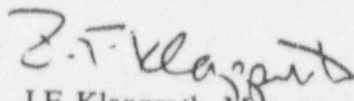


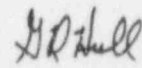


GE Nuclear Energy

24A5159
Revision 0
Class I
February 1995

24A5159, Rev. 0
Supplemental Reload Licensing Report
for
Brunswick Steam Electric Plant Unit 1
Reload 9 Cycle 10

Approved 
J.F. Klapproth, Manager
Fuel and Facility Licensing

Approved 
G.R. Hull
Fuel Project Manager

Important Notice Regarding

Contents of This Report

Please Read Carefully

This report was prepared by General Electric Company (GE) solely for Carolina Power and Light Company (CP&L) for CP&L's use in defining operating limits for the Brunswick Steam Electric Plant Unit 1. The information contained in this report is believed by GE to be an accurate and true representation of the facts known or obtained or provided to GE at the time this report was prepared.

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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 M.R. Morris. The Supplemental Reload Licensing Report was prepared by M.R. Morris. This document has been verified by R.N. Anderson.

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: Main Steamline Isolation Valve Out of Service
Appendix C: Reload Unique Anticipated Operational Occurrence (AOO) Analysis Input
Appendix D: Final Feedwater Temperature Reduction (FFWTR)
Appendix E: Maximum Extended Operating Domain

2. Reload Fuel Bundles

Fuel Type	Cycle Loaded	Number
<u>Irradiated:</u>		
GE8B-P8DQB339-11GZ-80M-4WR-150-T (GE8x8EB)	7	60
GE8B-P8DQB323-10GZ-80M-4WR-150-T (GE8x8EB)	7	60
GE10-P8HXB322-11GZ-70M-150-T (GE8x8NB-3)	8	108
GE10-P8HXB324-12GZ-70M-150-T (GE8x8NB-3)	8	52
GE10-P8HXB320-11GZ-100M-150-T (GE8x8NB-3)	9	68
GE10-P8HXB322-11GZ-70M-150-T (GE8x8NB-3)	9	56
<u>New:</u>		
GE10-P8HXB346-12GZ-100M-150-T (GE8x8NB-3)	10	156
Total		560

3. Reference Core Loading Pattern

Nominal previous cycle core average exposure at end of cycle:	24864 MWd/MT (22556 MWd/ST)
Minimum previous cycle core average exposure at end of cycle from cold shutdown considerations:	24547 MWd/MT (22269 MWd/ST)
Assumed reload cycle core average exposure at beginning of cycle:	15484 MWd/MT (14047 MWd/ST)
Assumed reload cycle core average exposure at end of cycle:	26734 MWd/MT (24253 MWd/ST)
Reference core loading pattern:	Figure 1

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

Beginning of Cycle, $k_{\text{effective}}$	
Uncontrolled	1.111
Fully controlled	0.969
Strongest control rod out	0.989
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)
600	0.029

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

Exposure: BOC10 to EOC10-2000 MWd/MT (1814 MWd/ST) BRUNSWICK 1 C10 ICF

Fuel Design	Peaking Factors			R-Factor	Bundle Power (MWt)	Bundle Flow (1000 lb/hr)	Initial MCPR
	Local	Radial	Axial				
GE8x8NB-3	1.20	1.70	1.40	1.000	7.203	107.6	1.21

Exposure: EOC10-2000 MWd/MT (1814 MWd/ST) to EOC10 BRUNSWICK 1 C10 ICF

Fuel Design	Peaking Factors			R-Factor	Bundle Power (MWt)	Bundle Flow (1000 lb/hr)	Initial MCPR
	Local	Radial	Axial				
GE8x8NB-3	1.20	1.62	1.40	1.000	6.897	109.7	1.27

Exposure: BOC10 to EOC10 BRUNSWICK 1 C10 MSIVOOS

Fuel Design	Peaking Factors			R-Factor	Bundle Power (MWt)	Bundle Flow (1000 lb/hr)	Initial MCPR
	Local	Radial	Axial				
GE8x8NB-3	1.20	1.64	1.40	1.000	6.944	109.4	1.26

Exposure: BRUNSWICK 1 C10 Extended EOC10 with FFWTR							
Fuel Design	Peaking Factors			R-Factor	Bundle Power (MWt)	Bundle Flow (1000 lb/hr)	Initial MCPR
	Local	Radial	Axial				
GE8x8NB-3	1.20	1.67	1.40	1.000	7.070	108.1	1.26

7. Selected Margin Improvement Options

Recirculation pump trip:	No
Thermal power monitor:	Yes
Improved scram time:	Yes (ODYN Option B)
Measured scram time:	No
Exposure dependent limits:	Yes
Exposure points analyzed:	2 (EOC10-2000 MWd/MT and EOC10)

8. Operating Flexibility Options

Single-loop operation:	Yes
Load line limit:	Yes
Extended load line limit:	Yes
Maximum extended load line limit:	Yes
Increased core flow throughout cycle:	Yes
Flow point analyzed:	105.0 %
Increased core flow at EOC:	Yes
Feedwater temperature reduction throughout cycle:	No
Final feedwater temperature reduction:	Yes
Temperature reduction:	130.0°F
ARTS Program:	Yes
Maximum extended operating domain:	Yes

Moisture separator reheater OOS:	No
Turbine bypass system OOS:	No
Safety/relief valves OOS: (credit taken for 9 of 11 valves)	Yes
ADS OOS:	Yes (2 valves OOS)
EOC RPT OOS:	No
Main steam isolation valve OOS:	Yes

9. Core-wide AOO Analysis Results

Methods used: GEMINI; GEXL-PLUS

Exposure range: BOC10 to EOC10-2000 MWd/MT (1814 MWd/ST) BRUNSWICK 1 C10 ICF					
Event	Flux (%NBR)	Q/A (%NBR)	Uncorrected Δ CPR		Fig.
			GE8x8NB-3		
	—	—			—
Load Reject w/o Bypass	376	117	0.14		2
Turbine Trip w/o Bypass	354	116	0.14		3

Exposure range: EOC10-2000 MWd/MT (1814 MWd/ST) to EOC10 BRUNSWICK 1 C10 ICF					
Event	Flux (%NBR)	Q/A (%NBR)	Uncorrected Δ CPR		Fig.
			GE8x8NB-3		
	—	—			—
Load Reject w/o Bypass	508	122	0.20		4
Turbine Trip w/o Bypass	521	121	0.20		5

Exposure range: BOC10 to EOC10 BRUNSWICK 1 C10 MSIVOOS					
Event	Flux (%NBR)	Q/A (%NBR)	Uncorrected Δ CPR		Fig.
			GE8x8NB-3		
	—	—			—
Load Reject w/o Bypass	435	120	0.19		6
Turbine Trip w/o Bypass	427	120	0.19		7

Exposure range: BRUNSWICK 1 C10 Extended EOC10 with FFWTR					
			Uncorrected Δ CPR		
Event	Flux (%NBR)	Q/A (%NBR)	GE8x8NB-3		Fig.
FW Controller Failure	402	124	0.19		8
	—	—			—
	—	—			—

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

The rod withdrawal error event in the maximum extended operating domain was originally analyzed in the GE BWR Licensing Report, *Maximum Extended Operating Domain Analysis for Brunswick Steam Electric Plant*, NEDC-31654P, dated February 1989. The MCPR limit for rod withdrawal error is bounded by the operating limit MCPRs presented in Section 11 of this report for RBM setpoints shown in Tables 10-5(a) or 10-5(b) of NEDC-31654P.

