987035
1988	Beaver Valley 2	11/17/1987	4121987036
1988	Beaver Valley 2	1/27/1988	4121988002
1988	Beaver Valley 2	4/4/1988	4121988007
1988	Beaver Valley 2	7/27/1988	4121988009
1988	Beaver Valley 2	8/23/1988	4121988011
1988	Beaver Valley 2	9/20/1988	4121988013
1989	Beaver Valley 2	2/12/1989	4121989003
1989	Beaver Valley 2	5/14/1989	4121989015
1989	Beaver Valley 2	6/22/1989	4121989019
1989	Beaver Valley 2	6/22/1989	4121989020
1990	Beaver Valley 2	7/2/1990	4121990008
1992	Beaver Valley 2	11/26/1991	4121991005
1992	Beaver Valley 2	5/5/1992	4121992007
1992	Beaver Valley 2	6/5/1992	4121992009
1993	Beaver Valley 2	1/30/1993	4121993002
1995	Beaver Valley 2	8/13/1995	4121995006
2000	Beaver Valley 2	9/23/2000	4122000001
2001	Beaver Valley 2	3/17/2001	4122001001
1987	Braidwood 1	9/10/1987	4561987046
1988	Braidwood 1	12/6/1987	4561987060
1988	Braidwood 1	8/11/1988	4561988016
1989	Braidwood 1	10/16/1988	4561988022
1989	Braidwood 1	10/17/1988	4561988023
1989	Braidwood 1	11/15/1988	4561988025
1989	Braidwood 1	3/6/1989	4561989004

FY	Plant	Date	LER
1990	Braidwood 1	1/12/1990	4561990001
1990	Braidwood 1	6/8/1990	4561990008
1991	Braidwood 1	12/1/1990	4561990021
1991	Braidwood 1	12/30/1990	4561990023
1992	Braidwood 1	11/6/1991	4561991012
1993	Braidwood 1	1/7/1993	4561993001
1994	Braidwood 1	8/11/1994	4561994012
1995	Braidwood 1	4/9/1995	4561995004
1988	Braidwood 2	6/20/1988	4571988012
1988	Braidwood 2	6/21/1988	4571988013
1988	Braidwood 2	6/22/1988	4571988014
1988	Braidwood 2	6/24/1988	4571988016
1988	Braidwood 2	7/2/1988	4571988018
1988	Braidwood 2	7/24/1988	4571988019
1988	Braidwood 2	9/4/1988	4571988020
1989	Braidwood 2	11/17/1988	4571988028
1989	Braidwood 2	10/25/1988	4571988029
1989	Braidwood 2	11/5/1988	4571988031
1989	Braidwood 2	5/11/1989	4571989002
1989	Braidwood 2	9/7/1989	4571989004
1990	Braidwood 2	6/9/1990	4571990010
1991	Braidwood 2	8/1/1991	4571991003
1992	Braidwood 2	12/1/1991	4571991006
1992	Braidwood 2	2/25/1992	4571992001
1992	Braidwood 2	3/15/1992	4571992002
1992	Braidwood 2	9/10/1992	4571992006
1993	Braidwood 2	11/14/1992	4571992007
1994	Braidwood 2	10/3/1993	4571993007
1994	Braidwood 2	4/5/1994	4571994003
1994	Braidwood 2	8/2/1994	4571994005
1996	Braidwood 2	5/6/1996	4571996005
1999	Braidwood 2	4/14/1999	4571999001
2000	Braidwood 2	4/15/2000	4572000002
2001	Braidwood 2	5/19/2001	4572001001
1987	Byron 1	8/11/1987	4541987018
1987	Byron 1	8/12/1987	4541987019
1988	Byron 1	4/18/1988	4541988002
1988	Byron 1	7/16/1988	4541988004
1988	Byron 1	8/4/1988	4541988005
1989	Byron 1	1/31/1989	4541989002
1990	Byron 1	5/3/1990	4541990006
1990	Byron 1	8/19/1990	4541990011
1991	Byron 1	12/3/1990	4541990014
1992	Byron 1	1/29/1992	4541992001
1996	Byron 1	7/2/1996	4541996011
1999	Byron 1	5/13/1999	4541999003
1987	Byron 2	3/31/1987	4551987005
1987	Byron 2	4/27/1987	4551987006
1987	Byron 2	5/4/1987	4551987007
1987	Byron 2	6/29/1987	4551987009
1987	Byron 2	7/25/1987	4551987011
1988	Byron 2	10/1/1987	4551987018
1988	Byron 2	5/6/1988	4551988004

FY	Plant	Date	LER
1988	Byron 2	6/2/1988	4551988006
1988	Byron 2	7/14/1988	4551988008
1988	Byron 2	7/15/1988	4551988009
1989	Byron 2	12/15/1988	4551988012
1990	Byron 2	1/18/1990	4551990001
1991	Byron 2	12/20/1990	4551990010
1992	Byron 2	11/7/1991	4551991005
1992	Byron 2	6/10/1992	4551992003
1993	Byron 2	5/11/1993	4551993003
1994	Byron 2	9/24/1994	4551994003
1998	Byron 2	10/10/1997	4551997003
2000	Byron 2	1/13/2000	4552000001
2000	Byron 2	7/26/2000	4552000002
2001	Byron 2	6/26/2001	4552001002
1988	Callaway	11/8/1987	4831987032
1988	Callaway	1/4/1988	4831988001
1988	Callaway	2/13/1988	4831988004
1988	Callaway	4/16/1988	4831988005
1988	Callaway	4/17/1988	4831988005
1988	Callaway	4/21/1988	4831988006
1988	Callaway	5/2/1988	4831988007
1988	Callaway	9/2/1988	4831988010
1988	Callaway	9/3/1988	4831988010
1989	Callaway	11/16/1988	4831988015
1989	Callaway	3/31/1989	4831989003
1989	Callaway	5/18/1989	4831989005
1989	Callaway	5/29/1989	4831989006
1989	Callaway	6/23/1989	4831989008
1990	Callaway	5/1/1990	4831990005
1990	Callaway	6/11/1990	4831990007
1991	Callaway	11/19/1990	4831990015
1991	Callaway	11/24/1990	4831990016
1991	Callaway	12/30/1990	4831990017
1992	Callaway	11/5/1991	4831991006
1992	Callaway	1/22/1992	4831992002
1992	Callaway	1/23/1992	4831992003
1992	Callaway	3/20/1992	4831992004
1992	Callaway	5/15/1992	4831992006
1992	Callaway	5/23/1992	4831992007
1992	Callaway	9/20/1992	4831992010
1992	Callaway	4/10/1992	4831995006
1995	Callaway	6/8/1995	4831995004
1995	Callaway	8/16/1995	4831995005
1996	Callaway	4/2/1996	4831996001
1997	Callaway	10/12/1996	4831996003
1997	Callaway	11/11/1996	4831996005
1997	Callaway	12/5/1996	4831996006
1999	Callaway	8/11/1999	4831999003
1999	Callaway	8/13/1999	4831999006
2000	Callaway	11/26/1999	4831999008
2001	Callaway	3/9/2001	4832001003
2001	Callaway	9/17/2001	4832001005
2002	Callaway	12/3/2001	4832002001

FY	Plant	Date	LER
1987	Calvert Cliffs 1	1/27/1987	3171987003
1987	Calvert Cliffs 1	7/23/1987	3171987012
1988	Calvert Cliffs 1	11/11/1987	3171987015
1988	Calvert Cliffs 1	8/24/1988	3171988009
1989	Calvert Cliffs 1	11/14/1988	3171988012
1992	Calvert Cliffs 1	10/1/1991	3171991003
1993	Calvert Cliffs 1	11/24/1992	3171992008
1994	Calvert Cliffs 1	1/24/1994	3171994001
1994	Calvert Cliffs 1	6/16/1994	3171994006
1994	Calvert Cliffs 1	7/19/1994	3171994007
1995	Calvert Cliffs 1	6/16/1995	3171995002
1996	Calvert Cliffs 1	11/16/1995	3171995006
1999	Calvert Cliffs 1	9/22/1999	3171999006
2000	Calvert Cliffs 1	9/10/2000	3172000005
1987	Calvert Cliffs 2	2/28/1987	3181987002
1987	Calvert Cliffs 2	9/7/1987	3181987006
1988	Calvert Cliffs 2	11/22/1987	3181987008
1988	Calvert Cliffs 2	12/21/1987	3181987009
1988	Calvert Cliffs 2	1/22/1988	3181988002
1988	Calvert Cliffs 2	4/27/1988	3181988004
1992	Calvert Cliffs 2	1/2/1992	3181992001
1992	Calvert Cliffs 2	6/24/1992	3181992003
1992	Calvert Cliffs 2	8/1/1992	3181992005
1992	Calvert Cliffs 2	8/17/1992	3181992006
1992	Calvert Cliffs 2	9/29/1992	3181992007
1994	Calvert Cliffs 2	1/12/1994	3181994001
1995	Calvert Cliffs 2	1/13/1995	3181995002
1995	Calvert Cliffs 2	1/15/1995	3181995003
1996	Calvert Cliffs 2	2/27/1996	3181996001
1997	Calvert Cliffs 2	11/17/1996	3181996005
1987	Catawba 1	1/31/1987	4131987006
1987	Catawba 1	3/16/1987	4131987013
1987	Catawba 1	4/9/1987	4131987015
1987	Catawba 1	7/6/1987	4131987026
1987	Catawba 1	7/11/1987	4131987028
1987	Catawba 1	7/13/1987	4131987029
1987	Catawba 1	8/23/1987	4131987034
1988	Catawba 1	1/23/1988	4131988007
1989	Catawba 1	2/6/1989	4131989003
1989	Catawba 1	3/5/1989	4131989008
1989	Catawba 1	6/26/1989	4131989017
1989	Catawba 1	8/24/1989	4131989022
1991	Catawba 1	6/20/1991	4131991013
1991	Catawba 1	7/10/1991	4131991015
1991	Catawba 1	9/6/1991	4131991018
1991	Catawba 1	9/11/1991	4131991019
1992	Catawba 1	10/2/1991	4131991021
1992	Catawba 1	7/12/1992	4131992008
1993	Catawba 1	6/12/1993	4131993006
1993	Catawba 1	7/18/1993	4131993008
1993	Catawba 1	7/19/1993	4131993008
1994	Catawba 1	1/11/1994	4131994001
1996	Catawba 1	6/13/1996	4131996005

FY	Plant	Date	LER
2000	Catawba 1	2/13/2000	4132000001
1987	Catawba 2	1/28/1987	4141987002
1987	Catawba 2	1/30/1987	4141987003
1987	Catawba 2	2/24/1987	4141987007
1987	Catawba 2	3/23/1987	4141987010
1987	Catawba 2	3/24/1987	4141987011
1987	Catawba 2	3/25/1987	4141987013
1987	Catawba 2	5/6/1987	4141987018
1987	Catawba 2	5/8/1987	4141987019
1987	Catawba 2	7/27/1987	4141987021
1987	Catawba 2	7/28/1987	4141987022
1987	Catawba 2	8/7/1987	4141987024
1987	Catawba 2	9/3/1987	4141987025
1987	Catawba 2	9/15/1987	4141987027
1988	Catawba 2	11/3/1987	4141987029
1988	Catawba 2	2/22/1988	4141988007
1988	Catawba 2	3/9/1988	4141988012
1988	Catawba 2	3/17/1988	4141988014
1988	Catawba 2	4/24/1988	4141988017
1988	Catawba 2	5/27/1988	4141988019
1988	Catawba 2	5/28/1988	4141988020
1988	Catawba 2	6/3/1988	4141988021
1988	Catawba 2	6/6/1988	4141988022
1988	Catawba 2	6/20/1988	4141988023
1988	Catawba 2	6/26/1988	4141988025
1988	Catawba 2	9/29/1988	4141988028
1989	Catawba 2	11/23/1988	4141988031
1989	Catawba 2	11/24/1988	4141988032
1989	Catawba 2	1/12/1989	4141989001
1989	Catawba 2	1/1/1989	4141989002
1989	Catawba 2	1/21/1989	4141989002
1989	Catawba 2	2/21/1989	4141989003
1989	Catawba 2	2/21/1989	4141989004
1989	Catawba 2	6/9/1989	4141989015
1991	Catawba 2	10/7/1990	4141990013
1991	Catawba 2	4/16/1991	4141991006
1991	Catawba 2	5/29/1991	4141991008
1992	Catawba 2	10/17/1991	4141991012
1992	Catawba 2	1/15/1992	4141992001
1993	Catawba 2	12/14/1992	4141992006
1993	Catawba 2	9/25/1993	4141993003
1994	Catawba 2	7/10/1994	4141994003
1994	Catawba 2	8/30/1994	4141994005
1994	Catawba 2	9/13/1994	4141994006
1995	Catawba 2	10/18/1994	4141994007
1995	Catawba 2	2/21/1995	4141995001
1995	Catawba 2	4/27/1995	4141995004
1995	Catawba 2	5/1/1995	4141995005
1996	Catawba 2	2/6/1996	4141996001
1997	Catawba 2	7/26/1997	4141997006
1997	Catawba 2	8/17/1997	4141997006
1998	Catawba 2	9/6/1998	4141998004
2000	Catawba 2	12/30/1999	4141999006

