GE Nuclear Energy

J11-02581SRLR
Revision 1
Class I
June 1996

Supplemental Reload Licensing Report

for

PERRY NUCLEAR POWER PLANT UNIT 1
Reload 5 Cycle 6

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Perry Nuclear Power Plant Unit 1

Reload 5 Cycle 6

Approved

R.J Reda, Manager
Fuel and Facility Licensing

Approved

R.D. Williams
Fuel Project Manager

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Contents of This Report

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Acknowledgement

The engineering and reload licensing analyses, which form the technical basis of this Supplemental Reload Licensing Report, were performed by J.E. Fawks. The Supplemental Reload Licensing Report was prepared by J.E. Fawks. This revision has been verified by B.R. Fischer.

The basis for this report is *General Electric Standard Application for Reactor Fuel*, NEDE-24011-P-A-11, November 1995; and the U.S. Supplement, NEDE-24011-P-A-11-US, November 1995.

1. Plant-unique Items

Appendix A: Analysis Conditions
Appendix B: Basis for Analysis of Loss-of-Feedwater Heating Event
Appendix C: Analyzed Operating Domain
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2. Reload Fuel Bundles

Fuel Type	Cycle Loaded	Number
Irradiated:		
CE8B-P8SQB322-7GZ-120M-150-T (GE8x8EB)	3	16
GE8B-P8SQB320-9GZ-120M-150-T (GE8x8EB)	3	24
GE10-P8SXB306-10GZ2-120M-150-T (GE8x8NB-1)	4	136
GE10-P8SXB306-11GZ3-120M-150-T (GE8x8NB-1)	4	68
GE10-P8SXB306-11GZ3-120M-150-T (GE8x8NB-1)	5	224
New:		
GE10-P8SXB306-11GZ3-120M-150-T (GE8x8NB-1)	6	44
GE11-P9SUB338-10GZ-120T-146-T (GE11)	6	152
GE11-P9SUB338-12GZ-120T-146-T (GE11)	6	84
Total		748

3. Reference Core Loading Pattern

Nominal previous cycle core average exposure at end of cycle:	25662 MWd/MT (23280 MWd/ST)
Minimum previous cycle core average exposure at end of cycle from cold shutdown considerations:	25551 MWd/MT (23180 MWd/ST)
Assumed reload cycle core average exposure at beginning of cycle:	13084 MWd/MT (11870 MWd/ST)
Assumed reload cycle core average exposure at end of cycle:	25155 MWd/MT (22820 MWd/ST)
Reference core loading pattern:	Figure 1

4. Calculated Core Effective Multiplication and Control System Worth – No Voids, 20°C

Beginning of Cycle, $k_{effective}$	
Uncontrolled	1.116
Fully controlled	0.952
Strongest control rod out	0.988
R, Maximum increase in cold core reactivity with exposure into cycle, Δk	0.000

5. Standby Liquid Control System Shutdown Capability

Boron (ppm)	Shutdown Margin (Δk) (20°C, Xenon Free)
660	0.033

6. Reload Unique GETAB Anticipated Operational Occurrences (AOO) Analysis Initial Condition Parameters

Exposure: BOC6 to EOC6 Increased core flow/Feedwater temperature 420°F							
	Peaking Factors						
Fuel Design	**Local**	**Radial**	**Axial**	**R–Factor**	**Bundle Power (MWt)**	**Bundle Flow (1000 lb/hr)**	**Initial MCPR**
GE11	1.45	1.34	1.57	1.035	6.275	122.2	1.23
GE8x8NB–1	1.20	1.59	1.40	1.000	7.408	114.3	1.19
GE8x8EB	1.20	1.49	1.40	1.051	6.975	118.6	1.16

Exposure: BOC6 to EOC6 Increased core flow/Feedwater temperature reduction to 250°F							
	Peaking Factors						
Fuel Design	**Local**	**Radial**	**Axial**	**R–Factor**	**Bundle Power (MWt)**	**Bundle Flow (1000 lb/hr)**	**Initial MCPR**
GE11	1.45	1.44	1.57	1.035	6.703	120.0	1.22
GE8x8NB–1	1.20	1.65	1.40	1.000	7.700	111.6	1.20
GE8x8EB	1.20	1.56	1.40	1.051	7.295	115.7	1.17

7. Selected Margin Improvement Options

Recirculation pump trip:	Yes
Rod withdrawal limiter:	Yes
Thermal power monitor:	Yes
Improved scram time:	No (ODYN Option B)
Measured scram time:	No
Exposure dependent limits:	No
Exposure points analyzed:	1

