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Supplemental Reload Licensing Report

for

Perry Nuclear Power Plant Unit 1

Reload 4 Cycle 5

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Important Notice Regarding

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 P. A. Hahn of engineering. The Supplemental Reload Licensing Report was prepared by P. A. Hahn. This document has been verified by C. W. Smith.

The basis for this report is *General Electric Standard Application for Reactor Fuel*, NEDE–24011–P–A–10, February 1991; and the U.S. Supplement, NEDE–24011–P–A–10–US, March 1991.

1. Plant–unique Items

Appendix A: Analysis Conditions
Appendix B: Basis for Analysis of Loss–of–feedwater Heating Event
Appendix C: Analyzed Operating Domain
Appendix D: Transient Analysis
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2. Reload Fuel Bundles

Fuel Type	Cycle Loaded	Number
Irradiated:		
GE8B–P8SQB301–5GZ–120M–150–T (GE8x8EB)	2	24
GE8B–P8SQB301–7GZ–120M–150–T (GE8x8EB)	2	24
GE8B–P8SQB322–7GZ–120M–150–T (GE8x8EB)	3	168
GE8B–P8SQB320–9GZ–120M–150–T (GE8x8EB)	3	104
GE10–P8SXB306–10GZ2–120M–150–T (GE8x8NB–1)	4	136
GE10–P8SXB306–11GZ3–120M–150–T (GE8x8NB–1)	4	68
New:		
GE10–P8SXB306–11GZ3–120M–150–T (GE8x8NB–1)	5	224
Total		748

3. Reference Core Loading Pattern

Nominal previous cycle core average exposure at end of cycle:	22343 MWd/MT (20269 MWd/ST)
Minimum previous cycle core average exposure at end of cycle from cold shutdown considerations:	21377 MWd/MT (19393 MWd/ST)
Assumed reload cycle core average exposure at beginning of cycle:	13318 MWd/MT (12082 MWd/ST)
Assumed reload cycle core average exposure at end of cycle:	25361 MWd/MT (23007 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	1.120
Fully controlled	0.954
Strongest control rod out	0.987
R, Maximum increase in cold core reactivity with exposure into cycle, Δk	0.002

5. Standby Liquid Control System Shutdown Capability

Boron (ppm)	Shutdown Margin (Δk) (20°C, Xenon Free)
660	0.026

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

Exposure: BOC5 to EOC5 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
GE8x8NB–1	1.20	1.57	1.40	1.000	7.345	115.7	1.21
GE8x8EB	1.20	1.48	1.40	1.051	6.907	119.6	1.17

Exposure: BOC5 to EOC5 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
GE8x8NB–1	1.20	1.64	1.40	1.000	7.645	113.6	1.20
GE8x8EB	1.20	1.54	1.40	1.051	7.168	117.7	1.18

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 %
Increased core flow at EOC:	Yes
Feedwater temperature reduction throughout cycle:	Yes
Temperature reduction:	170 °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: BOC5 to EOC5 Increased core flow/Feedwater temperature 420 °F					
			Uncorrected ΔCPR		
Event	Flux (%NBR)	Q/A (%NBR)	GE8x8NB–1	GE8x8EB	Fig.
Load Reject w/o Bypass	382	113	0.14	0.11	2
Loss of 100°F feedwater heating	–	–	0.12	0.12	–

Exposure range: BOC5 to EOC5 Increased core flow/Feedwater temperature reduction to 250 °F					
			Uncorrected ΔCPR		
Event	Flux (%NBR)	Q/A (%NBR)	GE8x8NB–1	GE8x8EB	Fig.
FW Controller Failure	266	116	0.13	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 applied.

11. Cycle MCPR Values[1]

Safety limit: 1.07

Single loop operation safety limit: 1.08

Non–pressurization events:

Exposure Range: BOC5 to EOC5		
	GE8x8NB–1	GE8x8EB
Rod Withdrawal Error	1.18	1.18
Fuel loading error[2]	1.23	1.21
Loss of 100°F feedwater heating	1.19	1.19

1. GEMINI ODYN adjustment factors are provided in the letter from J. S. Charnley (GE) to M. W. Hodges (NRC), GEMINI ODYN Adjustment Factors for BWR/6, dated July 6, 1987. The MCPR limit does not change because of channel bow. Channel bow is reflected in the monitoring of the core.