FY	Plant	Date	LER
2000	Catawba 2	6/5/2000	4142000003
2002	Catawba 2	12/7/2001	4142001003
1990	Comanche Peak 1	3/12/1990	4451990004
1990	Comanche Peak 1	4/21/1990	4451990009
1990	Comanche Peak 1	5/9/1990	4451990013
1990	Comanche Peak 1	5/27/1990	4451990017
1990	Comanche Peak 1	7/26/1990	4451990020
1990	Comanche Peak 1	7/30/1990	4451990021
1990	Comanche Peak 1	8/8/1990	4451990023
1990	Comanche Peak 1	8/25/1990	4451990025
1990	Comanche Peak 1	9/7/1990	4451990027
1990	Comanche Peak 1	9/8/1990	4451990028
1990	Comanche Peak 1	9/10/1990	4451990029
1990	Comanche Peak 1	9/15/1990	4451990030
1991	Comanche Peak 1	1/23/1991	4451991002
1991	Comanche Peak 1	2/10/1991	4451991004
1991	Comanche Peak 1	3/17/1991	4451991008
1991	Comanche Peak 1	6/9/1991	4451991019
1991	Comanche Peak 1	7/13/1991	4451991020
1991	Comanche Peak 1	7/28/1991	4451991021
1991	Comanche Peak 1	9/4/1991	4451991022
1991	Comanche Peak 1	4/13/1991	4451995007
1992	Comanche Peak 1	10/3/1991	4451991023
1992	Comanche Peak 1	1/8/1992	4451992001
1992	Comanche Peak 1	5/8/1992	4451992009
1992	Comanche Peak 1	6/11/1992	4451992014
1992	Comanche Peak 1	6/23/1992	4451992016
1992	Comanche Peak 1	7/20/1992	4451992020
1993	Comanche Peak 1	10/12/1992	4451992022
1993	Comanche Peak 1	1/18/1993	4451993001
1993	Comanche Peak 1	1/24/1993	4451993002
1993	Comanche Peak 1	6/26/1993	4451993007
1995	Comanche Peak 1	6/5/1995	4451995002
1995	Comanche Peak 1	6/11/1995	4451995003
1996	Comanche Peak 1	1/17/1996	4451996001
1996	Comanche Peak 1	1/22/1996	4451996002
1996	Comanche Peak 1	2/4/1996	4451996003
1996	Comanche Peak 1	8/9/1996	4451996007
1998	Comanche Peak 1	10/27/1997	4451997009
1993	Comanche Peak 2	5/4/1993	4461993003
1994	Comanche Peak 2	10/1/1993	4461993008
1994	Comanche Peak 2	11/17/1993	4461993011
1994	Comanche Peak 2	3/5/1994	4461994003
1994	Comanche Peak 2	6/27/1994	4461994010
1994	Comanche Peak 2	8/15/1994	4461994012
1996	Comanche Peak 2	12/5/1995	4461995004
1996	Comanche Peak 2	2/23/1996	4461996003
1996	Comanche Peak 2	5/5/1996	4461996005
1996	Comanche Peak 2	9/18/1996	4461996006
1997	Comanche Peak 2	10/18/1996	4461996007
1997	Comanche Peak 2	4/15/1997	4461997001
1998	Comanche Peak 2	10/25/1997	4461997002
1998	Comanche Peak 2	3/8/1998	4461998002

FY	Plant	Date	LER
1999	Comanche Peak 2	1/3/1999	4461999002
1999	Comanche Peak 2	5/22/1999	4461999004
2000	Comanche Peak 2	1/7/2000	4462000002
2001	Comanche Peak 2	7/18/2001	4462001001
2002	Comanche Peak 2	6/6/2002	4462002001
1987	Cook 1	6/4/1987	3151987008
1988	Cook 1	10/13/1987	3151987021
1988	Cook 1	1/13/1988	3151988001
1989	Cook 1	10/19/1988	3151988011
1989	Cook 1	11/23/1988	3151988013
1989	Cook 1	1/16/1989	3151989001
1989	Cook 1	3/18/1989	3151989003
1991	Cook 1	5/12/1991	3151991004
1995	Cook 1	7/14/1995	3151995003
1996	Cook 1	3/17/1996	3151996002
1997	Cook 1	9/23/1997	3151997025
2002	Cook 1	6/14/2002	3152002005
1987	Cook 2	6/1/1987	3161987004
1987	Cook 2	6/2/1987	3161987005
1987	Cook 2	7/14/1987	3161987007
1987	Cook 2	7/22/1987	3161987008
1989	Cook 2	8/14/1989	3161989014
1990	Cook 2	6/11/1990	3161990004
1991	Cook 2	12/12/1990	3161990012
1991	Cook 2	12/15/1990	3161990013
1991	Cook 2	3/13/1991	3161991004
1991	Cook 2	8/1/1991	3161991006
1992	Cook 2	11/15/1991	3161991010
1993	Cook 2	8/2/1993	3161993007
1994	Cook 2	2/21/1994	3161994001
1994	Cook 2	8/15/1994	3161994005
1995	Cook 2	12/11/1994	3161994008
1995	Cook 2	2/23/1995	3161995002
1995	Cook 2	8/26/1995	3161995004
1995	Cook 2	8/29/1995	3161995005
1996	Cook 2	5/8/1996	3161996005
1997	Cook 2	3/11/1997	3161997001
2002	Cook 2	1/19/2002	3162002004
2002	Cook 2	5/12/2002	3162002005
2002	Cook 2	7/22/2002	3162002006
1988	Crystal River 3	1/7/1988	3021988001
1988	Crystal River 3	1/9/1988	3021988001
1988	Crystal River 3	1/7/1988	3021988002
1988	Crystal River 3	2/28/1988	3021988006
1989	Crystal River 3	10/28/1988	3021988024
1989	Crystal River 3	1/15/1989	3021989003
1989	Crystal River 3	6/14/1989	3021989022
1989	Crystal River 3	6/16/1989	3021989023
1989	Crystal River 3	6/29/1989	3021989025
1991	Crystal River 3	10/10/1990	3021990016
1991	Crystal River 3	4/20/1991	3021991003
1992	Crystal River 3	11/25/1991	3021991014
1992	Crystal River 3	11/25/1991	3021991016

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1992	Crystal River 3	12/8/1991	3021991018
1992	Crystal River 3	3/27/1992	3021992001
1992	Crystal River 3	7/17/1992	3021992015
1993	Crystal River 3	12/29/1992	3021992027
1993	Crystal River 3	9/18/1993	3021993009
1996	Crystal River 3	5/31/1996	3021996017
1998	Crystal River 3	2/11/1998	3021998003
2000	Crystal River 3	10/1/1999	3021999004
2002	Crystal River 3	10/24/2001	3022001005
1987	Davis-Besse	3/13/1987	3461987006
1987	Davis-Besse	9/6/1987	3461987011
1992	Davis-Besse	12/10/1991	3461991008
1994	Davis-Besse	10/8/1993	3461993005
1998	Davis-Besse	6/24/1998	3461998006
1999	Davis-Besse	10/14/1998	3461998011
1987	Diablo Canyon 1	3/15/1987	2751987004
1987	Diablo Canyon 1	5/11/1987	2751987006
1988	Diablo Canyon 1	12/13/1987	2751987023
1988	Diablo Canyon 1	12/13/1987	2751987024
1988	Diablo Canyon 1	1/8/1988	2751988002
1988	Diablo Canyon 1	8/30/1988	2751988025
1990	Diablo Canyon 1	10/6/1989	2751989009
1990	Diablo Canyon 1	12/14/1989	2751989015
1990	Diablo Canyon 1	2/20/1990	2751990002
1990	Diablo Canyon 1	6/14/1990	2751990005
1991	Diablo Canyon 1	12/5/1990	2751990014
1991	Diablo Canyon 1	12/24/1990	2751990017
1991	Diablo Canyon 1	2/1/1991	2751991002
1991	Diablo Canyon 1	4/23/1991	2751991007
1991	Diablo Canyon 1	5/17/1991	2751991009
1992	Diablo Canyon 1	3/6/1992	2751992002
1992	Diablo Canyon 1	4/25/1992	2751992004
1994	Diablo Canyon 1	12/26/1993	2751993011
1995	Diablo Canyon 1	12/14/1994	2751994020
1995	Diablo Canyon 1	9/6/1995	2751995009
1996	Diablo Canyon 1	11/28/1995	2751995015
1996	Diablo Canyon 1	12/13/1995	2751995017
1996	Diablo Canyon 1	6/10/1996	2751996008
1996	Diablo Canyon 1	8/10/1996	2751996012
1997	Diablo Canyon 1	11/22/1996	2751996017
1999	Diablo Canyon 1	9/22/1999	2751999006
1999	Diablo Canyon 1	9/23/1999	2751999008
2000	Diablo Canyon 1	10/28/1999	2751999009
2000	Diablo Canyon 1	5/15/2000	2752000004
2001	Diablo Canyon 1	11/20/2000	2752000012
2002	Diablo Canyon 1	6/3/2002	2752002004
1987	Diablo Canyon 2	3/21/1987	3231987003
1987	Diablo Canyon 2	4/3/1987	3231987004
1987	Diablo Canyon 2	7/1/1987	3231987013
1987	Diablo Canyon 2	7/14/1987	3231987016
1988	Diablo Canyon 2	11/7/1987	3231987024
1988	Diablo Canyon 2	3/3/1988	3231988002
1988	Diablo Canyon 2	7/17/1988	3231988008

FY	Plant	Date	LER
1989	Diablo Canyon 2	4/16/1989	3231989005
1989	Diablo Canyon 2	7/16/1989	3231989007
1989	Diablo Canyon 2	8/28/1989	3231989008
1990	Diablo Canyon 2	10/27/1989	3231989010
1993	Diablo Canyon 2	1/30/1993	3231993001
1995	Diablo Canyon 2	12/19/1994	3231994012
1995	Diablo Canyon 2	9/23/1995	3231995002
1997	Diablo Canyon 2	3/29/1997	3231997002
1997	Diablo Canyon 2	7/2/1997	3231997003
1998	Diablo Canyon 2	10/24/1997	3231997005
1999	Diablo Canyon 2	12/1/1998	3231998005
2002	Diablo Canyon 2	2/9/2002	3232002002
1987	Farley 1	1/8/1987	3481987002
1987	Farley 1	1/9/1987	3481987003
1987	Farley 1	1/22/1987	3481987004
1987	Farley 1	5/14/1987	3481987010
1989	Farley 1	10/21/1988	3481988021
1990	Farley 1	11/12/1989	3481989006
1990	Farley 1	11/12/1989	3481989007
1990	Farley 1	7/20/1990	3481990005
1991	Farley 1	5/24/1991	3481991006
1991	Farley 1	6/29/1991	3481991007
1991	Farley 1	8/2/1991	3481991008
1991	Farley 1	8/19/1991	3481991009
1992	Farley 1	10/3/1991	3481991010
1993	Farley 1	12/13/1992	3481992008
1995	Farley 1	1/13/1995	3481995001
1995	Farley 1	6/11/1995	3481995005
1996	Farley 1	11/5/1995	3481995010
1996	Farley 1	6/2/1996	3481996003
1998	Farley 1	9/9/1998	3481998004
1999	Farley 1	5/27/1999	3481999002
2000	Farley 1	3/4/2000	3482000002
2000	Farley 1	5/28/2000	3482000006
1987	Farley 2	2/28/1987	3641987001
1988	Farley 2	12/3/1987	3641987009
1989	Farley 2	5/22/1989	3641989007
1989	Farley 2	5/27/1989	3641989008
1989	Farley 2	9/20/1989	3641989010
1990	Farley 2	10/18/1989	3641989012
1990	Farley 2	11/18/1989	3641989015
1990	Farley 2	5/12/1990	3641990001
1991	Farley 2	4/1/1991	3641991001
1991	Farley 2	4/9/1991	3641991002
1991	Farley 2	4/20/1991	3641991004
1991	Farley 2	8/6/1991	3641991005
1992	Farley 2	1/22/1992	3641992001
1992	Farley 2	3/6/1992	3641992002
1992	Farley 2	5/12/1992	3641992005
1992	Farley 2	5/15/1992	3641992006
1992	Farley 2	5/25/1992	3641992007
1992	Farley 2	5/26/1992	3641992008
1993	Farley 2	10/20/1992	3641992010