8. Operating Flexibility Options

Single-loop operation:	Yes
Load line limit:	No
Extended load line limit:	No
Maximum extended load line limit:	No
Increased core flow throughout cycle:	Yes
Flow point analyzed:	105.0 %
Increased core flow at EOC:	Yes
Feedwater temperature reduction throughout cycle:	Yes
Temperature reduction:	170.0°F
Final feedwater temperature reduction:	Yes
ARTS Program:	No
Maximum extended operating domain:	Yes
Moisture separator reheater OOS:	No
Turbine bypass system OOS:	No
Safety/relief valves OOS:	Yes
ADS OOS:	No
EOC RPT OOS:	No
Main steam isolation valves OOS:	No

9. Core–wide AOO Analysis Results

Methods used: GEMINI; GEXL–PLUS

Exposure range: BOC6 to EOC6 Increased core flow/Feedwater temperature 420°F						
			Uncorrected ΔCPR			
Event	Flux (%NBR)	Q/A (%NBR)	GE11	GE8x8NB–1	GE8x8EB	Fig.
Load Reject w/o Bypass	332	112	0.15	0.12	0.09	2
Loss of 100°F Feedwater Heating	115	115	0.12	0.12	0.12	–

Exposure range: BOC6 to EOC6 Increased core flow/Feedwater temperature reduction to 250°F						
			Uncorrected ΔCPR			
Event	Flux (%NBR)	Q/A (%NBR)	GE11	GE8x8NB–1	GE8x8EB	Fig.
FW Controller Failure	244	117	0.15	0.12	0.11	3

10. Local Rod Withdrawal Error (With Limiting Instrument Failure) AOO Summary

The generic bounding BWR/6 rod withdrawal error analysis described in NEDE–24011–P–A–US is not applied. A cycle–specific rod withdrawal analysis found the ΔCPR to be 0.12 based upon a one foot withdrawal, and is not bounded by the generic RWE analysis reported in the referenced report.

11. Cycle MCPR Values[1]

In agreement with commitments to the NRC (letter from M.A. Smith to the Document Control Desk, *10CFR Part 21, Reportable Condition, Safety Limit MCPR Evaluation*, May 24,1996) a cycle–specific Safety Limit MCPR calculation was performed, and has been reported in both the Safety Limit MCPR and the Operating Limit MCPR show below. This cycle specific SLMCPR was determined using the analysis basis documented in GESTAR with the following exceptions:

1. The Cycle Management Report (J11 – 02791CMR Rev. 0) loading was analyzed.
2. The actual bundle parameters (e.g., local peaking) were used.
3. The full cycle exposure range was analyzed.

1. For single–loop operation, the MCPR operating limit is 0.01 greater than the two–loop value. The MCPR limit does not change because of channel bow. Channel bow is reflected in the monitoring of the core.

11. Cycle MCPR Values (cont)

Safety limit: 1.09

Single loop operation safety limit: 1.10

Non-Pressurization events:

Exposure range: BOC6 to EOC6			
	Option A		
	GE11	GE8x8NB-1	GE8x8EB
Rod Withdrawal Error	1.21	1.21	1.21
Fuel Loading Error (misoriented) (see App. F)	1.24	1.25	1.23
Fuel Loading Error (mislocated)	1.24	1.24	1.24
Loss of 100°F Feedwater Heating	1.21	1.21	1.21

Pressurization events:[2]

Exposure range: BOC6 to EOC6 Increased core flow/Feedwater temperature 420°F Exposure point: EOC6			
	Option A		
	GE11	GE8x8NB-1	GE8x8EB
Load Reject w/o Bypass	1.26	1.22	1.19

Exposure range: BOC6 to EOC6 Increased core flow/Feedwater temperature reduction to 250°F Exposure point: EOC6			
	Option A		
	GE11	GE8x8NB-1	GE8x8EB
FW Controller Failure	1.25	1.23	1.21

2. ECCS MCPR value is 1.17.

12. Overpressurization Analysis Summary[3]

Event	Psl (psig)	Pv (psig)	Plant Response
MSIV Closure (Flux Scram)	1264	1294	Figure 4

13. Loading Error Results[4]

Variable water gap misoriented bundle analysis: Yes

Mislocated bundle analysis: Yes

	ΔCPR		
Event	GE11	GE8x8NB–1	GE8x8EB
Fuel loading error (misoriented) (see App. F)	0.15	0.16	0.14
Fuel loading error (mislocated)	0.15	0.15	0.15

14. Control Rod Drop Analysis Results

This is a banked position withdrawal sequence plant, therefore, the control rod drop accident analysis is not required. NRC approval is documented in NEDE–24011–P–A–US.