2 See Appendix E.

Pressurization events:

Exposure range: BOC5 to EOC5 Increased core flow/Feedwater temperature 420 °F Exposure point: EOC5		
	Option A	
	GE8x8NB–1	GE8x8EB
Load Reject w/o Bypass	1.22	1.18

Exposure range: BOC5 to EOC5 Increased core flow/Feedwater temperature reduction to 250 °F Exposure point: EOC5		
	Option A	
	GE8x8NB–1	GE8x8EB
FW Controller Failure	1.21	1.19

12. Overpressurization Analysis Summary

Event	Psl (psig)	Pv (psig)	Plant Response
MSIV Closure (Flux Scram)[1]	1264	1294	Figure 4

13. Loading Error Results

Variable water gap misoriented bundle analysis: Yes

	ΔCPR	
Event	GE8x8NB–1	GE8x8EB
Misoriented fuel bundle	0.16[2]	0.14[2]

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.

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1 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 Rev 2. The analysis was performed with the 13 highest setpoint safety valves operational.

2. ΔCPR penalty of 0.02 for the tilted misoriented bundle has been applied. See Appendix E.

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.

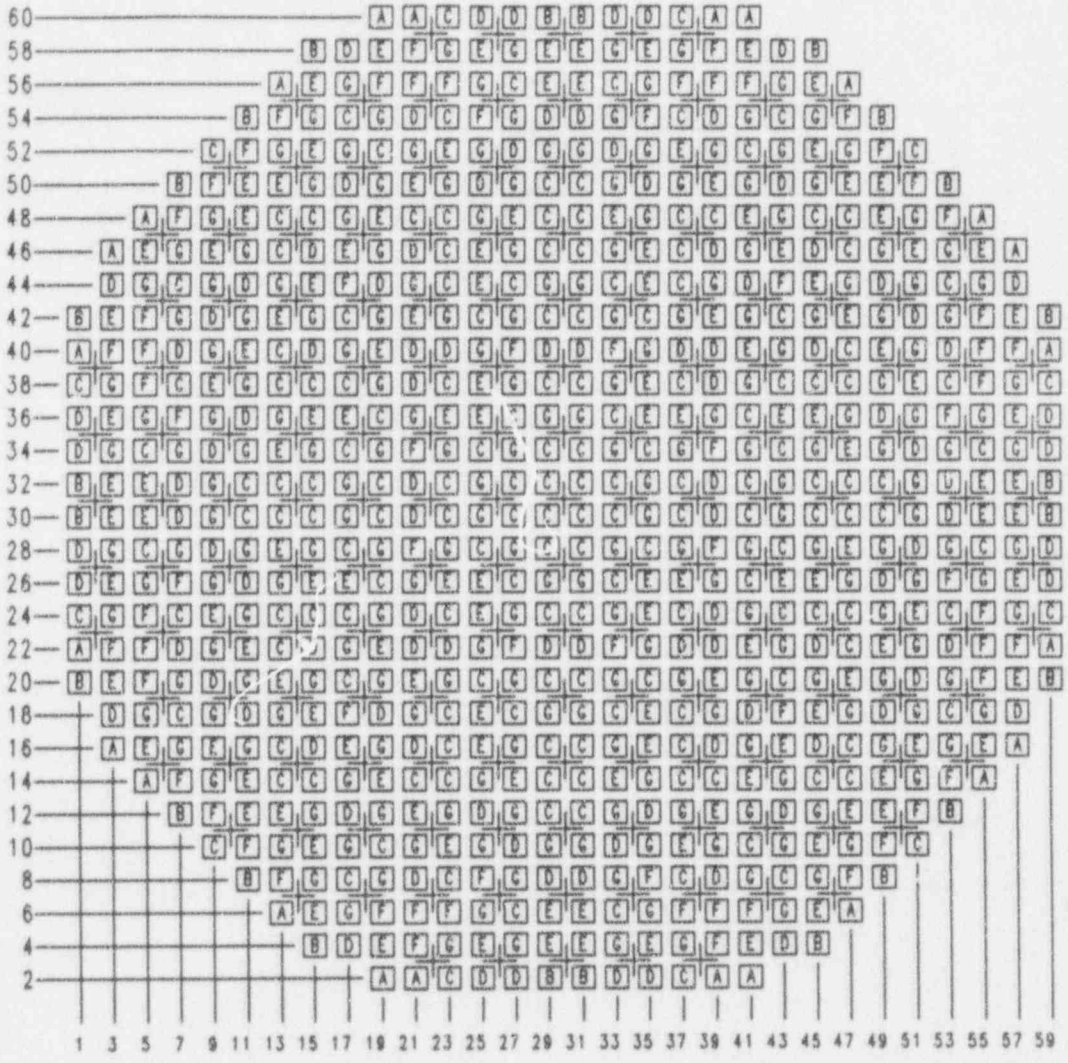
16. Loss–of–Coolant Accident Results

LOCA method used: SAFE/REFLOOD

Bundle Type: GE10–P8SXB306–11GZ3–120M–150–T (GE8x8NB–1)