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1994	Farley 2	12/2/1993	3641993004
1994	Farley 2	8/5/1994	3641994001
1995	Farley 2	12/18/1994	3641994003
1995	Farley 2	12/25/1994	3641994004
1995	Farley 2	1/13/1995	3641994004
1995	Farley 2	6/1/1995	3641995005
1995	Farley 2	6/25/1995	3641995007
1996	Farley 2	11/28/1995	3641995008
1999	Farley 2	11/16/1998	3641998007
1991	Fort Calhoun	11/19/1990	2851990026
1992	Fort Calhoun	7/3/1992	2851992023
1993	Fort Calhoun	6/24/1993	2851993011
1994	Fort Calhoun	12/6/1993	2851993018
1994	Fort Calhoun	2/11/1994	2851994001
1988	GINNA	3/10/1988	2441988003
1988	GINNA	6/1/1988	2441988005
1988	GINNA	7/16/1988	2441988006
1989	GINNA	6/1/1989	2441989004
1990	GINNA	5/10/1990	2441990007
1990	GINNA	6/9/1990	2441990010
1990	GINNA	9/26/1990	2441990012
1991	GINNA	12/11/1990	2441990013
1991	GINNA	12/20/1990	2441990018
1991	GINNA	12/21/1990	2441990019
1992	GINNA	2/3/1992	2441992002
1992	GINNA	2/29/1992	2441992003
1994	GINNA	11/10/1993	2441993006
1994	GINNA	4/27/1994	2441994007
1996	GINNA	3/7/1996	2441996002
1996	GINNA	3/9/1996	2441996004
1996	GINNA	7/7/1996	2441996008
1996	GINNA	8/6/1996	2441996010
1996	GINNA	8/7/1996	2441996011
1996	GINNA	8/20/1996	2441996012
1999	GINNA	4/21/1999	2441999006
1999	GINNA	4/23/1999	2441999007
1999	GINNA	4/27/1999	2441999008
2001	GINNA	10/21/2000	2442000005
1990	Haddam Neck	9/3/1990	2131990018
1994	Haddam Neck	7/11/1994	2131994018
1995	Haddam Neck	7/27/1995	2131995016
1987	HARRIS	1/22/1987	4001987005
1987	HARRIS	2/27/1987	4001987008
1987	HARRIS	3/11/1987	4001987012
1987	HARRIS	3/13/1987	4001987013
1987	HARRIS	3/31/1987	4001987017
1987	HARRIS	4/3/1987	4001987018
1987	HARRIS	4/12/1987	4001987019
1987	HARRIS	4/14/1987	4001987021
1987	HARRIS	4/21/1987	4001987024
1987	HARRIS	4/22/1987	4001987025
1987	HARRIS	4/23/1987	4001987026
1987	HARRIS	4/24/1987	4001987026

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1987	HARRIS	5/2/1987	4001987028
1987	HARRIS	5/24/1987	4001987031
1987	HARRIS	6/17/1987	4001987035
1987	HARRIS	6/21/1987	4001987037
1987	HARRIS	6/22/1987	4001987038
1987	HARRIS	8/4/1987	4001987041
1987	HARRIS	7/9/1987	4001987042
1987	HARRIS	7/22/1987	4001987046
1987	HARRIS	8/4/1987	4001987047
1987	HARRIS	8/5/1987	4001987047
1987	HARRIS	9/25/1987	4001987049
1987	HARRIS	8/31/1987	4001987051
1988	HARRIS	11/7/1987	4001987062
1988	HARRIS	11/8/1987	4001987063
1988	HARRIS	3/9/1988	4001988007
1988	HARRIS	7/30/1988	4001988018
1989	HARRIS	10/14/1988	4001988028
1989	HARRIS	10/30/1988	4001988032
1989	HARRIS	1/16/1989	4001989001
1989	HARRIS	2/6/1989	4001989003
1989	HARRIS	2/7/1989	4001989004
1989	HARRIS	2/22/1989	4001989005
1989	HARRIS	3/14/1989	4001989006
1990	HARRIS	10/9/1989	4001989017
1990	HARRIS	12/27/1989	4001989021
1991	HARRIS	5/21/1991	4001991009
1991	HARRIS	6/3/1991	4001991010
1991	HARRIS	5/19/1991	4001991015
1992	HARRIS	7/12/1992	4001992007
1992	HARRIS	7/13/1992	4001992008
1992	HARRIS	7/15/1992	4001992009
1992	HARRIS	7/17/1992	4001992010
1993	HARRIS	5/23/1993	4001993007
1996	HARRIS	10/12/1995	4001995010
1996	HARRIS	11/5/1995	4001995011
1996	HARRIS	4/25/1996	4001996008
1996	HARRIS	9/3/1996	4001996018
1997	HARRIS	1/31/1997	4001997001
1997	HARRIS	6/8/1997	4001997016
1997	HARRIS	7/20/1997	4001997019
1999	HARRIS	10/23/1998	4001998007
1999	HARRIS	1/14/1999	4001999002
1999	HARRIS	3/12/1999	4001999004
2000	HARRIS	12/14/1999	4001999009
2000	HARRIS	6/20/2000	4002000005
2002	HARRIS	7/13/2002	4002002002
2002	HARRIS	8/15/2002	4002002003
1989	Indian Point 2	11/22/1988	2471988018
1989	Indian Point 2	11/26/1988	2471988019
1989	Indian Point 2	3/5/1989	2471989003
1990	Indian Point 2	12/13/1989	2471989013
1991	Indian Point 2	1/7/1991	2471991001
1991	Indian Point 2	7/25/1991	2471991013

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1992	Indian Point 2	1/27/1992	2471992002
1992	Indian Point 2	4/13/1992	2471992007
1992	Indian Point 2	9/26/1992	2471992018
1995	Indian Point 2	1/17/1995	2471995001
1995	Indian Point 2	1/19/1995	2471995001
1995	Indian Point 2	6/12/1995	2471995016
1996	Indian Point 2	3/5/1996	2471996003
1996	Indian Point 2	5/23/1996	2471996012
1997	Indian Point 2	1/16/1997	2471997001
1997	Indian Point 2	5/1/1997	2471997010
1997	Indian Point 2	7/26/1997	2471997018
1999	Indian Point 2	8/31/1999	2471999015
2000	Indian Point 2	2/15/2000	2472000001
2001	Indian Point 2	1/2/2001	2472001001
1987	Indian Point 3	1/31/1987	2861987001
1988	Indian Point 3	12/22/1987	2861987012
1988	Indian Point 3	2/1/1988	2861988001
1988	Indian Point 3	3/31/1988	2861988002
1988	Indian Point 3	6/12/1988	2861988005
1989	Indian Point 3	10/9/1988	2861988006
1989	Indian Point 3	2/4/1989	2861989001
1990	Indian Point 3	10/19/1989	2861989015
1990	Indian Point 3	6/29/1990	2861990004
1991	Indian Point 3	12/27/1990	2861991003
1991	Indian Point 3	3/20/1991	2861991004
1991	Indian Point 3	3/22/1991	2861991005
1992	Indian Point 3	9/3/1992	2861992013
1992	Indian Point 3	9/15/1992	2861992015
1995	Indian Point 3	7/6/1995	2861995012
1995	Indian Point 3	9/14/1995	2861995018
1997	Indian Point 3	10/9/1996	2861996015
1997	Indian Point 3	1/2/1997	2861997001
1997	Indian Point 3	9/9/1997	2861997023
1997	Indian Point 3	9/15/1997	2861997025
1998	Indian Point 3	5/28/1998	2861998003
1998	Indian Point 3	8/30/1998	2861998006
1999	Indian Point 3	3/9/1999	2861999003
1999	Indian Point 3	8/12/1999	2861999010
2000	Indian Point 3	4/19/2000	2862000003
2000	Indian Point 3	6/4/2000	2862000007
2000	Indian Point 3	6/9/2000	2862000008
1987	Kewaunee	4/3/1987	3051987005
1987	Kewaunee	6/26/1987	3051987008
1987	Kewaunee	7/10/1987	3051987009
1988	Kewaunee	3/2/1988	3051988001
1988	Kewaunee	4/12/1988	3051988004
1988	Kewaunee	5/2/1988	3051988006
1988	Kewaunee	9/1/1988	3051988012
1990	Kewaunee	12/27/1989	3051989016
1992	Kewaunee	10/12/1991	3051991010
1992	Kewaunee	9/15/1992	3051992017
1993	Kewaunee	1/28/1993	3051993001
1993	Kewaunee	6/4/1993	3051993013

FY	Plant	Date	LER
1995	Kewaunee	9/5/1995	3051995005
1996	Kewaunee	3/31/1996	3051996002
1996	Kewaunee	4/2/1996	3051996003
1998	Kewaunee	2/24/1998	3051998005
1987	Maine Yankee	6/27/1987	3091987006
1988	Maine Yankee	1/5/1988	3091988001
1988	Maine Yankee	8/13/1988	3091988006
1989	Maine Yankee	1/10/1989	3091989001
1989	Maine Yankee	4/5/1989	3091989003
1991	Maine Yankee	4/29/1991	3091991005
1991	Maine Yankee	5/30/1991	3091991006
1992	Maine Yankee	10/5/1991	3091991010
1992	Maine Yankee	11/22/1991	3091991012
1992	Maine Yankee	2/8/1992	3091992001
1994	Maine Yankee	5/18/1994	3091994008
1995	Maine Yankee	1/14/1995	3091995001
1987	McGuire 1	4/15/1987	3691987009
1987	McGuire 1	8/16/1987	3691987017
1987	McGuire 1	9/4/1987	3691987019
1988	McGuire 1	11/20/1987	3691987028
1988	McGuire 1	12/28/1987	3691987036
1988	McGuire 1	1/7/1988	3691988001
1988	McGuire 1	3/23/1988	3691988005
1988	McGuire 1	4/16/1988	3691988007
1988	McGuire 1	6/20/1988	3691988013
1988	McGuire 1	6/26/1988	3691988015
1989	McGuire 1	12/10/1988	3691988042
1989	McGuire 1	8/26/1989	3691989022
1990	McGuire 1	1/8/1990	3691990001
1991	McGuire 1	10/13/1990	3691990027
1991	McGuire 1	11/17/1990	3691990032
1991	McGuire 1	2/11/1991	3691991001
1991	McGuire 1	2/19/1991	3691991004
1992	McGuire 1	7/26/1992	3691992008
1992	McGuire 1	6/25/1992	3691992009
1994	McGuire 1	5/12/1994	3691994004
1995	McGuire 1	1/29/1995	3691995001
1995	McGuire 1	9/27/1995	3691995005
1996	McGuire 1	10/1/1995	3691995006
1996	McGuire 1	2/3/1996	3691996001
1997	McGuire 1	11/9/1996	3691996006
1997	McGuire 1	5/12/1997	3691997006
1997	McGuire 1	9/6/1997	3691997009
1998	McGuire 1	2/9/1998	3691998002
2000	McGuire 1	5/25/2000	3692000004
2002	McGuire 1	3/4/2002	3692002001
1987	McGuire 2	1/20/1987	3701987003
1987	McGuire 2	9/6/1987	3701987016
1988	McGuire 2	11/5/1987	3701987019
1988	McGuire 2	11/30/1987	3701987021
1988	McGuire 2	1/12/1988	3701988001
1988	McGuire 2	7/31/1988	3701988008
1989	McGuire 2	3/3/1989	3701989001

FY	Plant	Date	LER
1989	McGuire 2	3/14/1989	3701989002
1989	McGuire 2	4/6/1989	3701989003
1991	McGuire 2	7/12/1991	3701991007
1991	McGuire 2	9/25/1991	3701991010
1992	McGuire 2	10/4/1991	3701991011
1992	McGuire 2	11/8/1991	3701991012
1992	McGuire 2	3/21/1992	3701992004
1992	McGuire 2	4/9/1992	3701992006
1992	McGuire 2	5/20/1992	3701992007
1992	McGuire 2	8/5/1992	3701992009
1992	McGuire 2	8/24/1992	3701992010
1993	McGuire 2	2/22/1993	3701993001
1993	McGuire 2	3/9/1993	3701993002
1994	McGuire 2	12/27/1993	3701993008
1996	McGuire 2	12/16/1995	3701995004
1996	McGuire 2	5/22/1996	3701996003
1997	McGuire 2	5/27/1997	3701997001
1997	McGuire 2	7/11/1997	3701997002
1998	McGuire 2	2/22/1998	3701998001
1999	McGuire 2	6/16/1999	3701999003
1999	McGuire 2	7/15/1999	3701999004
2001	McGuire 2	10/10/2000	3702000001
2001	McGuire 2	11/15/2000	3702000002
2001	McGuire 2	7/18/2001	3702001001
2002	McGuire 2	8/22/2002	3702002002
1987	Millstone 2	9/2/1987	3361987009
1988	Millstone 2	11/16/1987	3361987012
1992	Millstone 2	11/6/1991	3361991012
1993	Millstone 2	5/24/1993	3361993012
1993	Millstone 2	8/12/1993	3361993019
1995	Millstone 2	8/8/1995	3361995002
2000	Millstone 2	1/27/2000	3362000001
2000	Millstone 2	2/11/2000	3362000003
2001	Millstone 2	4/29/2001	3362001003
2002	Millstone 2	4/19/2002	3362002002
1987	Millstone 3	1/13/1987	4231987001
1987	Millstone 3	3/7/1987	4231987008
1987	Millstone 3	4/12/1987	4231987020
1987	Millstone 3	4/12/1987	4231987021
1987	Millstone 3	5/7/1987	4231987025
1987	Millstone 3	5/14/1987	4231987026
1987	Millstone 3	6/5/1987	4231987027
1987	Millstone 3	6/14/1987	4231987031
1987	Millstone 3	9/23/1987	4231987034
1988	Millstone 3	2/10/1988	4231988009
1989	Millstone 3	10/5/1988	4231988023
1989	Millstone 3	10/22/1988	4231988024
1989	Millstone 3	12/29/1988	4231988028
1989	Millstone 3	5/6/1989	4231989008
1989	Millstone 3	5/11/1989	4231989009
1990	Millstone 3	1/18/1990	4231990005
1990	Millstone 3	3/9/1990	4231990009
1990	Millstone 3	3/30/1990	4231990011