15. Stability Analysis Results

GE SIL–380 recommendations have been included in the operating procedures; therefore, no stability analysis is required. NRC approval for deletion of a cycle–specific stability analysis is documented in NEDE–24011–P–A–US. This plant recognizes the issuance of NRC Bulletin No. 88–07, Supplement 1, *Power Oscillations in Boiling Water Reactors (BWRs)*, and will comply with the recommendations contained therein.

3. The MSIV closure (flux scram) analysis is performed using GEMINI methods at the 102% power level to account for the power level uncertainties specified in Regulatory Guide 1.49. The dome pressure is set to 1045psig as specified in the OPL–3 Design Guide, 463HA247 Revision 2. The analysis was performed with the 13 highest setpoint safety valves operational.

4. Delta CPR penality of 0.02 for the tilted misoriented bundle has been applied.

16. Loss-of-Coolant Accident Results

LOCA method used: SAFE/REFLOOD

The peak clad temperature (PCT) is ≤ 2185°F at all exposures; the local oxidation (fraction) is ≤ 0.065 at all exposures. The core-wide metal water reaction is 0.20%. The MAPLHGR multiplier for single-loop operation (SLO) is 0.78. The MAPLHGRs for GE10-P8SXB306-11GZ3-120M-150-T are contained in document 23A7227.

16. Loss-of-Coolant Accident Results (cont)

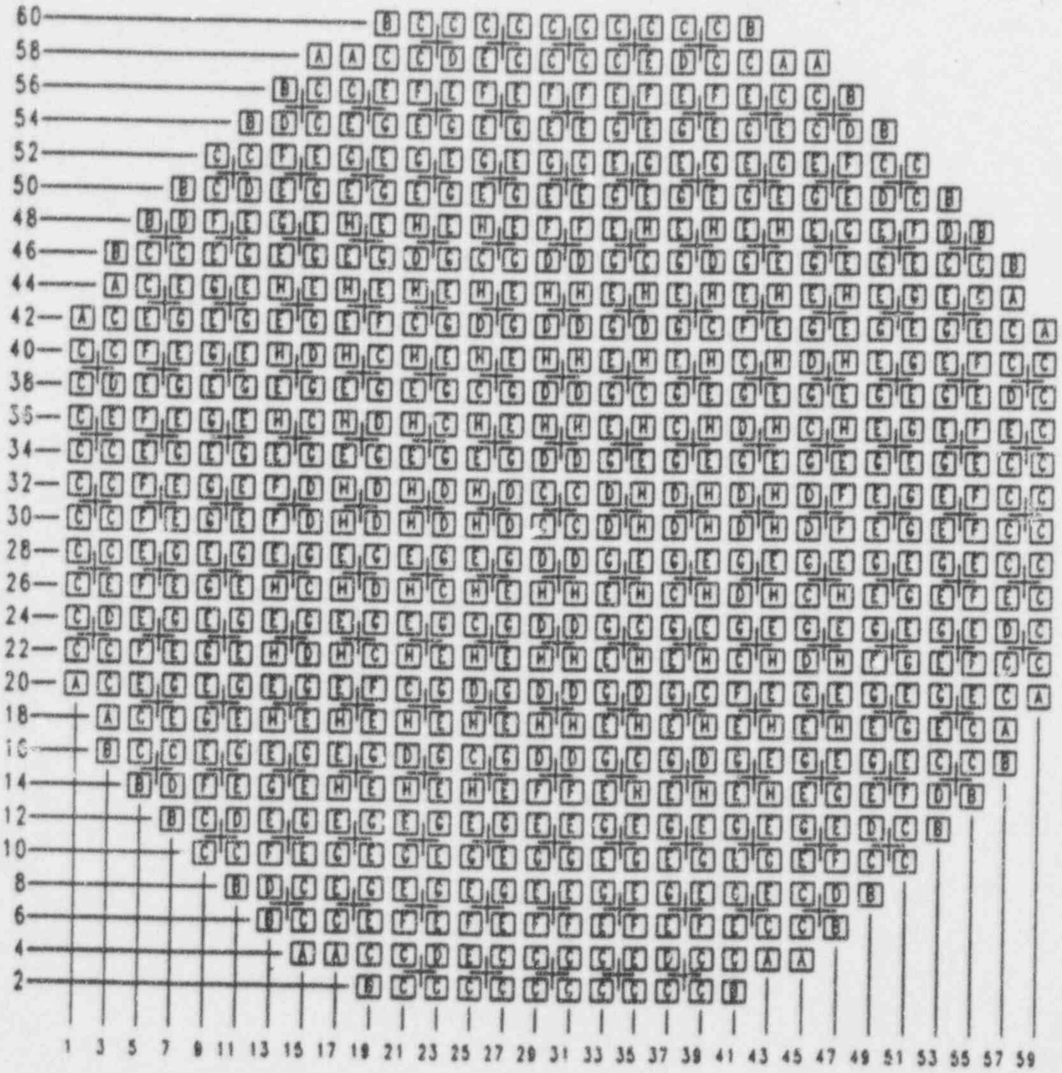
Bundle Type: GE11-P9SUB338-10GZ-120T-146-T