Average Planar Exposure		MAPLHGR (kw/ft)	
(GWd/ST)	(GWd/MT)	Most limiting	Least Limiting
0.0	0.0	11.55	12.43
0.2	0.2	11.61	12.47
1.0	1.1	11.71	12.58
2.0	2.2	11.92	12.72
3.0	3.3	12.17	12.88
4.0	4.4	12.41	13.04
5.0	5.5	12.61	13.20
6.0	6.6	12.81	13.33
7.0	7.7	12.99	13.41
8.0	8.8	13.16	13.50
9.0	9.9	13.31	13.56
10.0	11.0	13.34	13.43
12.5	13.8	13.23	13.40
15.0	16.5	12.92	13.07
20.0	22.0	12.16	12.40
25.0	27.6	11.44	11.76
35.0	38.6	10.14	10.40
45.0	49.6	8.90	9.15
51.7	57.0	5.87	6.03
51.9	57.2	—	5.95

The peak clad temperature (PCT) is $\leq 2149°F$ at all exposures; the local oxidation (fraction) is ≤ 0.061 at all exposures. The MAPLHGR multiplier for single–loop operation (SLO) is 0.80.



Fuel Type	
A=GE8B–P8SQB301–5GZ–120M–150–T B=GE8B–P8SQB301–7GZ–120M–150–T C=GE8B–P8SQB322–7GZ–120M–150–T D=GE8B–P8SQB320–9GZ–120M–150–T	E=GE10–P8SXB306–10GZ2–120M–150–T F=GE10–P8SXB306–11GZ3–120M–150–T(CYCLE 4) G=GE10–P8SXB306–11GZ3–120M–150–T(CYCLE 5)