FY	Plant	Date	LER
1990	Millstone 3	4/16/1990	4231990013
1990	Millstone 3	5/19/1990	4231990014
1990	Millstone 3	6/6/1990	4231990019
1991	Millstone 3	12/31/1990	4231990030
1991	Millstone 3	6/9/1991	4231991014
1992	Millstone 3	4/5/1992	4231992011
1993	Millstone 3	11/20/1992	4231992029
1993	Millstone 3	3/31/1993	4231993004
1994	Millstone 3	9/8/1994	4231994011
1995	Millstone 3	4/16/1995	4231995022
1998	Millstone 3	4/11/1998	4231998023
1998	Millstone 3	6/10/1998	4231998033
1999	Millstone 3	11/11/1998	4231998044
1999	Millstone 3	12/11/1998	4231998045
1987	North Anna 1	4/19/1987	3381987004
1987	North Anna 1	7/15/1987	3381987017
1988	North Anna 1	11/23/1987	3381987020
1988	North Anna 1	1/8/1988	3381988002
1988	North Anna 1	1/13/1988	3381988005
1988	North Anna 1	8/6/1988	3381988020
1989	North Anna 1	2/25/1989	3381989005
1990	North Anna 1	12/5/1989	3381989017
1994	North Anna 1	9/9/1994	3381994005
1995	North Anna 1	1/27/1995	3381995001
1996	North Anna 1	8/27/1996	3381996005
1997	North Anna 1	10/24/1996	3381996010
2000	North Anna 1	5/7/2000	3382000004
1990	North Anna 2	8/21/1990	3391990003
1991	North Anna 2	11/2/1990	3391990010
1991	North Anna 2	9/20/1991	3391991009
1992	North Anna 2	1/29/1992	3391992001
1992	North Anna 2	8/6/1992	3391992007
1993	North Anna 2	4/16/1993	3391993002
1993	North Anna 2	4/24/1993	3391993003
1994	North Anna 2	1/22/1994	3391994003
1996	North Anna 2	11/11/1995	3391995004
1997	North Anna 2	11/12/1996	3391996003
1998	North Anna 2	9/17/1998	3391998004
2000	North Anna 2	12/2/1999	3391999004
2000	North Anna 2	4/3/2000	3392000001
2002	North Anna 2	12/22/2001	3392001005
1988	Oconee 1	7/5/1988	2691988009
1989	Oconee 1	1/2/1989	2691989001
1989	Oconee 1	1/3/1989	2691989002
1992	Oconee 1	10/2/1991	2691991011
1992	Oconee 1	5/8/1992	2691992004
1993	Oconee 1	10/3/1992	2691992015
1993	Oconee 1	8/23/1993	2691993008
1994	Oconee 1	11/3/1993	2691993010
1994	Oconee 1	2/26/1994	2691994002
1996	Oconee 1	2/28/1996	2691996004
1997	Oconee 1	7/1/1997	2691997008
1999	Oconee 1	7/7/1999	2691999005

FY	Plant	Date	LER
2001	Oconee 1	9/12/2001	2692001002
1987	Oconee 2	4/20/1987	2701987004
1989	Oconee 2	4/3/1989	2701989004
1990	Oconee 2	9/13/1990	2701990001
1993	Oconee 2	10/19/1992	2701992004
1993	Oconee 2	4/29/1993	2701993001
1994	Oconee 2	4/6/1994	2701994002
1995	Oconee 2	12/8/1994	2701994005
1999	Oconee 2	11/3/1998	2701998007
1991	Oconee 3	7/3/1991	2871991007
1992	Oconee 3	1/14/1992	2871992001
1992	Oconee 3	6/24/1992	2871992003
1993	Oconee 3	1/26/1993	2871993001
1994	Oconee 3	8/10/1994	2871994002
1996	Oconee 3	3/16/1996	2871996001
1987	Palisades	3/25/1987	2551987009
1987	Palisades	7/14/1987	2551987024
1987	Palisades	8/23/1987	2551987027
1989	Palisades	8/4/1989	2551989020
1990	Palisades	1/9/1990	2551990001
1990	Palisades	2/28/1990	2551990002
1991	Palisades	7/3/1991	2551991012
1992	Palisades	7/1/1992	2551992034
1992	Palisades	7/24/1992	2551992035
1992	Palisades	8/14/1992	2551992037
1992	Palisades	8/25/1992	2551992038
1993	Palisades	10/30/1992	2551992039
1995	Palisades	8/15/1995	2551995010
1998	Palisades	7/21/1998	2551998010
2000	Palisades	4/4/2000	2552000003
1987	Palo Verde 1	1/10/1987	5281987003
1988	Palo Verde 1	8/27/1988	5281988024
1990	Palo Verde 1	6/20/1990	5281990008
1991	Palo Verde 1	9/14/1991	5281991009
1992	Palo Verde 1	10/27/1991	5281991010
1992	Palo Verde 1	5/6/1992	5281992007
1995	Palo Verde 1	5/30/1995	5281995008
1998	Palo Verde 1	2/22/1998	5281998002
1987	Palo Verde 2	7/22/1987	5291987008
1987	Palo Verde 2	6/4/1987	5291987010
1988	Palo Verde 2	7/26/1988	5291988006
1989	Palo Verde 2	11/16/1988	5291988014
1989	Palo Verde 2	1/3/1989	5291989001
1989	Palo Verde 2	2/16/1989	5291989003
1992	Palo Verde 2	1/9/1992	5291992001
1992	Palo Verde 2	3/23/1992	5291992002
1993	Palo Verde 2	11/13/1992	5291992006
1993	Palo Verde 2	3/14/1993	5291993001
1994	Palo Verde 2	11/1/1993	5291993004
1995	Palo Verde 2	7/17/1995	5291995005
1996	Palo Verde 2	1/21/1996	5291996001
1997	Palo Verde 2	9/23/1997	5291997005
2000	Palo Verde 2	8/26/2000	5292000001

FY	Plant	Date	LER
1989	Palo Verde 3	3/3/1989	5301989001
1991	Palo Verde 3	6/19/1991	5301991003
1991	Palo Verde 3	8/24/1991	5301991006
1992	Palo Verde 3	11/15/1991	5301991010
1993	Palo Verde 3	2/4/1993	5301993001
1994	Palo Verde 3	8/19/1994	5301994005
1994	Palo Verde 3	8/30/1994	5301994007
1989	Point Beach 1	5/5/1989	2661989006
1991	Point Beach 1	6/29/1991	2661991008
1993	Point Beach 1	10/5/1992	2661992008
1995	Point Beach 1	7/14/1995	2661995006
1996	Point Beach 1	4/5/1996	2661996001
2000	Point Beach 1	11/8/1999	2661999013
2000	Point Beach 1	1/21/2000	2662000001
2001	Point Beach 1	10/27/2000	2662000010
1987	Point Beach 2	8/16/1987	3011987002
1988	Point Beach 2	4/7/1988	3011988001
1989	Point Beach 2	3/29/1989	3011989002
1989	Point Beach 2	8/20/1989	3011989004
1992	Point Beach 2	12/17/1991	3011991006
1993	Point Beach 2	3/28/1993	3011993002
1996	Point Beach 2	5/18/1996	3011996001
2001	Point Beach 2	6/27/2001	3012001002
1989	Prairie Island 1	7/21/1989	2821989010
1989	Prairie Island 1	5/22/1989	2821990017
1993	Prairie Island 1	2/18/1993	2821993005
1996	Prairie Island 1	6/30/1996	2821996012
1997	Prairie Island 1	6/2/1997	2821997008
1998	Prairie Island 1	6/5/1998	2821998008
1999	Prairie Island 1	10/29/1998	2821998016
1999	Prairie Island 1	1/5/1999	2821999001
1999	Prairie Island 1	1/8/1999	2821999002
2001	Prairie Island 1	8/1/2001	2822001004
2001	Prairie Island 1	8/3/2001	2822001005
1989	Prairie Island 2	5/26/1989	3061989002
1990	Prairie Island 2	12/21/1989	3061989004
1990	Prairie Island 2	3/8/1990	3061990001
1990	Prairie Island 2	3/16/1990	3061990003
1991	Prairie Island 2	12/29/1990	3061990012
1992	Prairie Island 2	2/19/1992	3061992001
1994	Prairie Island 2	7/21/1994	3061994002
1996	Prairie Island 2	3/19/1996	3061996001
1996	Prairie Island 2	4/18/1996	3061996002
1997	Prairie Island 2	5/17/1997	3061997003
1987	Robinson 2	6/15/1987	2611987018
1987	Robinson 2	7/10/1987	2611987020
1987	Robinson 2	7/16/1987	2611987020
1988	Robinson 2	1/19/1988	2611988001
1988	Robinson 2	5/2/1988	2611988010
1989	Robinson 2	3/22/1989	2611989005
1989	Robinson 2	3/30/1989	2611989006
1990	Robinson 2	1/17/1990	2611990002
1990	Robinson 2	5/17/1990	2611990007

FY	Plant	Date	LER
1991	Robinson 2	8/30/1991	2611991011
1992	Robinson 2	8/22/1992	2611992017
1994	Robinson 2	4/3/1994	2611994006
1994	Robinson 2	8/2/1994	2611994016
1995	Robinson 2	6/30/1995	2611995004
1997	Robinson 2	10/20/1996	2611996007
1998	Robinson 2	11/16/1997	2611997011
1998	Robinson 2	4/25/1998	2611998003
1999	Robinson 2	10/17/1998	2611998005
2000	Robinson 2	6/21/2000	2612000001
1988	Salem 1	3/30/1988	2721988009
1989	Salem 1	2/6/1989	2721989007
1989	Salem 1	6/19/1989	2721989027
1990	Salem 1	4/9/1990	2721990012
1990	Salem 1	9/10/1990	2721990030
1991	Salem 1	6/16/1991	2721991024
1991	Salem 1	8/15/1991	2721994011
1993	Salem 1	7/19/1993	2721993013
1994	Salem 1	1/27/1994	2721994003
1994	Salem 1	2/10/1994	2721994005
1994	Salem 1	4/7/1994	2721994006
1994	Salem 1	6/10/1994	2721994009
1998	Salem 1	2/21/1998	2721998006
1999	Salem 1	5/20/1999	2721999004
2000	Salem 1	1/6/2000	2722000001
2000	Salem 1	4/11/2000	2722000002
2001	Salem 1	12/8/2000	2722000005
1988	Salem 2	6/22/1988	3111988014
1988	Salem 2	8/31/1988	3111988017
1989	Salem 2	11/28/1988	3111988024
1989	Salem 2	2/5/1989	3111989003
1989	Salem 2	3/12/1989	3111989005
1989	Salem 2	4/11/1989	3111989008
1990	Salem 2	6/28/1990	3111990029
1992	Salem 2	11/9/1991	3111991017
1992	Salem 2	5/14/1992	3111992009
1992	Salem 2	9/3/1992	3111992014
1993	Salem 2	1/28/1993	3111993002
1993	Salem 2	3/16/1993	3111993005
1993	Salem 2	6/22/1993	3111993009
1994	Salem 2	1/27/1994	3111994003
1994	Salem 2	6/29/1994	3111994008
1995	Salem 2	6/7/1995	3111995004
1998	Salem 2	10/2/1997	3111997014
2002	Salem 2	12/31/2001	3112001008
1987	San Onofre 2	2/5/1987	3611987001
1987	San Onofre 2	3/28/1987	3611987004
1988	San Onofre 2	12/17/1987	3611987031
1991	San Onofre 2	12/6/1990	3611990016
1991	San Onofre 2	4/10/1991	3611991007
1992	San Onofre 2	4/24/1992	3611992008
1992	San Onofre 2	7/31/1992	3611992012
1987	San Onofre 3	6/21/1987	3621987011