Average Planar Exposure		MAPLHGR(kW/ft)		PCT	Oxidation
(GWd/ST)	(GWd/MT)	Most Limiting	Least Limiting	(°F)	Fraction
0.00	0.00	11.65	11.67	—	—
0.20	0.22	11.69	11.69	2179	0.065
1.00	1.10	11.79	11.79	2175	0.063
2.00	2.20	11.83	11.83	—	—
3.00	3.31	11.86	11.86	—	—
4.00	4.41	11.90	11.90	—	—
5.00	5.51	11.93	11.93	2179	0.063
6.00	6.61	11.93	11.93	—	—
7.00	7.72	11.93	11.93	—	—
8.00	8.82	11.93	11.93	2180	0.063
9.00	9.92	11.92	11.92	—	—
10.00	11.02	11.90	11.90	2179	0.063
12.50	13.78	11.81	11.81	2180	0.062
15.00	16.53	11.76	11.76	2185	0.064
17.50	19.29	11.72	11.72	—	—
20.00	22.05	11.67	11.67	2182	0.062
25.00	27.56	11.32	11.43	2148	0.056
30.00	33.07	10.70	10.71	—	—
35.00	38.58	10.02	10.08	1970	0.031
40.00	44.09	9.34	9.42	—	—
45.00	49.60	8.68	8.74	1780	0.015
50.00	55.12	8.00	8.04	—	—
55.00	60.63	7.25	7.35	1557	0.002
59.17	65.22	6.62	6.72	—	—
59.26	65.32	—	6.71	—	—
59.73	65.84	—	6.64	—	—

16. Loss-of-Coolant Accident Results (cont)

Bundle Type: GE11-P9SUB338-12GZ-120T-146-T

Average Planar Exposure		MAPLHGR(kW/ft)		PCT	Oxidation
(GWd/ST)	(GWd/MT)	Most Limiting	Least Limiting	(°F)	Fraction
0.00	0.00	11.50	11.50	—	—
0.20	0.22	11.53	11.53	2148	0.059
1.00	1.10	11.67	11.67	2153	0.059
2.00	2.20	11.76	11.76	—	—
3.00	3.31	11.84	11.84	—	—
4.00	4.41	11.93	11.93	—	—
5.00	5.51	12.01	12.01	2175	0.062
6.00	6.61	11.99	11.99	—	—
7.00	7.72	11.96	11.96	—	—
8.00	8.82	11.94	11.94	2180	0.064
9.00	9.92	11.91	11.91	—	—
10.00	11.02	11.88	11.88	2180	0.063
12.50	13.78	11.79	11.79	2180	0.063
15.00	16.53	11.74	11.74	2182	0.064
17.50	19.29	11.71	11.71	—	—
20.00	22.05	11.67	11.67	2184	0.064
25.00	27.56	11.31	11.42	2153	0.057
30.00	33.07	10.70	10.71	—	—
35.00	38.58	10.01	10.07	1970	0.031
40.00	44.09	9.33	9.42	—	—
45.00	49.60	8.67	8.73	1779	0.015
50.00	55.12	7.99	8.03	—	—
55.00	60.63	7.25	7.34	1559	0.002
59.15	65.20	6.61	6.71	—	—
59.17	65.22	—	6.71	—	—
59.67	65.78	—	6.63	—	—