Figure 1 Reference Core Loading Pattern

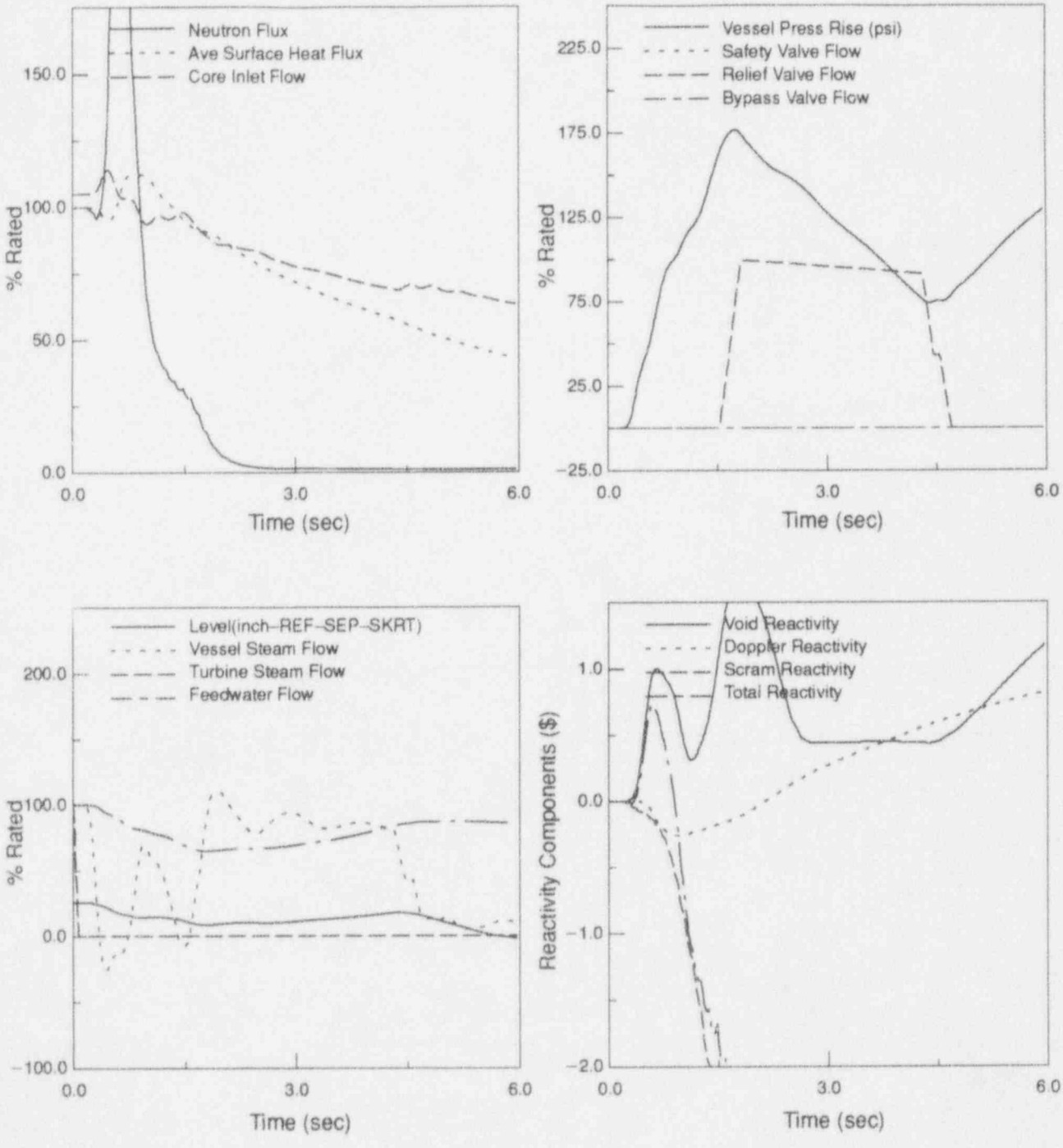


Figure 2 Plant Response to Load Reject w/o Bypass (BOC5 to EOC5 Increased core flow/Feedwater temperature 420 °F)