11. Cycle MCPR Values^{1, 2}

Safety limit: 1.07

Single loop operation safety limit: 1.08

Non-pressurization events:

Exposure Range: BOC10 to EOC10		
	GE8x8NB-3	
Fuel Loading Error (misoriented)	1.25	—
Fuel Loading Error (mislocated)	1.24	—
LFWH	1.20	—

1. *Brunswick Steam Electric Plant Units 1 and 2 Single-Loop Operation*, NEDC-31776P December 1989, Operating limit MCPR for two loop operation (TLO) bounds the operating limit MCPR for single loop operation (SLO): $\Delta\text{CPR}(\text{SLO}) < (\Delta\text{CPR}(\text{TLO}) - 0.01)$, therefore, operating limit MCPR need not be changed for SLO.

2. The GE8x8NB-3 fuel type MCPR values bound the GE8x8NB-3 MCPR values for all events.

Pressurization events:

Exposure range: BOC10 to EOC10-2000 MWd/MT (1814 MWd/ST) BRUNSWICK 1 C10 ICF Exposure point: EOC10-2000 MWd/MT (1814 MWd/ST)				
	Option A		Option B	
	GE8x8NB- 3		GE8x8NB- 3	
Load Reject w/o Bypass				
Turbine Trip w/o Bypass	1.31		1.24	
	1.31		1.24	

Exposure range: EOC10-2000 MWd/MT (1814 MWd/ST) to EOC10 BRUNSWICK 1 C10 ICF Exposure point: EOC10				
	Option A		Option B	
	GE8x8NB- 3		GE8x8NB- 3	
Load Reject w/o Bypass				
Turbine Trip w/o Bypass	1.32		1.28	
	1.32		1.28	

Exposure range: BOC10 to EOC10 BRUNSWICK 1 C10 MSIVOOS Exposure point: EOC10				
	Option A		Option B	
	GE8x8NB- 3		GE8x8NB- 3	
Load Reject w/o Bypass				
Turbine Trip w/o Bypass	1.32		1.28	
	1.31		1.27	

Exposure range: BRUNSWICK 1 C10 Extended EOC10 with FFWTR Exposure point: EOC10				
	Option A		Option B	
	GE8x8NB- 3		GE8x8NB- 3	
FW Controller Failure	1.30		1.27	

12. Overpressurization Analysis Summary

Event	Psl (psig)	Pv (psig)	Plant Response
MSIV Closure (Flux Scram)	1243	1272	Figure 9

13. Loading Error Results

Variable water gap misoriented bundle analysis: Yes³

Misoriented Fuel Bundle	Δ CPR
GE10-P8HXB346-12GZ-100M-150-T (GE8x8NB-3)	0.18

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 and GE interim corrective actions have been included in the Brunswick Steam Electric Plant Unit 1 operating procedures. Regions of restricted operation defined in Attachment 1 to NRC Bulletin No. 88-07, Supplement 1, *Power Oscillations in Boiling Water Reactors (BWRs)*, are applicable to Brunswick 1.

16. Loss-of-Coolant Accident Results

LOCA method used: SAFER/GESTR-LOCA

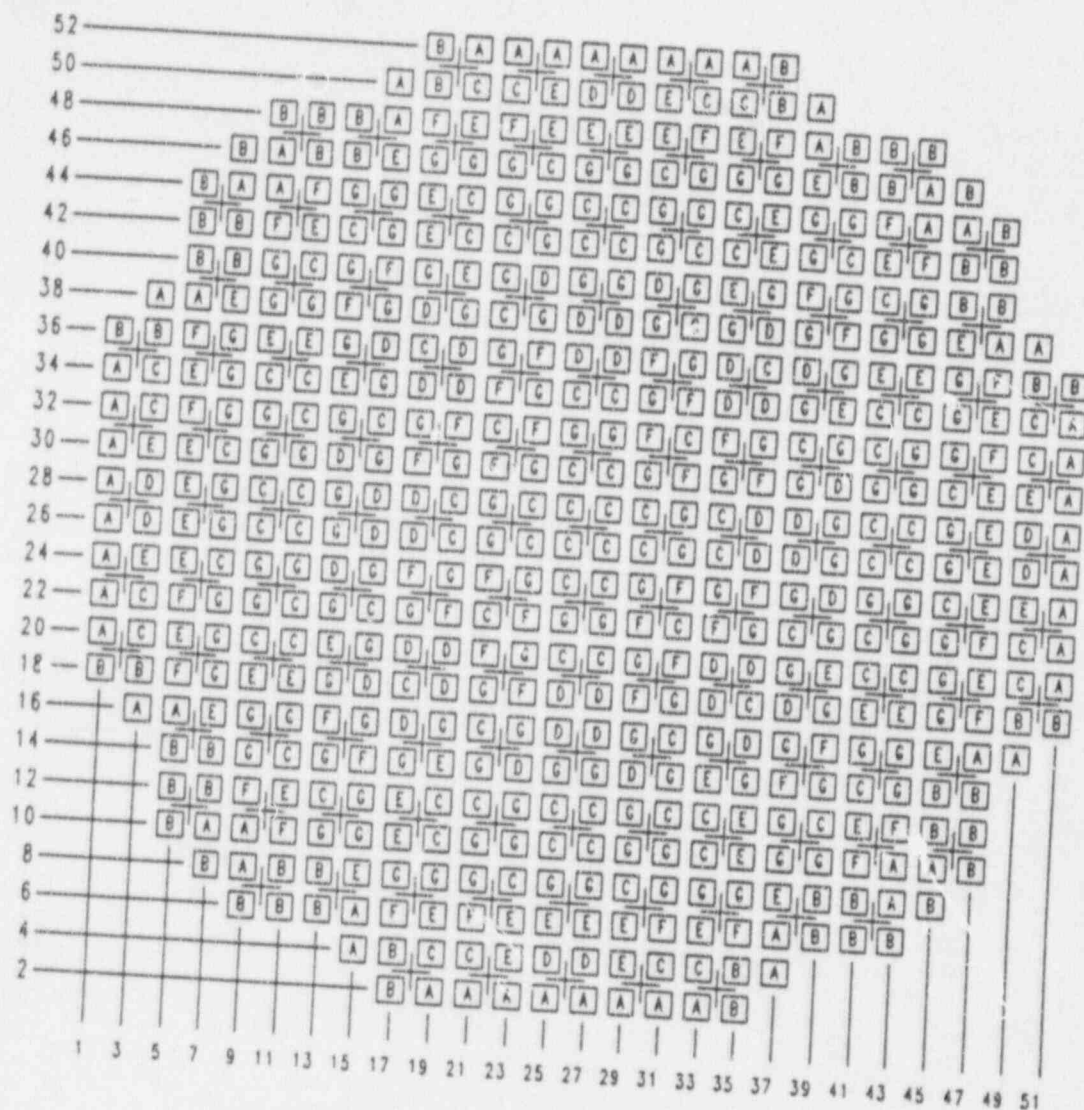
The GE8x8EB LOCA analysis results presented in Sections 5 and 6 of *Brunswick Steam Electric Plant Units 1 and 2 SAFER/GESTAR-LOCA Loss-of-coolant Accident Analysis*, NEDC-31624P, Revision 2, July 1990, conservatively bound the LOCA analysis of the GE8x8NB-3 fuel types. This analysis yielded a licensing basis peak clad temperature of 1533°F, a peak local oxidation fraction of <0.30%, and a core-wide metal-water reaction of 0.046%. The most and the least limiting MAPLHGRs for the new GE8x8NB-3 fuel design are as follows:

³. Includes a 0.02 penalty due to variable water gap R-factor uncertainty.

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

Bundle Type: GE10-P8HXB346-12GZ-100M-150-T

Average Planar Exposure		MAPLHGR(kW/ft)	
(GWd/ST)	(GWd/MT)	Most Limiting	Least Limiting
0.00	0.00	10.92	11.44
0.20	0.22	10.95	11.52
1.00	1.10	11.04	11.65
2.00	2.20	11.21	11.83
3.00	3.31	11.41	12.00
4.00	4.41	11.65	12.19
5.00	5.51	11.90	12.37
6.00	6.61	12.08	12.56
7.00	7.72	12.26	12.75
8.00	8.82	12.47	12.96
9.00	9.92	12.71	13.05
10.00	11.02	12.94	13.09
12.50	13.78	12.86	13.18
15.00	16.53	12.73	12.95
20.00	22.05	12.05	12.43
25.00	27.56	11.33	11.67
35.00	38.58	10.06	10.28
45.00	49.60	8.76	8.93
51.31	56.56	5.86	6.16
51.37	56.62	—	6.13
51.92	57.24	—	5.89
52.06	57.39	—	5.83



Fuel Type			
A=GE8B-P8DQB339-11GZ-80M-4WR-150-T	(Cycle 7)	E=GE10-P8HXB320-11GZ-100M-150-T	(Cycle 9)
B=GE8B-P8DQB323-10GZ-80M-4WR-150-T	(Cycle 7)	F=GE10-P8HXB322-11GZ-70M-150-T	(Cycle 9)
C=GE10-P8HXB322-11GZ-70M-150-T	(Cycle 8)	G=GE10-P8HXB346-12GZ-100M-150-T	(Cycle 10)
D=GE10-P8HXB324-12GZ-70M-150-T	(Cycle 8)		

Figure 1 Reference Core Loading Pattern

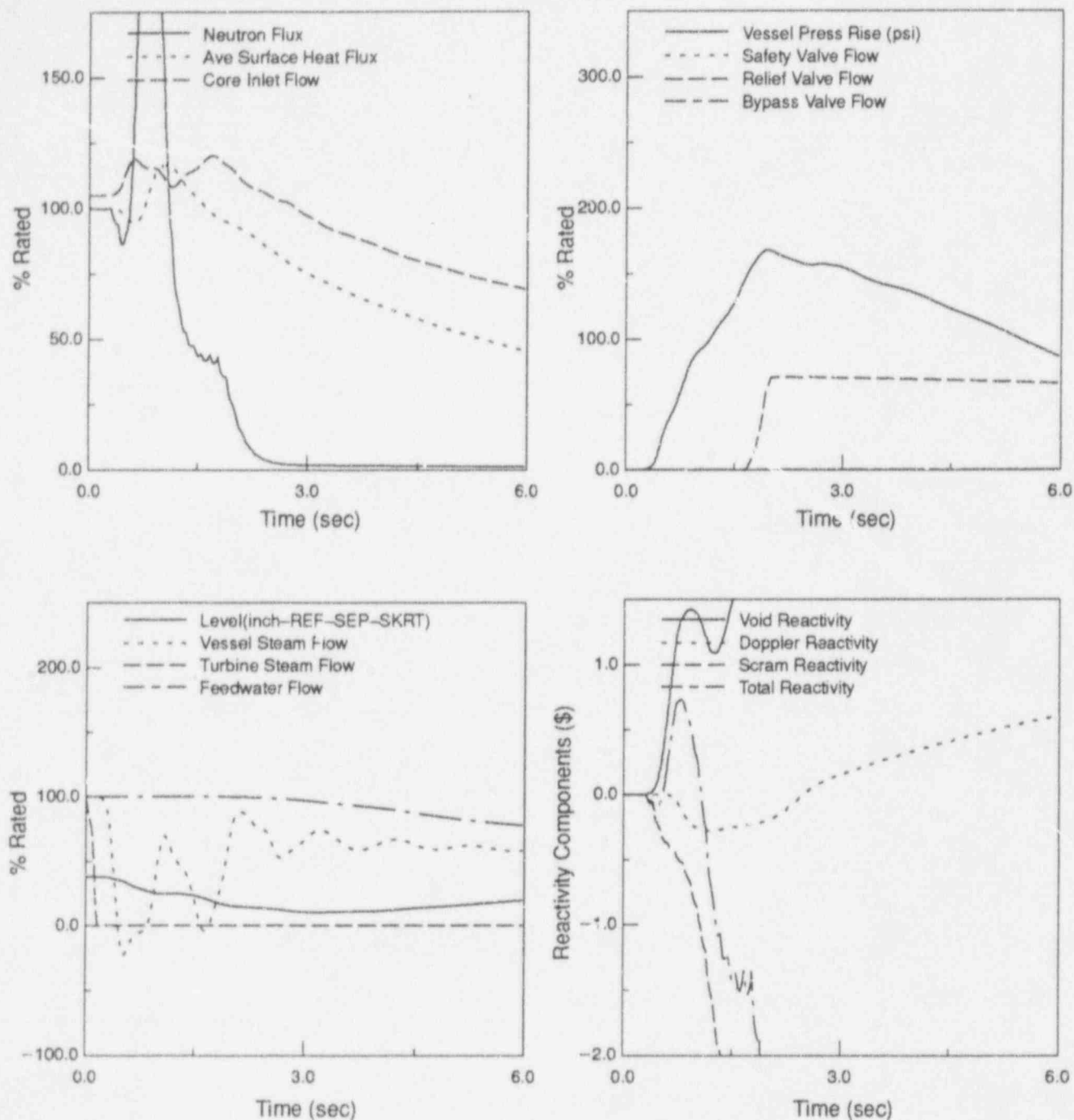


Figure 2 Plant Response to Load Reject w/o Bypass (BOC10 to EOC10-2000 MWd/MT
(1814 MWd/ST) BRUNSWICK 1 C10 ICF)