Fuel Type			
A=GE8B-P8SQB322-7GZ-120M-150-T	(Cycle 3)	E=GE10-P8SXB306-11GZ3-120M-150-T	(Cycle 5)
B=GE8B-P8SQB320-9GZ-120M-150-T	(Cycle 3)	F=GE10-P8SXB306-11GZ3-120M-150-T	(Cycle 6)
C=GE10-P8SXB306-10GZ2-120M-150-T	(Cycle 4)	G=GE11-P9SUB338-10GZ-120T-146-T	(Cycle 6)
D=GE10-P8SXB306-11GZ3-120M-150-T	(Cycle 4)	H=GE11-P9SUB338-12GZ-120T-146-T	(Cycle 6)

Figure 1 Reference Core Loading Pattern

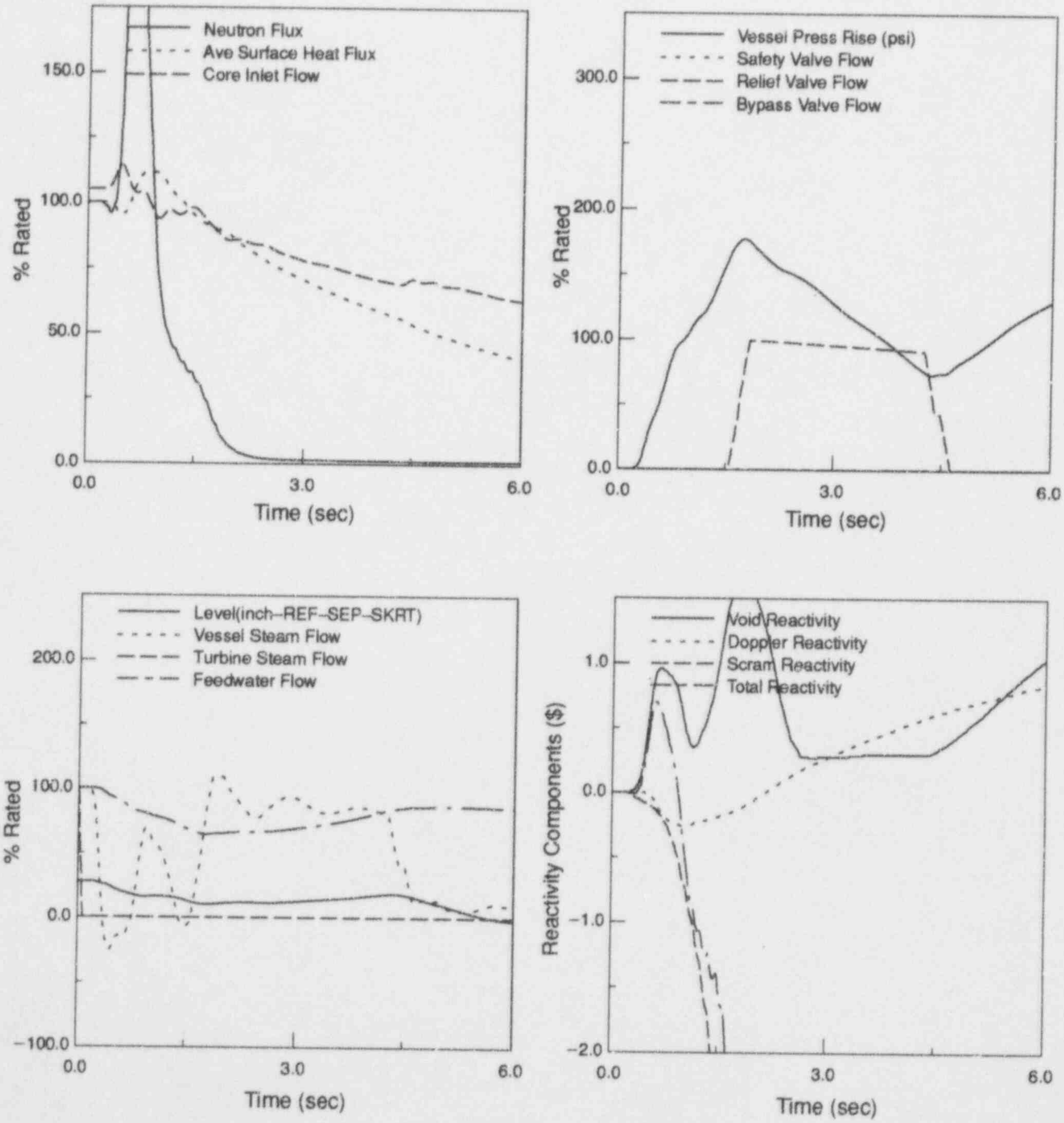


Figure 2 Plant Response to Load Reject w/o Bypass (BOC6 to EOC6 Increased core flow/Feedwater temperature 420°F)