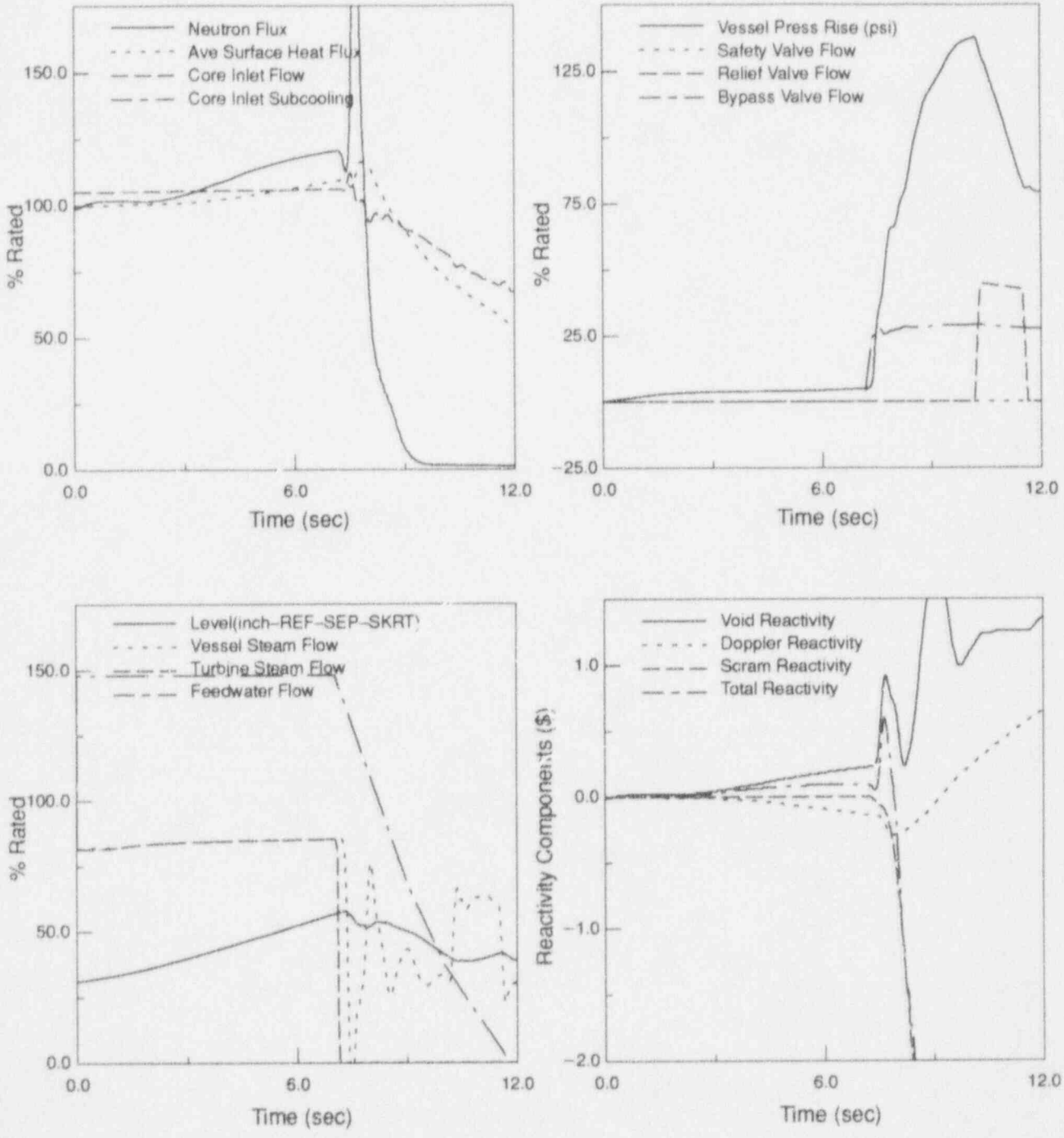


Figure 3 Plant Response to FW Controller Failure (BOC5 to EOC5 Increased core flow/Feedwater temperature reduction to 250 °F)