FY	Plant	Date	LER
1988	San Onofre 3	10/11/1987	3621987017
1989	San Onofre 3	1/6/1989	3621989001
1989	San Onofre 3	4/7/1989	3621989006
1990	San Onofre 3	2/23/1990	3621990002
1991	San Onofre 3	3/15/1991	3621991001
1992	San Onofre 3	5/15/1992	3621992003
1992	San Onofre 3	7/20/1992	3621992004
1993	San Onofre 3	7/5/1993	3621993004
1999	San Onofre 3	5/13/1999	3621999003
2002	San Onofre 3	2/27/2002	3622002001
1990	Seabrook	6/20/1990	4431990015
1990	Seabrook	7/5/1990	4431990018
1990	Seabrook	8/22/1990	4431990022
1991	Seabrook	11/9/1990	4431990025
1991	Seabrook	2/12/1991	4431991001
1991	Seabrook	3/30/1991	4431991002
1991	Seabrook	6/27/1991	4431991008
1991	Seabrook	7/4/1991	4431991009
1992	Seabrook	9/7/1992	4431992017
1993	Seabrook	11/27/1992	4431992024
1993	Seabrook	12/13/1992	4431992025
1993	Seabrook	1/14/1993	4431993003
1993	Seabrook	5/20/1993	4431993009
1993	Seabrook	7/27/1993	4431993012
1993	Seabrook	9/22/1993	4431993018
1994	Seabrook	1/25/1994	4431994001
1996	Seabrook	1/27/1996	4431996001
1999	Seabrook	12/22/1998	4431998014
2000	Seabrook	6/26/2000	4432000004
2001	Seabrook	3/5/2001	4432001002
1989	Sequoyah 1	11/18/1988	3271988045
1989	Sequoyah 1	12/25/1988	3271988047
1989	Sequoyah 1	2/10/1989	3271989005
1990	Sequoyah 1	12/10/1989	3271989035
1990	Sequoyah 1	6/2/1990	3271990012
1990	Sequoyah 1	9/14/1990	3271990021
1990	Sequoyah 1	9/19/1990	3271990022
1991	Sequoyah 1	11/15/1990	3271990030
1992	Sequoyah 1	4/28/1992	3271992010
1992	Sequoyah 1	5/16/1992	3271992012
1993	Sequoyah 1	10/26/1992	3271992018
1993	Sequoyah 1	12/31/1992	3271992027
1994	Sequoyah 1	7/15/1994	3271994011
1995	Sequoyah 1	11/29/1994	3271994014
1995	Sequoyah 1	6/23/1995	3271995008
1996	Sequoyah 1	6/23/1996	3271996006
1997	Sequoyah 1	11/16/1996	3271996010
1997	Sequoyah 1	8/1/1997	3271997012
1998	Sequoyah 1	5/19/1998	3271998001
1999	Sequoyah 1	11/9/1998	3271998003
2000	Sequoyah 1	3/21/2000	3272000003
2000	Sequoyah 1	9/25/2000	3272000004
2002	Sequoyah 1	7/12/2002	3272002004

FY	Plant	Date	LER
1988	Sequoyah 2	3/20/1988	3281988014
1988	Sequoyah 2	5/19/1988	3281988023
1988	Sequoyah 2	5/23/1988	3281988024
1988	Sequoyah 2	6/6/1988	3281988027
1988	Sequoyah 2	6/8/1988	3281988028
1988	Sequoyah 2	6/9/1988	3281988028
1989	Sequoyah 2	4/19/1989	3281989005
1989	Sequoyah 2	7/10/1989	3281989008
1990	Sequoyah 2	4/10/1990	3281990008
1991	Sequoyah 2	11/23/1990	3281990017
1991	Sequoyah 2	1/3/1991	3281991001
1992	Sequoyah 2	11/7/1991	3281991006
1992	Sequoyah 2	2/10/1992	3281992001
1992	Sequoyah 2	6/27/1992	3281992008
1992	Sequoyah 2	8/21/1992	3281992011
1992	Sequoyah 2	9/4/1992	3281992012
1993	Sequoyah 2	12/8/1992	3281992015
1995	Sequoyah 2	1/5/1995	3281995001
1995	Sequoyah 2	4/28/1995	3281995002
1995	Sequoyah 2	5/31/1995	3281995003
1996	Sequoyah 2	12/21/1995	3281995007
1996	Sequoyah 2	4/18/1996	3281996001
1997	Sequoyah 2	10/11/1996	3281996005
1997	Sequoyah 2	12/6/1996	3281996006
1997	Sequoyah 2	12/7/1996	3281996007
1998	Sequoyah 2	8/27/1998	3281998001
1999	Sequoyah 2	10/16/1998	3281998002
2000	Sequoyah 2	1/18/2000	3282000001
2001	Sequoyah 2	11/17/2000	3282000004
1988	South Texas 1	2/28/1988	4981988022
1988	South Texas 1	7/19/1988	4981988045
1988	South Texas 1	8/16/1988	4981988048
1988	South Texas 1	8/26/1988	4981988049
1989	South Texas 1	1/3/1989	4981989001
1989	South Texas 1	7/4/1989	4981989015
1990	South Texas 1	3/29/1990	4981990005
1990	South Texas 1	7/30/1990	4981990006
1990	South Texas 1	6/20/1990	4981990014
1990	South Texas 1	6/28/1990	4981990015
1990	South Texas 1	7/2/1990	4981990016
1990	South Texas 1	7/16/1990	4981990020
1990	South Texas 1	9/29/1990	4981990023
1991	South Texas 1	11/24/1990	4981990025
1991	South Texas 1	4/12/1991	4981991012
1992	South Texas 1	10/10/1991	4981991021
1992	South Texas 1	10/14/1991	4981991022
1992	South Texas 1	3/14/1992	4981992003
1994	South Texas 1	2/28/1994	4981994009
1994	South Texas 1	9/20/1994	4981994015
1995	South Texas 1	1/24/1995	4981995001
1995	South Texas 1	8/29/1995	4981995009
1996	South Texas 1	12/18/1995	4981995013
1998	South Texas 1	11/10/1997	4981997012

FY	Plant	Date	LER
1999	South Texas 1	5/16/1999	4981999004
1999	South Texas 1	6/27/1999	4981999006
1999	South Texas 1	9/12/1999	4981999008
2001	South Texas 1	12/16/2000	4982000007
1989	South Texas 2	4/5/1989	4991989009
1989	South Texas 2	4/10/1989	4991989011
1989	South Texas 2	4/15/1989	4991989013
1989	South Texas 2	6/2/1989	4991989016
1989	South Texas 2	7/13/1989	4991989017
1989	South Texas 2	8/23/1989	4991989019
1989	South Texas 2	8/29/1989	4991989020
1989	South Texas 2	9/5/1989	4991989021
1989	South Texas 2	9/19/1989	4991989022
1989	South Texas 2	9/22/1989	4991989023
1990	South Texas 2	10/13/1989	4991989026
1990	South Texas 2	2/2/1990	4991990002
1990	South Texas 2	3/26/1990	4991990004
1990	South Texas 2	4/14/1990	4991990005
1990	South Texas 2	7/13/1990	4991990012
1990	South Texas 2	9/17/1990	4991990013
1991	South Texas 2	1/9/1991	4991991001
1991	South Texas 2	3/14/1991	4991991003
1991	South Texas 2	3/30/1991	4991991004
1992	South Texas 2	12/24/1991	4991991010
1992	South Texas 2	1/22/1992	4991992001
1992	South Texas 2	2/24/1992	4991992003
1993	South Texas 2	12/27/1992	4991992010
1993	South Texas 2	1/23/1993	4991993001
1993	South Texas 2	2/3/1993	4991993004
1994	South Texas 2	6/25/1994	4991994007
1995	South Texas 2	3/28/1995	4991995003
1996	South Texas 2	11/15/1995	4991995008
1997	South Texas 2	3/19/1997	4991997004
1997	South Texas 2	3/26/1997	4991997005
1997	South Texas 2	4/30/1997	4991997006
1998	South Texas 2	11/21/1997	4991997007
1998	South Texas 2	9/22/1998	4991998002
1999	South Texas 2	1/21/1999	4991999002
1999	South Texas 2	3/12/1999	4991999003
2000	South Texas 2	2/9/2000	4992000001
2001	South Texas 2	2/7/2001	4992001001
2001	South Texas 2	3/1/2001	4992001002
2001	South Texas 2	5/8/2001	4992001004
2002	South Texas 2	6/14/2002	4992002002
1987	St. Lucie 1	2/7/1987	3351987002
1987	St. Lucie 1	5/21/1987	3351987011
1987	St. Lucie 1	6/14/1987	3351987013
1988	St. Lucie 1	10/29/1987	3351987016
1988	St. Lucie 1	12/21/1987	3351987017
1988	St. Lucie 1	3/28/1988	3351988003
1988	St. Lucie 1	6/30/1988	3351988004
1988	St. Lucie 1	9/20/1988	3351988008
1989	St. Lucie 1	7/17/1989	3351989003

FY	Plant	Date	LER
1989	St. Lucie 1	9/13/1989	3351989005
1990	St. Lucie 1	5/24/1990	3351990007
1991	St. Lucie 1	5/6/1991	3351991003
1991	St. Lucie 1	7/1/1991	3351991005
1991	St. Lucie 1	9/18/1991	3351991006
1992	St. Lucie 1	9/24/1992	3351992006
1994	St. Lucie 1	1/9/1994	3351994001
1994	St. Lucie 1	3/28/1994	3351994003
1994	St. Lucie 1	4/3/1994	3351994004
1996	St. Lucie 1	11/16/1995	3351995010
1996	St. Lucie 1	2/22/1996	3351996002
1997	St. Lucie 1	3/4/1997	3351997003
1998	St. Lucie 1	1/4/1998	3351998001
1998	St. Lucie 1	1/10/1998	3351998003
1999	St. Lucie 1	8/23/1999	3351999003
2000	St. Lucie 1	10/29/1999	3351999006
2001	St. Lucie 1	6/5/2001	3352001007
1987	St. Lucie 2	3/3/1987	3891987001
1987	St. Lucie 2	3/5/1987	3891987002
1987	St. Lucie 2	4/9/1987	3891987003
1987	St. Lucie 2	4/22/1987	3891987004
1988	St. Lucie 2	11/25/1987	3891987007
1989	St. Lucie 2	9/23/1989	3891989007
1990	St. Lucie 2	1/14/1990	3891990001
1992	St. Lucie 2	7/8/1992	3891992004
1992	St. Lucie 2	7/10/1992	3891992005
1992	St. Lucie 2	8/10/1992	3891992006
1995	St. Lucie 2	2/21/1995	3891995002
1996	St. Lucie 2	1/5/1996	3891996001
1996	St. Lucie 2	6/6/1996	3891996002
1998	St. Lucie 2	9/18/1998	3891998006
1987	Summer	6/16/1987	3951987015
1987	Summer	9/2/1987	3951987021
1988	Summer	10/29/1987	3951987027
1988	Summer	2/16/1988	3951988002
1988	Summer	5/12/1988	3951988006
1988	Summer	6/1/1988	3951988007
1988	Summer	7/26/1988	3951988009
1989	Summer	5/28/1989	3951989011
1989	Summer	7/11/1989	3951989012
1989	Summer	8/25/1989	3951989015
1990	Summer	12/2/1989	3951989020
1993	Summer	1/12/1993	3951993001
1997	Summer	4/26/1997	3951997002
1999	Summer	5/18/1999	3951999008
2002	Summer	6/17/2002	3952002004
1987	Surry 1	9/20/1987	2801987024
1988	Surry 1	2/16/1988	2801988003
1988	Surry 1	8/15/1988	2801988029
1990	Surry 1	5/22/1990	2801990004
1990	Surry 1	7/1/1990	2801990006
1992	Surry 1	1/2/1992	2801992001
1992	Surry 1	5/7/1992	2801992007

FY	Plant	Date	LER
1993	Surry 1	1/8/1993	2801993001
1993	Surry 1	2/9/1993	2801993002
1994	Surry 1	5/11/1994	2801994006
1995	Surry 1	1/8/1995	2801995001
1995	Surry 1	4/12/1995	2801995003
1997	Surry 1	2/19/1997	2801997003
1998	Surry 1	2/2/1998	2801998002
1999	Surry 1	11/22/1998	2801998013
1999	Surry 1	11/26/1998	2801998014
2001	Surry 1	10/24/2000	2802000004
1988	Surry 2	3/27/1988	2811988004
1988	Surry 2	5/16/1988	2811988010
1989	Surry 2	9/19/1989	2811989010
1990	Surry 2	5/31/1990	2811990003
1990	Surry 2	8/27/1990	2811990004
1992	Surry 2	12/17/1991	2811991011
1993	Surry 2	6/23/1993	2811993002
1993	Surry 2	8/3/1993	2811993003
1993	Surry 2	8/23/1993	2811993004
1993	Surry 2	8/27/1993	2811993005
1994	Surry 2	11/15/1993	2811993006
1995	Surry 2	5/11/1995	2811995004
1995	Surry 2	5/21/1995	2811995005
1995	Surry 2	6/14/1995	2811995006
1996	Surry 2	11/7/1995	2811995007
1996	Surry 2	6/6/1996	2811996004
1996	Surry 2	8/3/1996	2811996005
1997	Surry 2	12/13/1996	2811996006
1997	Surry 2	2/18/1997	2811997001
1998	Surry 2	12/2/1997	2811997004
1999	Surry 2	7/5/1999	2811999003
1988	Three Mile Isl 1	8/13/1988	2891988004
1991	Three Mile Isl 1	9/27/1991	2891991003
1993	Three Mile Isl 1	3/12/1993	2891993003
1997	Three Mile Isl 1	6/21/1997	2891997007
1987	Turkey Point 3	1/4/1987	2501987001
1988	Turkey Point 3	3/18/1988	2501988004
1989	Turkey Point 3	2/15/1989	2501989005
1990	Turkey Point 3	12/23/1989	2501989020
1990	Turkey Point 3	6/9/1990	2501990011
1995	Turkey Point 3	12/6/1994	2501994006
1996	Turkey Point 3	10/17/1995	2501995007
1996	Turkey Point 3	2/9/1996	2501996002
1996	Turkey Point 3	3/27/1996	2501996006
1997	Turkey Point 3	4/11/1997	2501997004
1997	Turkey Point 3	7/22/1997	2501997006
1997	Turkey Point 3	7/30/1997	2501997007
1998	Turkey Point 3	2/16/1998	2501998001
1987	Turkey Point 4	1/6/1987	2511987001
1988	Turkey Point 4	8/16/1988	2511988009
1988	Turkey Point 4	8/19/1988	2511988010
1989	Turkey Point 4	9/15/1989	2511989011
1990	Turkey Point 4	4/9/1990	2511990003