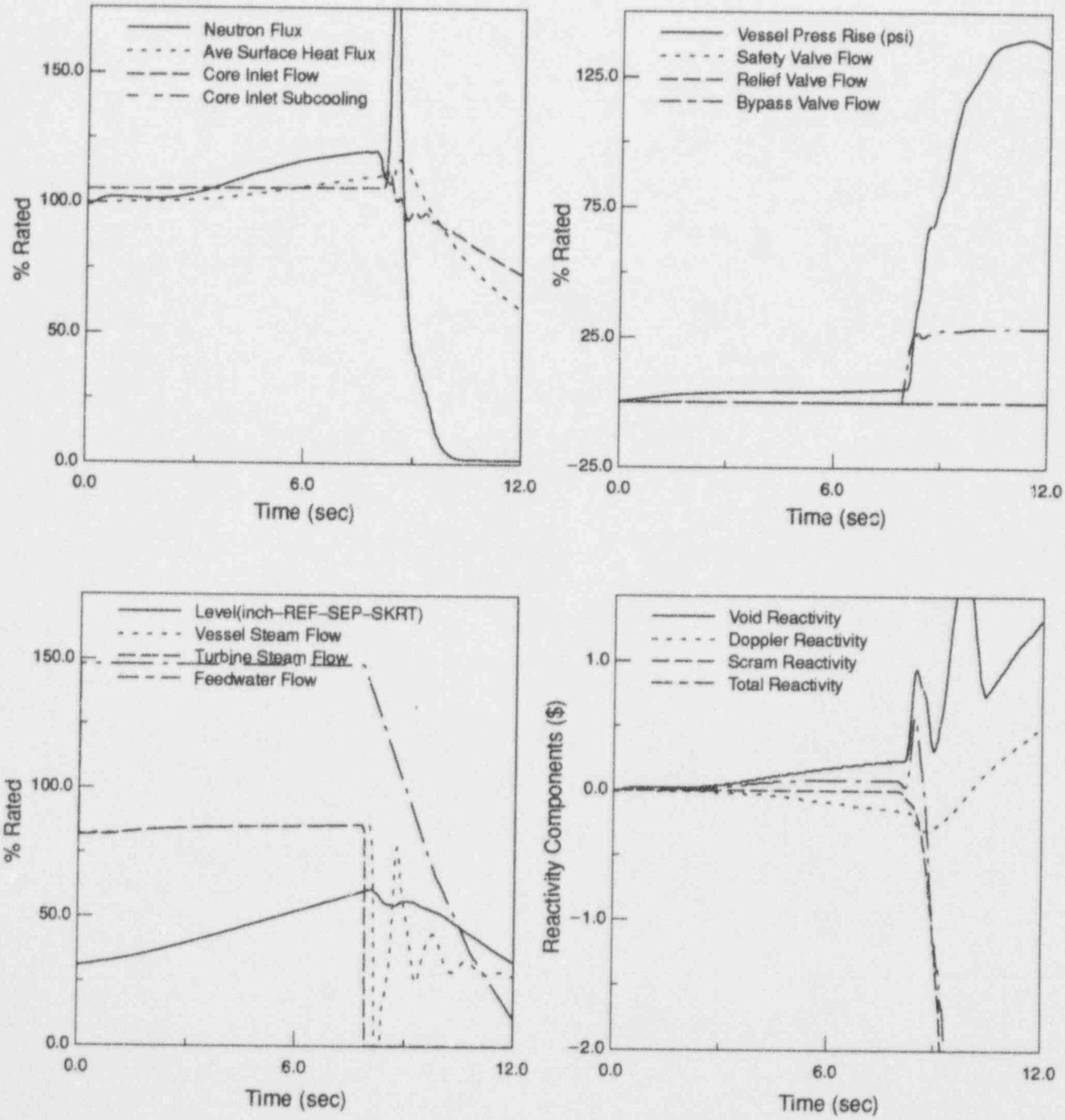


Figure 3 Plant Response to FW Controller Failure (BOC6 to EOC6 Increased core flow/Feedwater temperature reduction to 250°F)