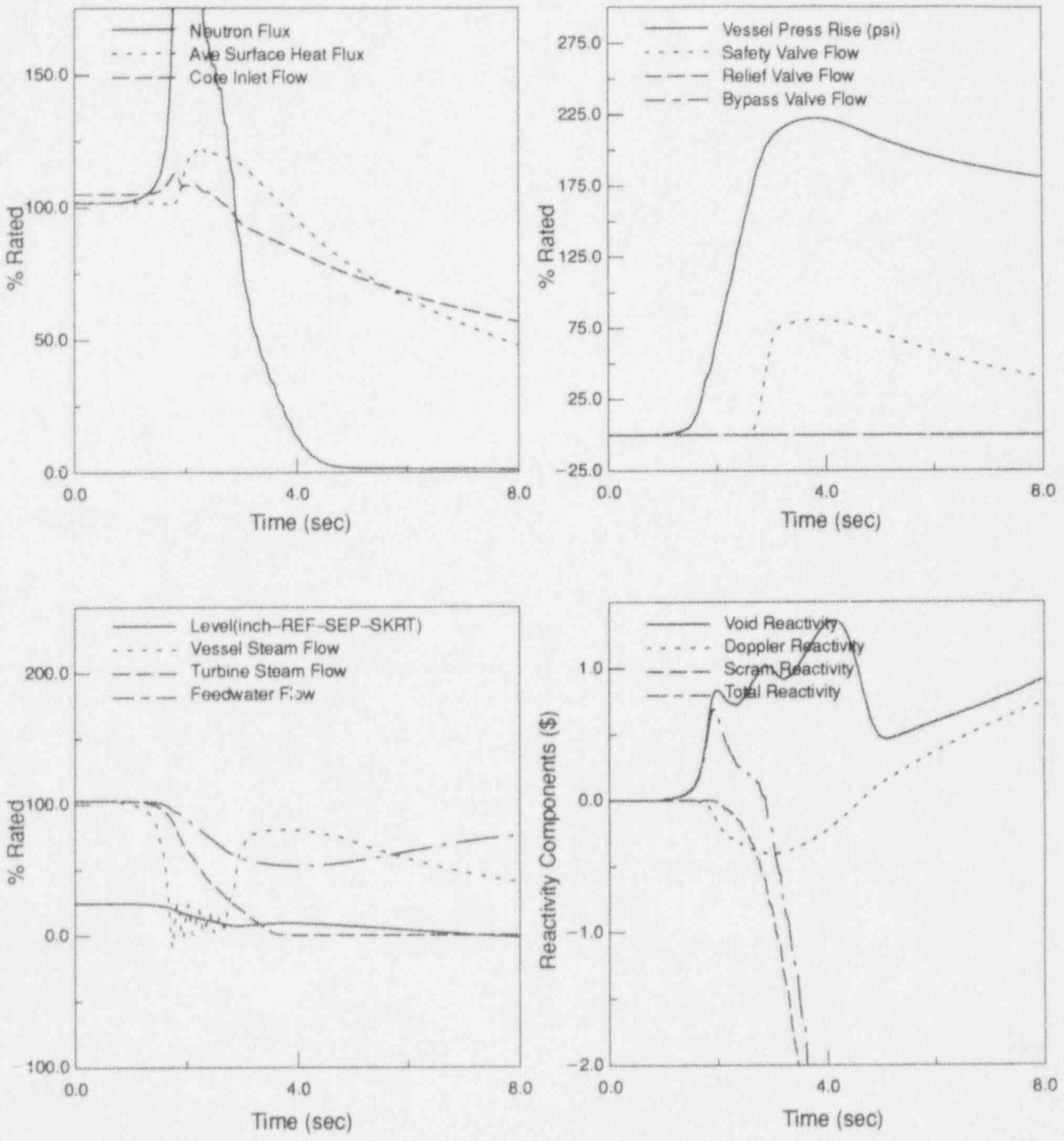


Figure 4 Plant Response to MSIV Closure (Flux Scram)

Appendix A

Analysis Conditions

To reflect actual plant parameters accurately, the values shown in Table A–1 were used this cycle.

Table A–1

	Analysis Value	
Parameter	**STANDARD**	**ICF/FWT250**
Thermal power, MWt	3579.0	3579.0
Core flow, Mlb/hr	109.2	109.2
Reactor pressure, psia	1056.0	1056.0
Inlet enthalpy, BTU/lb	528.8	512.4
Non–fuel power fraction	0.038	0.038
Power analysis, MWt	3579.0	3579.0
Steam flow analysis, Mlb/hr	15.41	12.55
Core flow analysis, Mlb/hr	109.2	109.2
Dome pressure, psig	1025.6	1008.0
Turbine pressure, psig	975.4	974.5
No. of Dual Mode S/R Valves	17(1)	17(1)
Relief mode lowest setpoint, psig	1143.0(1)	1143.0(1)
Safety mode lowest setpoint, psig	1200.0	1200.0

1 There are a total of 19 valves; the 2 lowest setpoint safety/relief valves are assumed to be out–of–service in the transient analyses. For the MSIV–F 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 using the BWR Simulator Code (Reference B–1). The use of this code is permitted in GESTAR II (Reference B–2). The transient plots, neutron flux and heat flux values normally reported in Section 9 are not an output of the BWR Simulator Code; therefore, these items are not included in this document.

The transient analysis inputs normally reported in Section 6 of the licensing submittal are internally calculated in the BWR Simulator Code and in ODYN.

References

B–1. *Steady–State Nuclear Methods*, NEDE–30130–P–A and NEDO–30130–A, April 1985.

B–2. *General Electric Standard Application for Reactor Fuel*, NEDE–24011–P–A–10, February 1991.

Appendix C

Analyzed Operating Domain

The core–wide abnormal operational occurence (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 Reference C–1 and the USAR analytical results. The Reload 4/Cycle 5 analyses were performed assuming all four turbine control valves in a full arc mode of operation. This is conservative for partial arc configuration.

The single–loop operation (SLO) analysis was reverified for the standard power/flow map with normal feedwater temperature.

References

C–1. *General Electric Standard Application for Reactor Fuel*, NEDE–24011–P–A–10–US, April 1991.

Appendix D

Transient Analyses

The turbine trip without bypass (TTNBP) analysis AOO is a pressure increase event normally checked on a cycle–by–cycle basis to determine if this AOO could potentially establish the cycle MCPR operating limit.

The Perry turbine control valves will be operated in a full arc mode throughout Cycle 5. The load rejection without bypass (LRNBP) is always more limiting in this mode of operation; therefore, the TTNBP will not be limiting for Cycle 5 and was not analyzed.

The load rejection without bypass (LRNBP) AOO was run for the standard case only since it has been shown to be more limiting than the feedwater temperature reduction cases in previous reload analyses.

The pressure regulator failure down scale (PRFDS) AOO was not run this cycle since it has been shown to be significantly less limiting than the other pressurization events in previous reload analyses.

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 rotated bundle analysis sets the operating limit, and does not change with feedwater temperature.

Appendix E

Rotated Bundle Analysis

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

Table E–1

	ΔCPR
GE8B–P8SQB301–7GZ–120M–150–T (GE8x8EB)	0.13
GE8B–P8SQB301–5GZ–120M–150–T (GE8x8EB)	0.12
GE8B–P8SQB320–9GZ–120M–150–T (GE8x8EB)	0.14
GE8B–P8SQB322–7GZ–120M–150–T (GE8x8EB)	0.14
GE10–P8SXB306–11GZ3–120M–150–T (GE8x8NB–1)	0.16
GE10–P8SXB306–10GZ2–120M–150–T (GE8x8NB–1)	0.09

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