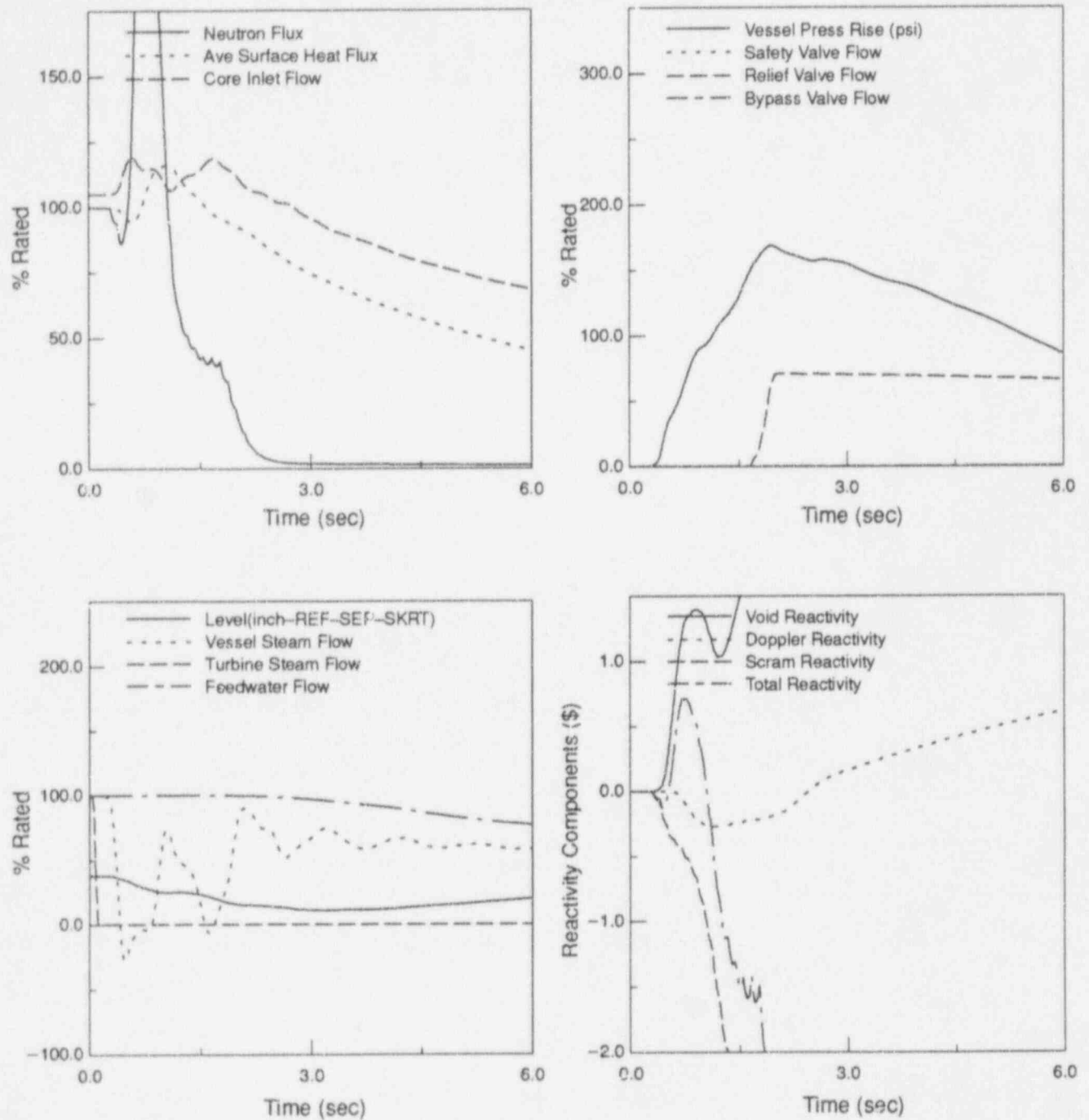


Figure 3 Plant Response to Turbine Trip w/o Bypass (BOC10 to EOC10-2000 MWd/MT
(1814 MWd/ST) BRUNSWICK 1 C10 ICF)