FY	Plant	Date	LER
1990	Turkey Point 4	8/12/1990	2511990008
1992	Turkey Point 4	10/29/1991	2511991006
1992	Turkey Point 4	9/29/1992	2511992007
1993	Turkey Point 4	8/16/1993	2511993003
1994	Turkey Point 4	9/23/1994	2511994004
1995	Turkey Point 4	11/30/1994	2511994006
2001	Turkey Point 4	10/21/2000	2512000004
1987	Vogtle 1	3/20/1987	4241987009
1987	Vogtle 1	3/23/1987	4241987009
1987	Vogtle 1	3/25/1987	4241987009
1987	Vogtle 1	3/26/1987	4241987009
1987	Vogtle 1	3/21/1987	4241987010
1987	Vogtle 1	3/24/1987	4241987010
1987	Vogtle 1	3/26/1987	4241987011
1987	Vogtle 1	4/5/1987	4241987012
1987	Vogtle 1	4/10/1987	4241987013
1987	Vogtle 1	4/11/1987	4241987014
1987	Vogtle 1	4/13/1987	4241987015
1987	Vogtle 1	4/29/1987	4241987018
1987	Vogtle 1	5/4/1987	4241987018
1987	Vogtle 1	5/9/1987	4241987025
1987	Vogtle 1	5/10/1987	4241987026
1987	Vogtle 1	5/13/1987	4241987027
1987	Vogtle 1	5/24/1987	4241987029
1987	Vogtle 1	6/3/1987	4241987030
1987	Vogtle 1	6/7/1987	4241987033
1987	Vogtle 1	6/7/1987	4241987034
1987	Vogtle 1	6/14/1987	4241987035
1987	Vogtle 1	6/23/1987	4241987041
1987	Vogtle 1	7/8/1987	4241987047
1987	Vogtle 1	7/22/1987	4241987047
1987	Vogtle 1	7/28/1987	4241987050
1988	Vogtle 1	11/5/1987	4241987063
1988	Vogtle 1	11/11/1987	4241987066
1988	Vogtle 1	1/17/1988	4241988001
1988	Vogtle 1	2/15/1988	4241988006
1988	Vogtle 1	4/7/1988	4241988008
1988	Vogtle 1	4/24/1988	4241988013
1988	Vogtle 1	7/14/1988	4241988022
1988	Vogtle 1	7/30/1988	4241988024
1988	Vogtle 1	7/31/1988	4241988025
1989	Vogtle 1	12/15/1988	4241988043
1989	Vogtle 1	12/17/1988	4241988044
1989	Vogtle 1	2/10/1989	4241989005
1989	Vogtle 1	5/9/1989	4241989012
1989	Vogtle 1	7/8/1989	4241989016
1989	Vogtle 1	8/3/1989	4241989016
1990	Vogtle 1	10/2/1989	4241989018
1990	Vogtle 1	1/24/1990	4241990001
1990	Vogtle 1	4/25/1990	4241990011
1990	Vogtle 1	7/23/1990	4241990016
1991	Vogtle 1	12/18/1990	4241990023
1992	Vogtle 1	9/14/1992	4241992008

FY	Plant	Date	LER
1993	Vogtle 1	5/3/1993	4241993008
1993	Vogtle 1	7/28/1993	4241993009
1994	Vogtle 1	3/11/1994	4241994002
1995	Vogtle 1	7/23/1995	4241995002
1996	Vogtle 1	5/25/1996	4241996006
1997	Vogtle 1	11/27/1996	4241996012
1997	Vogtle 1	8/4/1997	4241997005
2000	Vogtle 1	6/5/2000	4242000002
2001	Vogtle 1	12/9/2000	4242000004
2002	Vogtle 1	4/20/2002	4242002003
1989	Vogtle 2	4/22/1989	4251989018
1989	Vogtle 2	5/2/1989	4251989019
1989	Vogtle 2	5/12/1989	4251989020
1989	Vogtle 2	5/22/1989	4251989021
1989	Vogtle 2	7/20/1989	4251989023
1989	Vogtle 2	7/26/1989	4251989024
1990	Vogtle 2	10/11/1989	4251989027
1990	Vogtle 2	11/5/1989	4251989029
1990	Vogtle 2	12/2/1989	4251989031
1990	Vogtle 2	3/20/1990	4251990002
1990	Vogtle 2	5/6/1990	4251990007
1990	Vogtle 2	6/28/1990	4251990008
1990	Vogtle 2	6/30/1990	4251990009
1991	Vogtle 2	2/18/1991	4251991005
1991	Vogtle 2	2/23/1991	4251991006
1991	Vogtle 2	5/7/1991	4251991007
1992	Vogtle 2	3/9/1992	4251992002
1992	Vogtle 2	5/14/1992	4251992010
1993	Vogtle 2	6/28/1993	4251993004
1993	Vogtle 2	9/8/1993	4251993006
1994	Vogtle 2	1/7/1994	4251994001
1994	Vogtle 2	1/19/1994	4251994002
1997	Vogtle 2	10/14/1996	4251996006
1997	Vogtle 2	10/23/1996	4251996008
1998	Vogtle 2	5/9/1998	4251998003
1998	Vogtle 2	6/9/1998	4251998005
1998	Vogtle 2	8/24/1998	4251998007
1998	Vogtle 2	9/4/1998	4251998008
1999	Vogtle 2	3/21/1999	4251999001
2001	Vogtle 2	4/7/2001	4252001001
1987	Waterford 3	3/15/1987	3821987008
1987	Waterford 3	4/13/1987	3821987012
1987	Waterford 3	5/25/1987	3821987016
1987	Waterford 3	7/31/1987	3821987020
1988	Waterford 3	12/11/1987	3821987028
1988	Waterford 3	1/26/1988	3821988002
1988	Waterford 3	6/14/1988	3821988016
1989	Waterford 3	12/8/1988	3821988033
1989	Waterford 3	7/15/1989	3821989013
1990	Waterford 3	12/23/1989	3821989024
1990	Waterford 3	3/22/1990	3821990002
1990	Waterford 3	3/29/1990	3821990003
1990	Waterford 3	8/25/1990	3821990012

FY	Plant	Date	LER
1991	Waterford 3	6/24/1991	3821991013
1991	Waterford 3	8/25/1991	3821991019
1992	Waterford 3	11/17/1991	3821991022
1993	Waterford 3	3/4/1993	3821993001
1993	Waterford 3	6/15/1993	3821993002
1995	Waterford 3	6/10/1995	3821995002
1996	Waterford 3	5/17/1996	3821996006
1998	Waterford 3	7/16/1998	3821998014
2001	Waterford 3	2/13/2001	3822001003
1996	Watts Bar 1	2/19/1996	3901996004
1996	Watts Bar 1	3/13/1996	3901996009
1996	Watts Bar 1	3/27/1996	3901996011
1996	Watts Bar 1	4/16/1996	3901996014
1996	Watts Bar 1	4/21/1996	3901996015
1996	Watts Bar 1	4/28/1996	3901996016
1997	Watts Bar 1	1/22/1997	3901997002
1997	Watts Bar 1	3/6/1997	3901997006
1997	Watts Bar 1	3/6/1997	3901997008
1997	Watts Bar 1	4/20/1997	3901997010
1998	Watts Bar 1	10/19/1997	3901997015
1998	Watts Bar 1	3/7/1998	3901998001
2000	Watts Bar 1	9/10/2000	3902000004
2001	Watts Bar 1	10/6/2000	3902000005
2001	Watts Bar 1	6/29/2001	3902001001
2001	Watts Bar 1	9/4/2001	3902001002
2002	Watts Bar 1	12/19/2001	3902001004
2002	Watts Bar 1	7/13/2002	3902002003
2002	Watts Bar 1	9/21/2002	3902002004
2002	Watts Bar 1	9/27/2002	3902002005
1987	Wolf Creek	1/8/1987	4821987002
1987	Wolf Creek	1/20/1987	4821987004
1987	Wolf Creek	1/17/1987	4821987005
1987	Wolf Creek	1/21/1987	4821987005
1987	Wolf Creek	4/19/1987	4821987017
1987	Wolf Creek	4/23/1987	4821987017
1987	Wolf Creek	5/28/1987	4821987022
1987	Wolf Creek	6/29/1987	4821987027
1987	Wolf Creek	7/20/1987	4821987030
1987	Wolf Creek	9/10/1987	4821987037
1987	Wolf Creek	9/11/1987	4821987037
1987	Wolf Creek	9/12/1987	4821987037
1987	Wolf Creek	9/27/1987	4821987041
1988	Wolf Creek	12/26/1987	4821987051
1989	Wolf Creek	1/23/1989	4821989002
1989	Wolf Creek	2/2/1989	4821989004
1989	Wolf Creek	7/11/1989	4821989013
1990	Wolf Creek	2/6/1990	4821990001
1990	Wolf Creek	5/14/1990	4821990011
1990	Wolf Creek	5/17/1990	4821990012
1990	Wolf Creek	5/19/1990	4821990013
1990	Wolf Creek	6/13/1990	4821990014
1991	Wolf Creek	10/23/1990	4821990023
1991	Wolf Creek	5/12/1991	4821991006

FY	Plant	Date	LER
1992	Wolf Creek	2/19/1992	4821992002
1993	Wolf Creek	11/10/1992	4821992016
1994	Wolf Creek	2/19/1994	4821994002
1995	Wolf Creek	3/8/1995	4821995001
1996	Wolf Creek	11/10/1995	4821995006
1996	Wolf Creek	1/30/1996	4821996001
1996	Wolf Creek	6/6/1996	4821996006
1999	Wolf Creek	5/12/1999	4821999005
1999	Wolf Creek	8/5/1999	4821999008
2000	Wolf Creek	9/4/2000	4822000003
2002	Wolf Creek	5/8/2002	4822002003
2002	Wolf Creek	9/9/2002	4822002005
1987	Zion 1	2/27/1987	2951987005
1988	Zion 1	5/7/1988	2951988011
1989	Zion 1	6/20/1989	2951989009
1990	Zion 1	1/27/1990	2951990004
1992	Zion 1	11/7/1991	2951991016
1994	Zion 1	4/3/1994	2951994005
1994	Zion 1	7/2/1994	2951994010
1996	Zion 1	4/17/1996	2951996015
1996	Zion 1	8/18/1996	2951996021
1989	Zion 2	10/8/1988	3041988007
1990	Zion 2	1/18/1990	3041990001
1990	Zion 2	9/7/1990	3041990010
1991	Zion 2	11/11/1990	3041990013

Table 13. LER listing for failure trends,, Figure 8.

FY	Plant	Date	LER
1995	Arkansas 1	4/20/1995	3131995005
1994	Arkansas 1	1/31/1994	3131994001
1992	Arkansas 1	5/19/1992	3131992005
1989	Arkansas 1	11/26/1988	3131988021
1994	Arkansas 2	4/22/1994	3681994002
1991	Arkansas 2	12/5/1990	3681990024
1989	Arkansas 2	4/18/1989	3681989006
1997	Beaver Valley 1	3/19/1997	3341997005
1994	Beaver Valley 2	11/29/1993	4121993014
1990	Beaver Valley 2	7/2/1990	4121990008
1989	Beaver Valley 2	5/14/1989	4121989015
1988	Beaver Valley 2	11/10/1987	4121987035
1990	Braidwood 2	11/1/1989	4571989007
1990	Braidwood 2	11/1/1989	4571989007
1989	Braidwood 2	5/11/1989	4571989002
1988	Byron 2	5/6/1988	4551988004
1988	Byron 2	7/14/1988	4551988008
2002	Callaway	12/3/2001	4832002001
1992	Callaway	4/10/1992	4831992005
1987	Callaway	4/2/1987	4831987003
2001	Calvert Cliffs 1	5/16/2001	3172001001
1993	Calvert Cliffs 1	11/24/1992	3171992008
1987	Calvert Cliffs 1	7/23/1987	3171987012