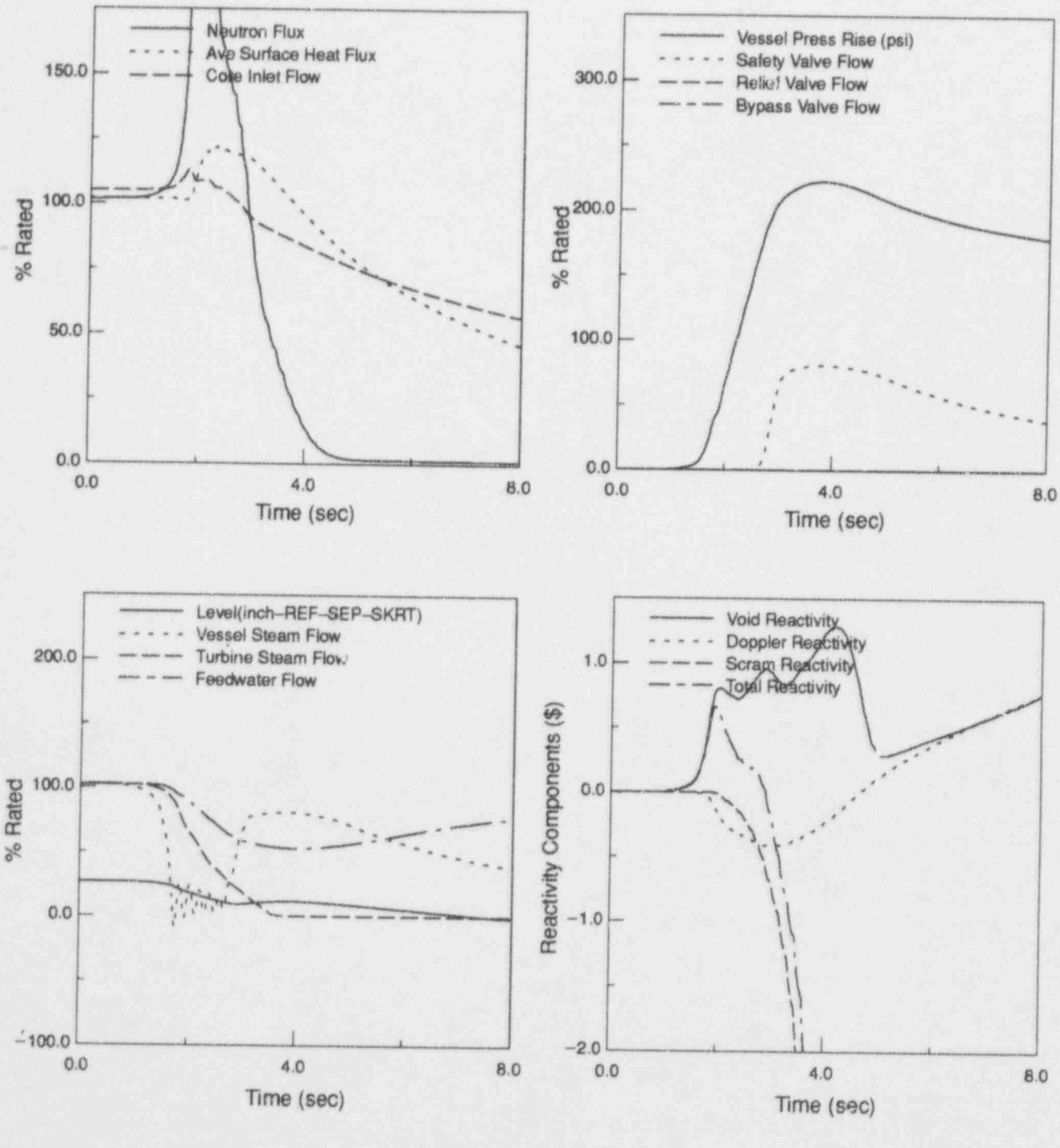


Figure 4 Plant Response to MSIV Closure (Flux Scram)

Appendix A
Analysis Conditions

To reflect actual plant parameters accurately, the values shown in Table A-1 were used this cycle.[5]

Table A-1

Increased core flow/Feedwater temperature 420°F	
Parameter	**Analysis Value**
Thermal power, MWt	3579.0
Core flow, Mlb/hr	109.2
Reactor pressure, psia	1056.0
Inlet enthalpy, BTU/lb	528.8
Non-fuel power fraction	0.038
Steam flow analysis, Mlb/hr	15.41
Dome pressure, psig	1025.0
Turbine pressure, psig	974.8
No. of Dual Mode S/R Valves (see footnote 5)	19
Relief mode lowest setpoint, psig (see footnote 5)	1133.0
Safety mode lowest setpoint, psig (see footnote 5)	1200.0