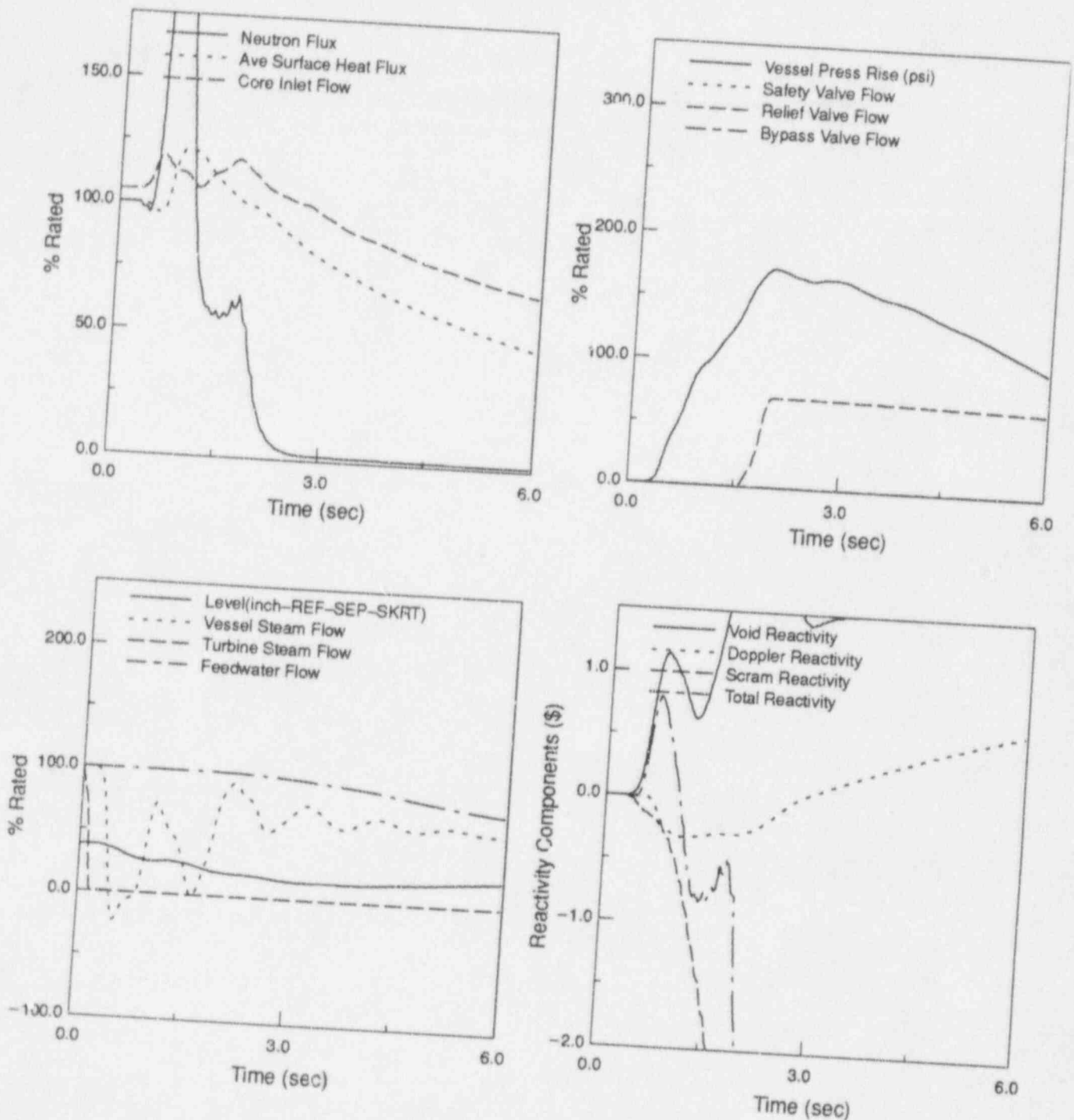


Figure 4 Plant Response to Load Reject w/o Bypass (EOC10-2000 MWd/MT (1814 MWd/ST) to EOC10 BRUNSWICK 1 C10 ICF)

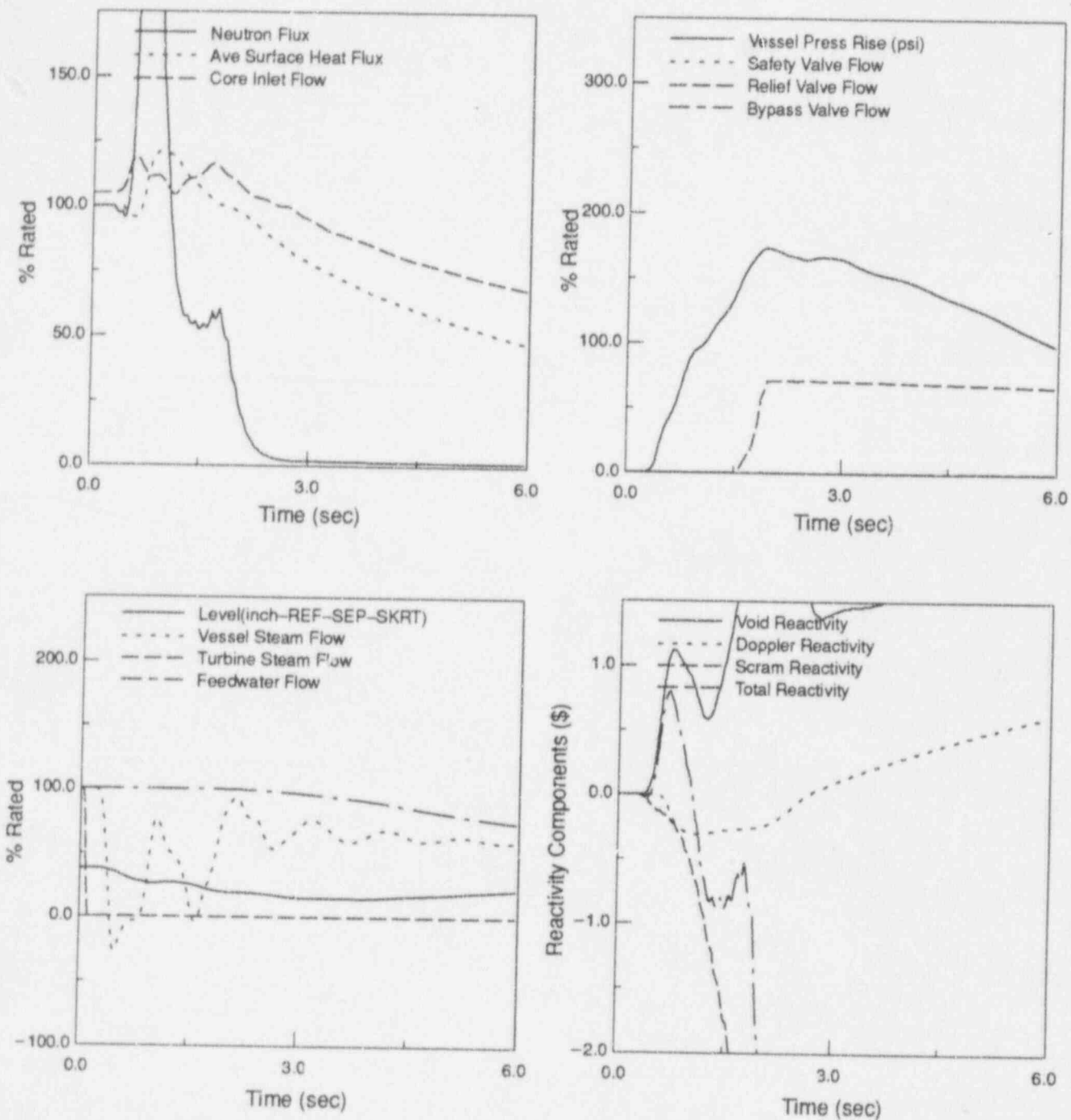


Figure 5 Plant Response to Turbine Trip w/o Bypass (EOC10-2000 MWd/MT (1814 MWd/ST) to EOC10 BRUNSWICK 1 C10 ICF)