FY	Plant	Date	LER
1998	Calvert Cliffs 2	3/5/1998	3181998002
1995	Calvert Cliffs 2	1/13/1995	3181995002
1989	Calvert Cliffs 2	3/1/1989	3181989004
1994	Catawba 1	12/25/1993	4131993012
1992	Catawba 1	7/12/1992	4131992008
1991	Catawba 1	7/10/1991	4131991015
1989	Catawba 1	1/27/1989	4131989007
1989	Catawba 1	1/27/1989	4131989007
1988	Catawba 1	3/9/1988	4131988015
1987	Catawba 1	7/6/1987	4131987026
1995	Catawba 2	10/18/1994	4141994007
1989	Catawba 2	3/14/1989	4141989010
1989	Catawba 2	9/12/1989	4141989019
1989	Catawba 2	7/31/1989	4141989017
1988	Catawba 2	3/9/1988	4141988012
1988	Catawba 2	3/9/1988	4141988012
1988	Catawba 2	11/3/1987	4141987029
1987	Catawba 2	8/7/1987	4141987024
1987	Catawba 2	9/12/1987	4141987026
1995	Comanche Peak 1	6/21/1995	4451995004
1992	Comanche Peak 1	12/4/1991	4451991029
1989	Cook 1	1/16/1989	3151989001
1995	Cook 2	8/29/1995	3161995005
1993	Cook 2	8/2/1993	3161993007
1991	Cook 2	8/1/1991	3161991006
1991	Cook 2	3/13/1991	3161991004
1990	Cook 2	10/19/1989	3161989017
1992	Crystal River 3	11/19/1991	3021991013
1989	Crystal River 3	6/16/1989	3021989023
1988	Crystal River 3	1/7/1988	3021988002
1987	Crystal River 3	2/21/1987	3021987002
1987	Crystal River 3	2/21/1987	3021987002
1987	Crystal River 3	7/12/1987	3021987013
1987	Crystal River 3	7/12/1987	3021987013
2000	Davis-Besse	6/8/2000	3462000005
1989	Diablo Canyon 2	1/17/1989	3231989001
1989	Diablo Canyon 2	12/31/1988	3231988024
1991	Farley 1	5/18/1991	3481991005
1990	Farley 1	11/12/1989	3481989007
1994	Fort Calhoun	12/9/1993	2851993019
1991	GINNA	12/11/1990	2441990013
1991	Haddam Neck	3/4/1991	2131991005
1990	Haddam Neck	3/16/1990	2131990004
1997	Harris	6/2/1997	4001997015
1997	Harris	8/29/1997	4001997022
1990	Harris	10/9/1989	4001989017
1989	Harris	1/16/1989	4001989001
1987	Harris	6/17/1987	4001987035
1996	Indian Point 2	3/5/1996	2471996003
1992	Indian Point 2	4/13/1992	2471992007
1991	Indian Point 2	1/7/1991	2471991001
1993	Indian Point 3	1/13/1993	2861993004
1988	Indian Point 3	3/31/1988	2861988002

FY	Plant	Date	LER
1987	Indian Point 3	1/31/1987	2861987001
1996	Kewaunee	11/9/1995	3051995007
1992	Kewaunee	4/13/1992	3051992010
1990	Kewaunee	4/14/1990	3051990006
1988	Kewaunee	8/31/1988	3051988011
1996	Maine Yankee	6/12/1996	3091996012
1994	Maine Yankee	10/12/1993	3091993020
1992	Maine Yankee	4/11/1992	3091992006
1993	McGuire 1	12/10/1992	3691992011
1993	McGuire 1	12/10/1992	3691992011
1989	McGuire 1	12/10/1988	3691988045
1988	McGuire 1	8/17/1988	3691988021
1991	McGuire 2	4/22/1991	3701991004
1994	Millstone 2	1/18/1994	3361994001
1988	Millstone 2	11/16/1987	3361987012
1995	Millstone 3	11/21/1994	4231994014
1994	Millstone 3	9/8/1994	4231994011
1990	Millstone 3	10/23/1989	4231989026
1989	Millstone 3	5/11/1989	4231989009
1988	Millstone 3	4/25/1988	4231988016
1993	North Anna 1	4/11/1993	3381993014
1992	North Anna 1	3/19/1992	3381992008
1988	North Anna 1	1/8/1988	3381988002
1994	North Anna 2	1/5/1994	3391994001
1993	North Anna 2	4/16/1993	3391993002
1993	North Anna 2	4/16/1993	3391993002
1987	North Anna 2	6/1/1987	3391987005
1987	North Anna 2	6/1/1987	3391987005
1992	Oconee 1	5/8/1992	2691992004
1989	Oconee 1	1/2/1989	2691989001
1994	Oconee 2	2/8/1994	2701994001
1993	Oconee 3	1/26/1993	2871993001
1991	Oconee 3	7/3/1991	2871991007
1995	Palisades	6/29/1995	2551995006
1995	Palisades	6/29/1995	2551995006
1988	Palo Verde 1	11/27/1987	5281987025
1988	Palo Verde 1	11/27/1987	5281987025
1988	Palo Verde 1	3/25/1988	5281988013
1987	Prairie Island 1	5/16/1987	2821987007
1987	Prairie Island 1	5/16/1987	2821987007
1987	Prairie Island 1	5/16/1987	2821987007
1991	Prairie Island 2	10/9/1990	3061990011
1991	Prairie Island 2	10/9/1990	3061990011
1987	Robinson 2	6/15/1987	2611987018
2000	Salem 1	1/6/2000	2722000001
2000	Salem 1	1/6/2000	2722000001
1992	Salem 1	8/5/1992	2721992019
1998	Salem 2	7/25/1998	3111998012
1992	San Onofre 2	2/22/1992	3611992007
1991	San Onofre 2	9/10/1991	3611991014
1990	San Onofre 2	8/26/1990	3611990012
1989	San Onofre 2	1/12/1989	3611989001
1996	San Onofre 3	3/12/1996	3621996001

FY	Plant	Date	LER
2001	Seabrook	3/5/2001	4432001002
1996	Seabrook	5/21/1996	4431996003
1990	Seabrook	6/20/1990	4431990015
1989	Sequoyah 1	2/10/1989	3271989005
1997	Sequoyah 2	10/11/1996	3281996005
1988	Sequoyah 2	3/5/1988	3281988012
1988	Sequoyah 2	6/11/1988	3281988026
1999	South Texas 1	5/19/1999	4981999005
1993	South Texas 1	2/4/1993	4981993007
1992	South Texas 1	3/18/1992	4981992006
1992	South Texas 1	3/18/1992	4981992006
1990	South Texas 1	7/30/1990	4981990006
1990	South Texas 1	7/30/1990	4981990006
1988	South Texas 1	2/28/1988	4981988032
1988	South Texas 1	2/28/1988	4981988032
1993	South Texas 2	2/3/1993	4991993004
1989	South Texas 2	4/15/1989	4991989013
1996	St. Lucie 2	6/6/1996	3891996002
1990	St. Lucie 2	1/14/1990	3891990001
1989	St. Lucie 2	9/23/1989	3891989007
1987	St. Lucie 2	4/9/1987	3891987003
2000	Summer	9/21/2000	3952000006
1995	Surry 1	1/8/1995	2801995001
1998	Surry 2	12/2/1997	2811997004
1997	Surry 2	2/18/1997	2811997001
1988	Surry 2	3/27/1988	2811988004
1988	Surry 2	5/16/1988	2811988010
1988	Surry 2	5/16/1988	2811988010
2001	Three Mile Isl 1	1/6/2001	2892001001
1999	Three Mile Isl 1	5/10/1999	2891999004
1998	Turkey Point 3	2/16/1998	2501998001
1997	Turkey Point 3	7/30/1997	2501997007
1996	Turkey Point 3	2/9/1996	2501996002
1992	Vogtle 1	9/9/1992	4241992007
1989	Vogtle 1	2/10/1989	4241989005
1988	Vogtle 1	10/28/1987	4241987062
1988	Vogtle 1	4/7/1988	4241988008
1987	Vogtle 1	4/30/1987	4241987020
1987	Vogtle 1	6/15/1987	4241987036
1987	Vogtle 1	3/20/1987	4241987009
1994	Vogtle 2	10/19/1993	4251993007
1987	Waterford 3	7/31/1987	3821987020
2001	Watts Bar 1	9/4/2001	3902001002
1996	Wolf Creek	1/30/1996	4821996001
1993	Wolf Creek	5/8/1993	4821993010
1987	Wolf Creek	9/10/1987	4821987037
1987	Wolf Creek	9/10/1987	4821987037
1994	Zion 1	6/10/1994	2951994008
1993	Zion 1	10/21/1992	2951992020
1992	Zion 1	9/9/1992	2951992014
1992	Zion 1	9/26/1992	2951992016
1990	Zion 1	12/18/1989	2951989025
1990	Zion 1	1/16/1990	2951990002

FY	Plant	Date	LER
1994	Zion 2	4/7/1994	3041994004
1994	Zion 2	4/7/1994	3041994004
1994	Zion 2	3/7/1994	3041994002
1994	Zion 2	4/7/1994	3041994004
1991	Zion 2	6/8/1991	3041991003

5 DESIGN CLASSES

The AFW systems analyzed can be grouped into 11 different design classes as shown in [Table 14](#). Each system typically consists of at least two independent divisions. The divisions consist of a number of different combinations of electric-motor-driven and/or turbine-driven pump trains. Electrical power, control, and instrumentation associated with each division are independent from one another. Typically, the electric-motor-driven pump trains make up one division and the turbine-driven pump train the other. Some plants have a diesel-driven pump in place of the turbine-driven pump, or a second turbine-driven pump in place of the electric-motor-driven pumps.

The AFW system is typically started automatically by the engineered safety features actuation system (ESFAS) or equivalent, depending on plant design and terminology. The ESFAS system automatic start signals include a predetermined low water level condition in one or more steam generators, a loss of the operating main feedwater pumps, a loss of electrical power on safety-related buses, and a safety injection signal. There are additional start signals, but these four are the most common. There is significant variation among the plants in how the system responds given a start signal. However, in most cases, a low-level condition in one steam generator starts only the electric-motor-driven pumps, while a low-level condition in two or more steam generators starts both the electric and turbine-driven pumps. For the plants that have two divisions consisting of one train per division (i.e., an electric-motor and turbine-driven pump train), most start signals start both pumps.

A typical AFW system is configured with two separate mechanical divisions. Each division has independent initiation and control functions, and is designed to feed all the steam generators at full capacity. One division may consist of two electric-motor-driven pumps, while the other division may have only one turbine-driven pump. Typically, in a four-steam generator plant, each electric-motor-driven pump train has the capacity to supply two steam generators, while the turbine-driven pump train can supply all four steam generators. In the two-division two-train plants, both pumps are aligned and rated to supply all the steam generators.

Feedwater flow to each steam generator is normally controlled by a flow control valve that will modulate either open or closed to maintain steam generator level. The flow control valve can be controlled either automatically or manually. A flow recirculation line is provided downstream of each pump discharge. The recirculation line allows for continuous flow back to the suction source to provide minimum flow protection for the pump. In addition, a test return line is provided downstream of each pump discharge to allow for either full or partial testing of the pumps. To limit the flow, as steam generator pressure lowers during a cool down, the system utilizes several different methods depending on plant design. Some plants use a current limiter that acts to increase downstream pump pressure thereby reducing motor amps, others use flow restricting orifices or pipe design configurations, and others use the flow control valve that modulates closed when a flow reduction signal is received.

The turbine for each turbine-driven pump is classified as an atmospheric discharge, non-condensing turbine. Typically, driving steam is supplied from the main steam lines upstream of the main steam isolation valves from at least two steam generators. (Design class 11 turbine steam supply is from one steam generator.) Each steam supply line to the turbine contains a normally closed fail-open air-operated steam isolation valve. Some plants have a dc-powered motor-operated valve. A bypass is provided around each of these isolation valves with a flow-restricting orifice and a normally-closed fail-open air-operated bypass isolation valve. The bypass provides a small, controlled rate of steam flow to the AFW turbine for warming the steam lines and turbine. Steam drain traps are provided in the low points of the steam line to drain condensate from the lines as condensate present in the steam lines could have an adverse affect on turbine reliability during an unplanned demand.

Each turbine is supplied with a hydraulic governor control valve, and a trip and throttle valve with motor reset capability. The turbine is brought up to speed by governor control upon being supplied with steam by opening the steam supply isolation valve(s). The governor then controls the turbine speed at the pump rated speed by modulating the governor control valve. The governor controlled turbine speed can be adjusted from the control room, the remote shutdown panel, or manually at the governor.

The turbine is stopped by remotely closing the trip throttle valve from the control room or the remote shutdown panel. The trip and throttle valve is automatically (electrically) tripped on turbine overspeed at 115% of rated speed. The electric overspeed trip can be reset from either the control room or remote shutdown panel. A mechanical overspeed trip also provides automatic overspeed protection at 125% of rated speed. The mechanical overspeed trip can only be reset at the trip and throttle valve.

Feedwater is supplied to both divisions through either a single condensate storage tank with separate suction supply lines or two storage tanks with redundant supply lines. Each tank typically will have its level maintained above the minimum volume needed to provide a net positive suction head to the pumps and allow for 6 hours of system operation. For extended operation of the system or as a backup for the storage tanks, an ensured source of water is provided from a service water system. The switchover to the ensured source can be accomplished by either an automatic re-alignment of the suction valves based on a sensed, low-suction pressure condition or manually by operator action depending on the plant design (typical alignment at most plants is by manual capability). This switchover is not included in the models.