Increased core flow/Feedwater temperature reduction to 250°F	
Parameter	**Analysis Value**
Thermal power, MWt	3579.0
Core flow, Mlb/hr	109.2
Reactor pressure, psia	1023.7
Inlet enthalpy, BTU/lb	508.4
Non-fuel power fraction	0.038
Steam flow analysis, Mlb/hr	12.59
Dome pressure, psig	994.6
Turbine pressure, psig	960.3
No. of Dual Mode S/R Valves (see footnote 5)	19
Relief mode lowest setpoint, psig (see footnote 5)	1133.0
Safety mode lowest setpoint, psig (see footnote 5)	1200.0

5. There are a total of 19 valves; the two lowest setpoint safety/relief valves are assumed to be out-of-service in the transient analysis. For the MSIVFS overpressurization analysis, 6 safety valves are assumed out-of-service.

Appendix B
Basis for Analysis of Loss–of–Feedwater Heating Event

The loss of feedwater heating event was analyzed with the 3D BWR simulator code described in NEDE–24011–P–A, which permits the use of this code for this analysis. The transient plots normally reported in Section 9 are not outputs of the 3D BWR simulator code; therefore, these items are not included in this document.

The transient analysis inputs normally reported in Section 6 of this document are internally calculated in the 3D BWR simulator code.

Appendix C
Analyzed Operating Domain

The core–wide adnormal operational occurrence (AOO) analysis results reported in Section 9 are the most limiting values over the entire allowable operating range. This range covers the following operating options:

1. Standard 100% power/flow map;
2. End–of–cycle power coastdown;
3. MEOD with 100% power, flow range from 75% to 105% of rated; and
4. Partial feedwater heating to 320°F during the cycle with final feedwater temperature reduction to 250°F after *All Rods Out* at end of cycle.

Limiting events and conditions analyzed are based on NEDE–24011–P–A–US and the USAR analytical results. The Reload 5/Cycle 6 analyses were performed assuming all four turbine control valves in a full arc mode of operation. This is conservative for partial arc configuration.

Appendix D
Transient Analyses

The turbine trip without bypass (TTNBP) analysis is a pressure increase event that is bounded by the load rejection without bypass (LRNBP) analysis.

The LRNBP is limiting at normal feedwater temperature and increased core flow.

The feedwater controller failure (FWCF) is limiting at reduced feedwater temperature and increased core flow.

The pressure regulator failure down scale (PRFDS) is not limiting.

Transients were not run for the intermediate feedwater temperature cases (320°F and 370°F) because the operating limit would not improve for those conditions. The LRNBP and fuel loading error analysis sets the operating limit and does not change with feedwater temperature.

Appendix E
Power and Flow Dependent MCPR and MAPLHGR Multipliers

The original MEOD offrated MCPR and MAPLHGR multipliers were confirmed to be applicable to this cycle. The original MEOD absolute MCPR power limit at or below 40% power and the absolute MCPR flow limit above the OLMCPR need to be multiplied by the ratio of 1.09/1.07. Furthermore, the absolute power and flow dependent MCPR limit must be limited to the cycle 6 rated OLMCPR. For the power dependent MCPR curves, the MEOD original $MCPR_p$ equations at or below 40% rated power must be multiplied by the ratio of 1.09/1.07; and the MEOD original K_p equations above 40% rated power must be multiplied by the rated OLMCPR in order to obtain the equivalent $MCPR_p$ equation. The MEOD original $MCPR_f$ equations must be multiplied by the ratio of 1.09/1.07 and limited to the rated OLMCPR. Futhermore, for fuel types GE8x8EB and GE8x8NB–1 the $MCPR_f$ equation at or below 40% rated flow needs to be multiplied by (1.0+0.0032(40–F)) where F is core flow in terms of % rated.

Appendix F
GE8x8NB–1 Rotated Bundle Analysis

The results for each GE8x8NB–1 fuel type are listed in Table F–1. These results do not change from the previous cycle.

Table F–1

	ΔCPR
GE10–P8SXB306–11GZ3–120M–150–T	0.16
GE10–P8SXB306–10GZ2–120M–150–T	0.09