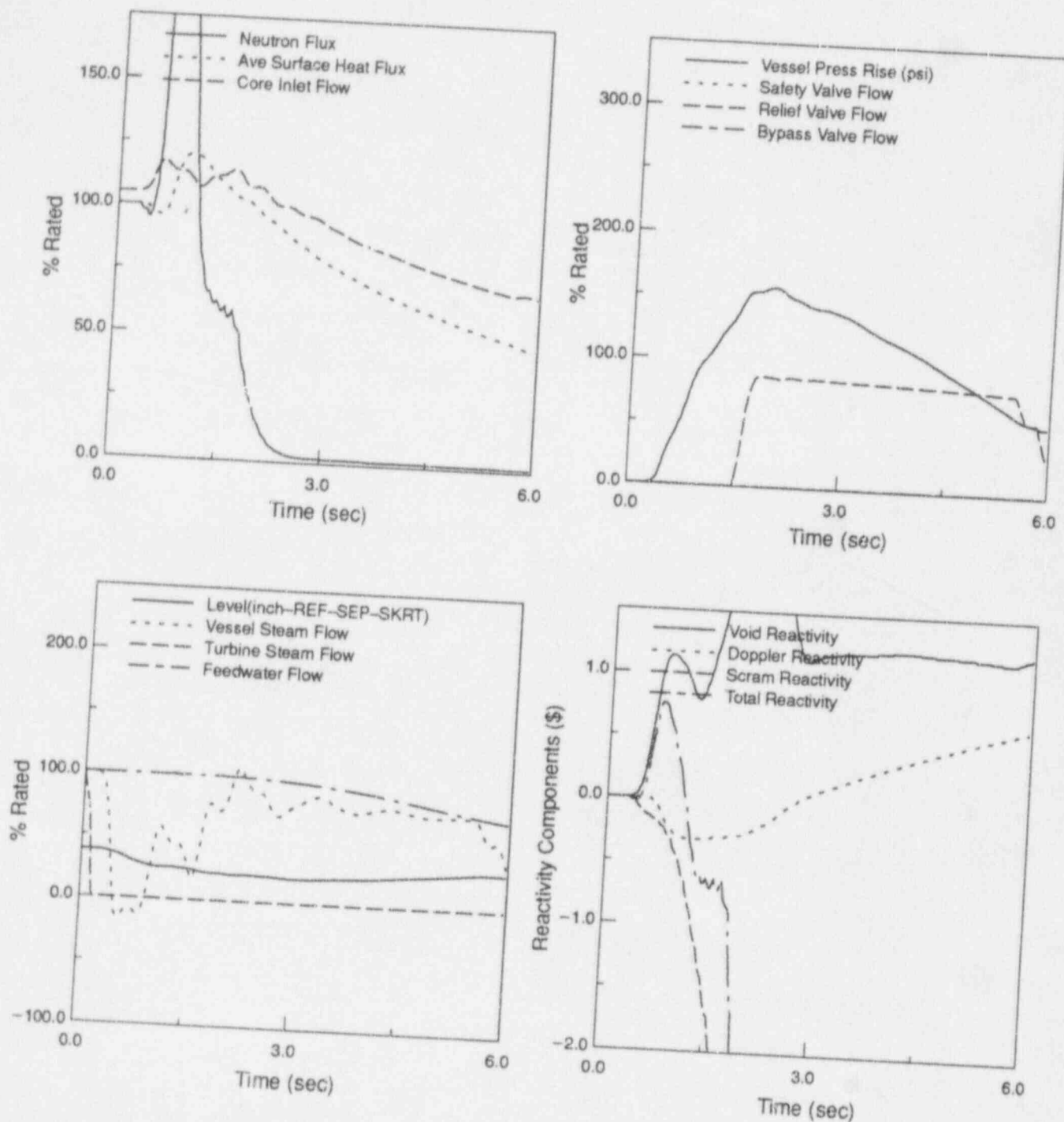


Figure 6 Plant Response to Load Reject w/o Bypass (BOC10 to EOC10 BRUNSWICK 1 C10 MSIVOOS)

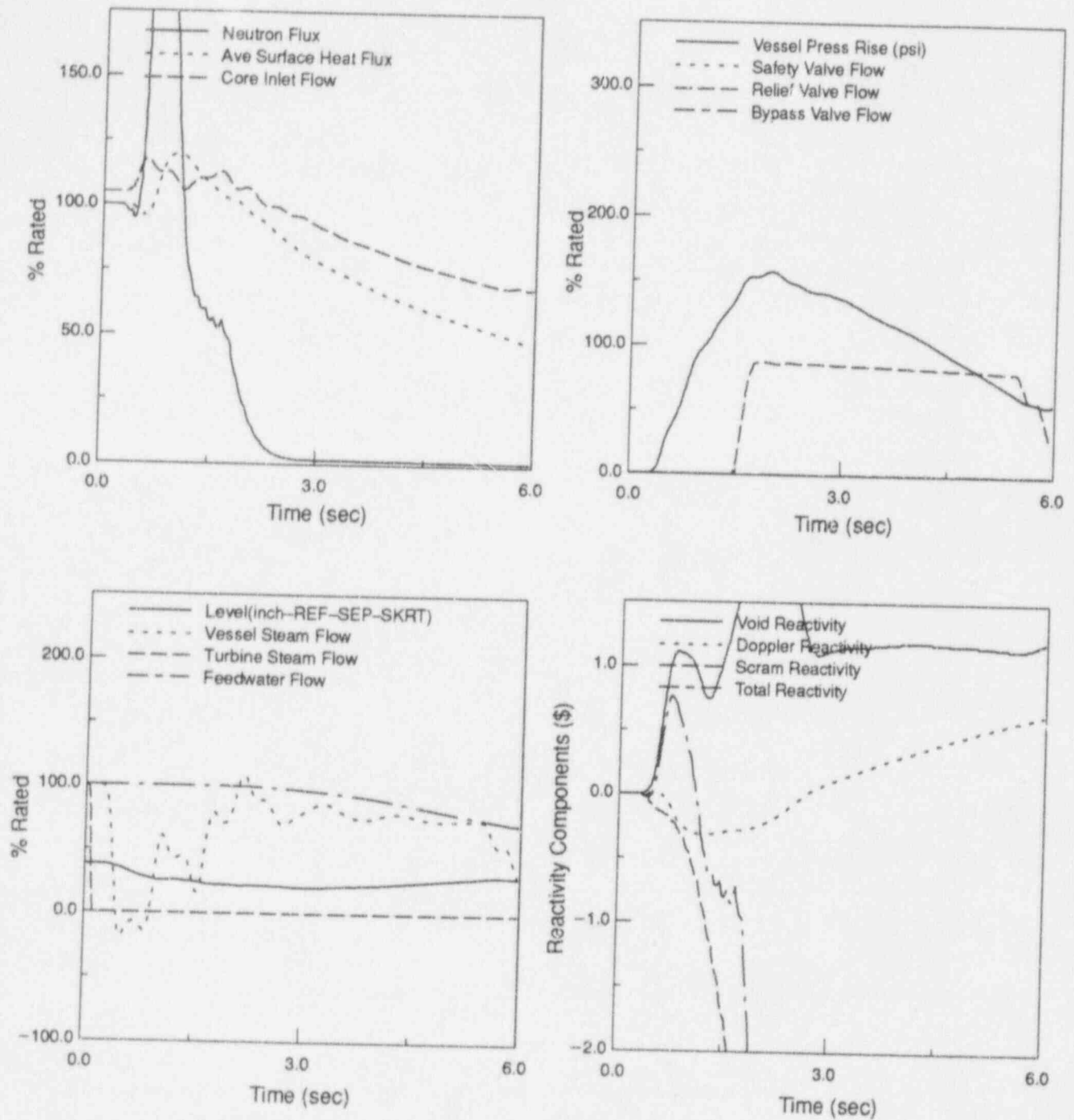


Figure 7 Plant Response to Turbine Trip w/o Bypass (BOC10 to EOC10 BRUNSWICK 1 C10 MSIVOOS)