For the purposes of this analysis, the AFW system was partitioned into several different segments. These segments are (1) suction, (2) turbine-driven pump, (3) turbine steam supply, (4) turbine-driven pump feed control, (5) electric-motor-driven pump, (6) electric-motor-driven pump feed control, (7) diesel-driven pump, (8) diesel-driven pump feed control, (9) common feed control, and (10) steam generator feed. These segments are described in more detail below:

1. The suction segment includes all piping and valves (including valve operators) from the condensate storage tank (or equivalent based on plant terminology) to the pump suction isolation.
2. The turbine-driven pump segment includes the turbine, trip and throttle valve, governor assembly with the associated controls, the turbine steam supply isolation just upstream of the trip throttle valve, and the valve operators. Also included with this segment are the pump and associated piping from and including the suction isolation up to and including the discharge isolation valve, and associated valve operators. The minimum flow and test recirculation line is included if the associated tap off is prior to the discharge isolation valve.
3. The turbine steam supply segment includes the associated piping, valves, and valve operators from the main steam line penetrations (but not including) to the turbine steam supply isolation valve. The instrument air supply and dc power to the solenoid-operated valves were excluded.
4. The turbine-driven pump feed control segment includes the piping and valves from the pump discharge isolation up to the steam generator for plants with only one AFW injection header per steam generator or plants where AFW has no connection with the main feedwater system. For plants with more than one injection header per steam generator or AFW connects with the main feedwater system, the turbine-driven pump feed control segment includes the pump discharge isolation valve and upstream piping up to the connection point for the alternate injection path or main feedwater system. Included with the segment are the

associated valves and valve operators, the flow control valve and the control logic, and the test recirculation line where applicable.

5. The electric-motor driven pump segment includes the motor and associated breaker at the power board (excluding the power board itself). Also included with this segment are the pump and associated piping from and including the suction isolation up to and including the discharge isolation valve, and associated valve operators. The minimum flow and test recirculation line is included if the associated tap off is prior to the discharge isolation valve.
6. The electric motor driven pump feed control segment includes the piping and valves from the pump discharge isolation up the steam generator for plants with only one AFW injection header per steam generator or plants where AFW has no connection with the main feedwater system. For plants with more than one injection header per steam generator or AFW connects with the main feedwater system, the electric-motor driven pump feed control segment includes the pump discharge isolation valve and upstream piping up to the connection point for the alternate injection path or main feedwater system. Included with the segment are the associated valves and valve operators, the flow control valve and the control logic, and the test recirculation line where applicable
7. The diesel-driven pump segment includes the diesel engine, the associated fuel oil including the day tank, diesel-cooling water back to the supply isolation and the governor, and the engine starting system. Also included with this segment are the pumps and associated piping from and including the suction isolation up to and including the discharge isolation valve, and associated valve operators. The minimum flow and test recirculation line is included if the associated tap off is prior to the discharge isolation valve.
8. The diesel-driven pump feed control segment includes the piping and valves from the pump discharge isolation up to the steam generator for plants with only one AFW injection header per steam generator or plants where AFW has no connection with the main feedwater system. For plants with more than one injection header per steam generator or AFW connects with the main feedwater system, the diesel-driven pump feed control segment includes the pump discharge isolation valve and upstream piping up to the connection point for the alternate injection path or main feedwater system. Included with the segment are the associated valves and valve operators, the flow control valve and the control logic, and the test recirculation line where applicable.
9. The common feed control segment applies to plants where the turbine/diesel and electric-motor-driven pumps discharge to a shared header with flow to the steam generator being regulated in the common header. This segment includes the piping and valves from (but not including) the pump discharge isolation up to the steam generator for plants with only one AFW injection header per steam generator or plants where AFW has no connections with the main feedwater system. For plants with more than one injection header per steam generator or AFW connects with the main feedwater system, the feed control segment includes the pump discharge isolation valve and upstream piping up to the connection point for the alternate injection path or main feedwater system. Included with this segment are the associated valves and valve operators, the flow control valve and the control logic, and the test recirculation line where applicable.
10. The steam generator feed segment includes the check valve(s) and associated piping downstream of the common or turbine/motor feed segments. This segment generally

includes the last check valves in the feedwater system piping that prevent short cycling of AFW flow to the main feedwater system.

The Instrumentation and Control subsystem includes the circuits for the system initiation, operation, and the containment isolation function of the AFW turbine steam lines. However, each of the component failures in these circuits were screened to ensure that the failed component identified in the circuit was dedicated to the AFW system. Instrumentation and Control failures are implicit in the segment boundaries. That is, the segment affected by this type of failure would be recorded as a segment failure caused by instrumentation and control.

Additional components that were considered part of the AFW system are the circuit breakers at the motor control centers (MCCs) (but not the MCCs themselves). Heating, ventilating, and air conditioning systems and room cooling associated with the AFW system were also included. Losses of a specific AFW room cooler are included, but not failures within the service water system.

5.1.1 Design Class 1

The AFW system configuration for Design Class 1 plants consists of one motor-driven and one turbine-driven train supplying two steam generators.

5.1.2 Design Class 2

The AFW system configuration for Design Class 2 plants consists of one motor-driven and two turbine-driven trains supplying two steam generators. Overall, the two plants assigned to this design class had an operational unreliability lower than the industry average. This design class consists of Calvert Cliffs Units 1 and 2.

5.1.3 Design Class 3

The AFW system configuration for Design Class 3 plants consists of two turbine-driven trains supplying two steam generators. Overall, there is only one plant (Davis-Besse) assigned to this design class.

5.1.4 Design Class 4

The AFW system configuration for Design Class 4 plants consists of two motor-driven pump trains and a turbine-driven train supplying two steam generators.

5.1.5 Design Class 5

The AFW system configuration for Design Class 5 plants consists of two motor-driven pump trains and a turbine-driven train supplying three steam generators.

5.1.6 Design Class 6

The AFW system configuration for Design Class 6 plants consists of only three turbine-driven trains supplying three steam generators. Turkey Point Units comprise this design class.

5.1.7 Design Class 7

The AFW system configuration for Design Class 7 plants consists of only one motor-driven train and a diesel-driven pump train supplying four steam generators. The Byron and Braidwood Units comprise this design class.

5.1.8 Design Class 8

The AFW system configuration for Design Class 8 plants consists of a turbine-driven train and motor-driven train supplying four steam generators. Seabrook is the only plant that comprises this design class.

5.1.9 Design Class 9

The AFW system configuration for Design Class 9 plants consists of two turbine-driven trains supplying four steam generators. Haddam Neck is the only plant that comprises this design class.

5.1.10 Design Class 10

The AFW system configuration for Design Class 10 plants consists of two motor-driven pump trains and a turbine-driven train supplying four steam generators.

5.1.11 Design Class 11

The AFW system configuration for Design Class 11 plants consists of one turbine-driven train and three motor-driven trains with each train supplying one of four steam generators. This design class is comprised of the two South Texas plants.

Table 14. Listing of the AFW design classes, PWRs associated with each design class, the number and type of AFW trains, the number of steam generators, and the success criterion (as stated in the IPEs).

AFW Design Class	Plant Name	Motor Trains	Turbine Trains	Diesel Trains	Total Pump Trains	Steam Generators	Success Criterion Reported in the IPE
1	Arkansas Nuclear One 2	1	1		2	2	1 of 2 trains to 1 of 2 SGs
1	Crystal River 3	1	1		2	2	1 of 2 trains to 1 of 2 SGs
1	Fort Calhoun	1	1	1*	3	2	<u>1 of 2 trains or FW-54 (diesel-driven)</u> to 1 of 2 SGs; since diesel is non-safety and manual start—model as 1 of 2 trains with diesel as recovery train
1	Palo Verde 1, 2, & 3	2*	1		3	2	1 of 3 pumps to one (1 of 2) SGs; <u>one motor train (MD-N) is nonessential; so net is 1 of 2 trains</u>
1	Prairie Island 1 & 2	1	1		2	2	1 of 2 trains to 1 of 2 SGs
2	Calvert Cliffs 1 & 2	1	2		3	2	300 gpm to 1 (or 2) SGs -- <u>IPE models pumps as 1 of 4 (3 plus xtie) available</u>
3	Davis-Besse	1*	2		3	2	<u>1 of 3 trains</u> to at least 1 SG (1 of 2 SGs); the MDFP serves as the MDP train and as BU to turbines, needs to be manually started; treat the MD train as recovery if the auto turbines fail. Success is 1 of 2 safety trains to 1 of 2 SGs
4	Arkansas Nuclear One 1	1	1		2	2	1 of 2 trains to 1 of 2 SGs
4	Ginna	2	1		3	2	1 of 3 pumps to 1 of 2 SGs
4	Kewaunee	2	1		3	2	200 gpm to 1 of 2 SGs from 1 of 3 AFW pumps
4	Millstone 2	2	1		3	2	1 of 2 MDP or the steam-driven pump delivers flow to 1 of 2 SGs
4	Oconee 1, 2, & 3	2	1		3	2	1 of 3 trains to 1 of 2 SGs
4	Palisades	2	1		3	2	1 of 3 pumps to 1 of 2 SGs
4	Point Beach 1 & 2	2	1		3	2	The units have only one MDP but supplies a SG at each unit net effect is 2 MD trains; 1 of 3 trains to 1 of 2 SGs
4	San Onofre 1, 2 & 3	2	1		3	2	1 of 3 AFW pumps to 1 of 2 SGs
4	St. Lucie 1 & 2	2	1		3	2	1 of 3 AFW pumps to 1 of 2 SGs
4	Three Mile Island 1	2	1		3	2	1 of 3 pumps to 1 of 2 SGs
4	Waterford 3	2	1		3	2	Any pump (1 of 3 AFW) to 1 of 2 SGs
5	Beaver Valley 1 & 2	2	1		3	3	1 of 3 trains to 1 of 3 SGs
5	Farley 1 & 2	2	1		3	3	1 of 3 trains to 2 of 3 SGs
5	Harris 1	2	1		3	3	1 of 3 trains to 1 of 3 SGs
5	Maine Yankee	2	1		3	3	1 of 3 trains to 1 of 3 SGs (2 of 2 pumps with flow diversion)
5	North Anna 1 & 2	2	1		3	3	1 of 3 trains to 1 of 3 SGs
5	Robinson	2	1		3	3	1 of 3 pumps to 1 of 3 SGs
5	Summer 1	2	1		3	3	1 of 2 MDPs OR 1 TDP to 1 of 3 SGs
5	Surry 1 & 2	2	1		3	3	1 of 3 pumps to any one SG
6	Turkey Point 3 & 4		3		3	3	1 of 3 pumps to at least 1 of 3 SGs (375 gpm)
7	Braidwood 1 & 2	1		1	2	4	1 of 2 trains to 1 of 4 SGs
7	Byron 1 & 2	1		1	2	4	1 of 2 trains to 1 of 4 SGs

AFW Design Class	Plant Name	Motor Trains	Turbine Trains	Diesel Trains	Total Pump Trains	Steam Generators	Success Criterion Reported in the IPE
8	Seabrook	1	1		2	4	PRA states 1 of 2 pumps to 2 of 4 SGs
9	Haddam Neck		2		2	4	(1 of 2 AFW pumps to 3 of 4 SGs) OR (2 of 2 pumps to 2 of 4 SGs)
10	Callaway	2	1		3	4	1 of 3 trains delivering flow to at least 2 SGs
10	Catawba 1 & 2	2	1		3	4	1 of 3 trains to 2 SGs
10	Comanche Peak 1 & 2	2	1		3	4	At least 300 gpm (1 of 3 trains) to 1 of 4 SGs; also have a 860 gpm (2 of MDP to 1 of 4 SGs or 1 TDP flow to 2 SGs); full flow--3 of 3 pumps with MDPs to 1 SG and TDP to 2 SGs
10	Cook 1 & 2	2	1		3	4	450 gpm AFW flow (1 of 3 trains) to 2 of 4 SGs
10	Diablo Canyon 1 & 2	2	1		3	4	1 of 3 trains to 1 of 4 SGs
10	Indian Point 2	2	1		3	4	1 of 3 AFW pumps to 1 SG
10	Indian Point 3	2	1		3	4	1 of 3 trains injecting to 1 of 4 SGs
10	McGuire 1 & 2	2	1		3	4	1 of 3 trains to 2 of 4 SGs
10	Millstone 3	2	1		3	4	1 of 3 pumps to any 2 of 4 SGs
10	Salem 1 & 2	2	1		3	4	426 gpm flow (1 of 3 pumps) to 2 SGs (MDP 440 gpm; TDP 880 gpm)
10	Sequoyah 1 & 2	2	1		3	4	at least one pump (1 of 3) feeding 2 SGs
10	Vogtle 1 & 2	2	1		3	4	Flow to 2 of 4 SGs from 1 of 2 MDPs or 1 TDP
10	Watts Bar	2	1		3	4	1 of 3 trains to 2 of 4 SGs
10	Wolf Creek	2	1		3	4	1 of 3 trains to 2 of 4 SGs
10	Zion 1 & 2	2	1		3	4	1 of 3 pumps to 4 of 4 SGs or 1 of 4 SGs w/o all power. Page 4-48 states 1 MDP supplying 2/4 SGs is enough to safely cool down plant to RHR temp.
11	South Texas 1 & 2	3	1		4	4	1 of 4 AFW trains to 1 of 4 SGs (pump flow to its respective SG) no xtie to other SGs modeled in PRA

Note: * denotes plants that used non-safety pump trains as part of the IPE success criteria.