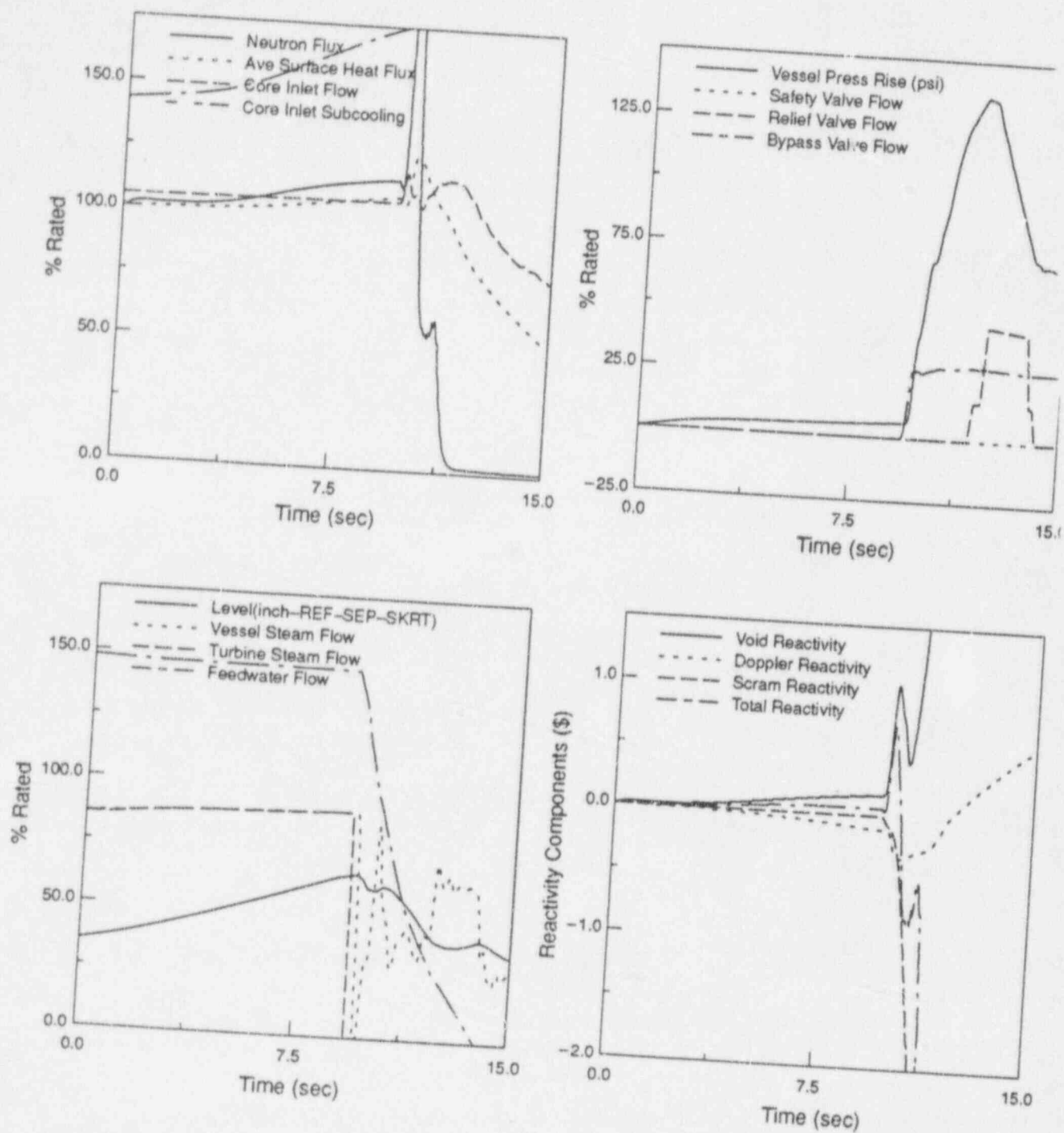


Figure 8 Plant Response to FW Controller Failure (BRUNSWICK 1 C10 Extended EOC10 with FFWTR)

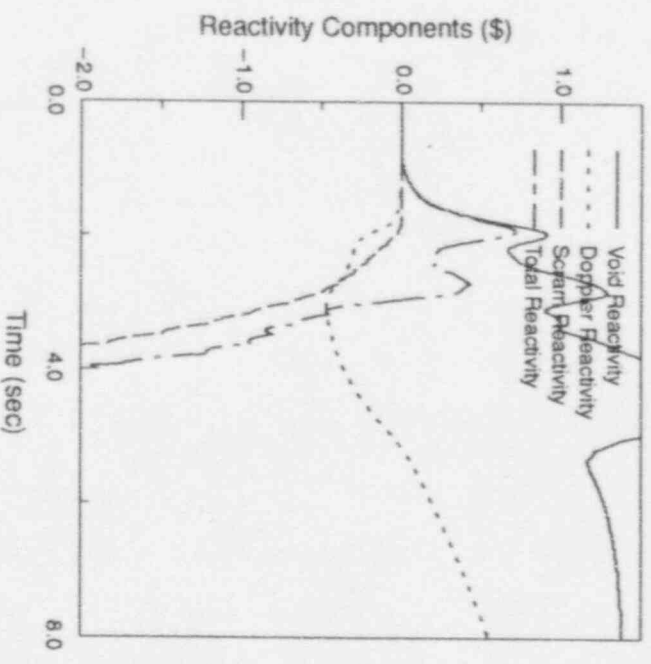
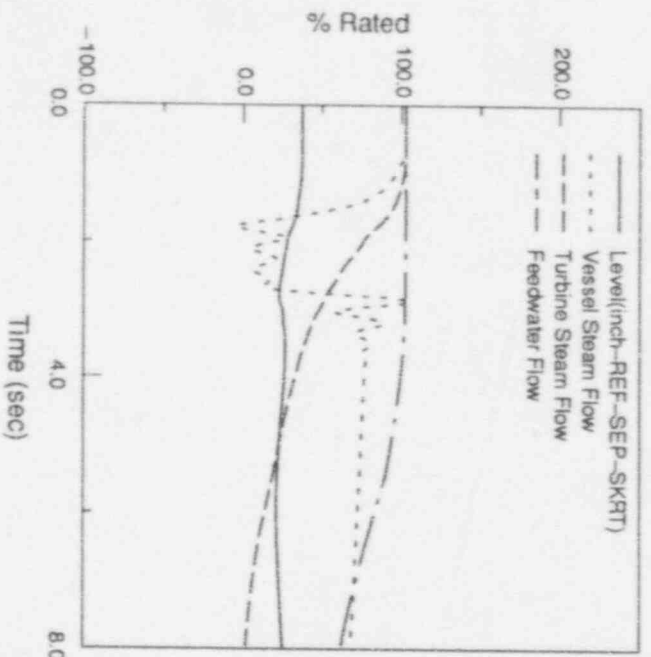
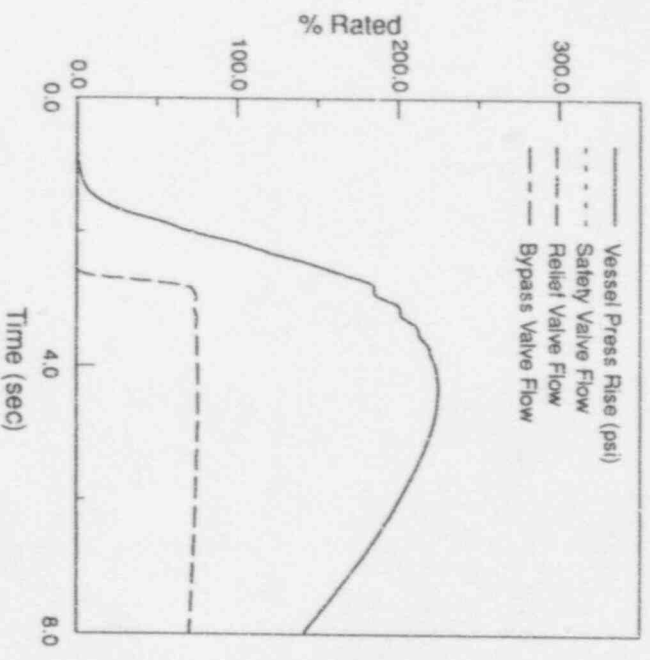
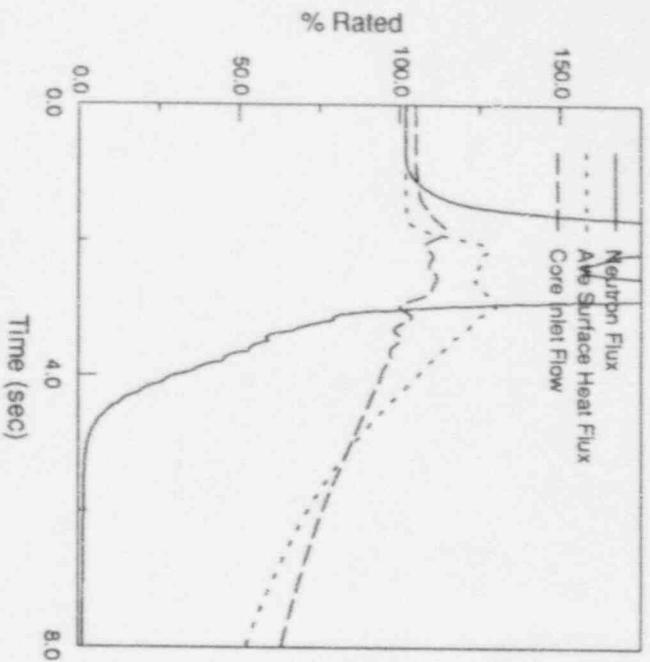


Figure 9 Plant Response to MSIV Closure (Flux Scram)

Appendix A Analysis Conditions

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

Table A-1

Parameter	Analysis Value		
	ICF	MSIVOOS	FFWTR
Thermal power, MWt	2436.0	2436.0	2436.0
Core flow, Mlb/hr	80.8	80.8	80.8
Reactor pressure, psia	1036.0	1036.0	1034.5
Inlet enthalpy, BTU/lb	528.0	528.0	515.8
Non-fuel power fraction	0.038	0.038	0.038
Steam flow analysis, Mlb/hr	10.48	10.48	8.94
Dome pressure, psig	1005.7	1020.3	992.1
Turbine pressure, psig	950.0	919.9	951.3
No. of Safety/Relief Valves	9	11	9
Relief mode lowest setpoint, psig	1116.0	1116.0	1116.0
Recirculation pump power source	On-site ⁴	On-site ⁴	On-site ⁴
Turbine control valve mode of operation	Partial arc	Partial arc	Partial arc

4. Bounds operation with off-site power source for reload licensing events for Cycle 10.

Appendix B

Main Steamline Isolation Valve Out of Service

Reference B-1 provided a basis for operation of Brunswick Steam Electric Plant (BSEP) with one Main Steamline Isolation Valve Out of Service (MSIVOOS) (three steamline operation) and all S/RVs in service. For this mode of operation in BSEP Unit 1 throughout Cycle 10, the EOC10-2000 MWd/MT to EOC10 MCPR limits presented in Section 11 of the body of this report are bounding and should be applied when operating in the MSIVOOS mode at any time during the cycle. The peak steamline and peak vessel pressures for the limiting overpressurization event (MSIV closure with flux scram) were not calculated for the MSIVOOS mode of operation. In this mode of operation it is required that all S/RVs be operational versus the assumed 2 S/RVs OOS for the events evaluated during normal plant operation. Previous cycles analyses have shown that the MSIV closure with flux scram, evaluated in the MSIVOOS mode, has resulted in the peak vessel pressure being reduced by more than 25 psi, when compared to the same case evaluated with all (four) steamlines operational.

Reference

B-1. *Main Steamline Isolation Valve Out of Service for the Brunswick Steam Electric Plant*, EAS-117-0987, GE Nuclear Energy, April 1988.

Appendix C Reload Unique Anticipated Operational Occurrence (AOO) Analysis Input

The data previously recorded in this Appendix (input to be used in the analysis of the cold water injection transient) (Inadvertent startup of the HPCI system), has been eliminated. The basis of this is the information contained in Reference C-1.

Reference

C-1. *Determination of Limiting Cold Water Event*, March 14, 1994 letter from J.F. Klapproth (GE Nuclear Energy) to USNRC.

Appendix D

Final Feedwater Temperature Reduction (FFWTR)

An NEDC report will be issued that justifies the use of Final Feedwater Temperature Reduction (FFWTR) for Brunswick 1 Cycle 10. The MCPR limits presented in section 11 are bounding and should be applied when operating with FFWTR.

Appendix E Maximum Extended Operating Domain

Reference E-1 provided a basis for operation of the Brunswick Steam Electric Plant in the Maximum Extended Operating Domain (MEOD). The reload licensing analysis performed for Cycle 10 and documented herein is consistent with and provide the cycle-specific update to the reference E-1 analysis. Application of the GEXL-PLUS correlation to the reload fuel has been confirmed as required in reference E-1.

Reference

E-1. *Maximum Extended Operating Domain Analysis for Brunswick Steam Electric Plant*, NEDC-31654P, GE Nuclear Energy (Proprietary), February 1989.

ENCLOSURE 3

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 1
NRC DOCKET NO. 50-325
OPERATING LICENSE NO. DPR-71
TRANSMITTAL OF CORE OPERATING LIMITS REPORT, SUPPLEMENTAL RELOAD
LICENSING REPORT, AND LOSS-OF-ACCIDENT ANALYSIS REPORT

LOSS-OF-COOLANT ACCIDENT ANALYSIS REPORT
FOR
BRUNSWICK STEAM ELECTRIC PLANT UNIT 1
RELOAD 9, CYCLE 10
NEDC-31624P, SUPPLEMENT 1, REVISION 2