GE Nuclear Energy

24A5399
Revision 0
Class I
April 1997

Supplemental Reload Licensing Report
for
COOPER NUCLEAR STATION
Reload 17 Cycle 18

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24A5399, Rev. 0

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Reload 17 Cycle 18

Approved

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Important Notice Regarding

Contents of This Report

Please Read Carefully

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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 A. F. Alzaben. The Supplemental Reload Licensing Report was prepared by A. F. Alzaben. This document has been verified by D. B. Waltermire of Nuclear Fuel Engineering.

The basis for this report is *General Electric Standard Application for Reactor Fuel*, NEDE-24011-P-A-13, August 1996; and the U.S. Supplement, NEDE-24011-P-A-13-US, August 1996.

1. Plant-unique Items

Appendix A: Analysis Conditions
Appendix B: Decrease in Core Coolant Temperature Events
Appendix C: SRV Tolerance Analysis
Appendix D: One Turbine Bypass Valve Out of Service

2. Reload Fuel Bundles

Fuel Type	Cycle Loaded	Number
Irradiated:		
GE9B-P8DWB320-10GZ1-80M-150-T (GE8x8NB)	15	48
GE9B-P8DWB348-11GZ-80M-150-T (GE8x8NB)	16	136
GE9B-P8DWB348-12GZ-80M-150-T (GE8x8NB)	16	48
GE9B-P8DWB348-11GZ-80M-150-T (GE8x8NB)	17	148
GE9B-P8DWB348-11GZ-80M-150-T (GE8x8NB)	17	4[1]
New:		
GE9B-P8DWB350-10GZ-80U-150-T (GE8x8NB)	18	160
GE9B-P8DWB348-11GZ-80M-150-T (GE8x8NB)	18	4
Total		548

3. Reference Core Loading Pattern[2]

Nominal previous cycle core average exposure at end of cycle:	26092 MWd/MT (23670 MWd/ST)
Minimum previous cycle core average exposure at end of cycle from cold shutdown considerations:	25761 MWd/MT (23370 MWd/ST)
Assumed reload cycle core average exposure at beginning of cycle:	15342 MWd/MT (13918 MWd/ST)
Assumed reload cycle core average exposure at end of cycle:	26585 MWd/MT (24118 MWd/ST)
Reference core loading pattern:	Figure 1

1. Re-inserted from spent fuel pool (discharged mid-cycle 17 outage).
2. The end of cycle core average exposure reflects the basis for the license work.

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

Beginning of Cycle, $k_{effective}$	
Uncontrolled	1.106
Fully controlled	0.965
Strongest control rod out	0.987
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	0.039

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

Exposure: BOC18 to EHFP18–2205 MWd/MT (2000 MWd/ST)							
	Peaking Factors						
Fuel Design	**Local**	**Radial**	**Axial**	**R–Factor**	**Bundle Power (MWt)**	**Bundle Flow (1000 lb/hr)**	**Initial MCPR**
GE8x8NB	1.20	1.74	1.40	1.000	7.376	100.7	1.17

Exposure: EHFP18–2205 MWd/MT (2000 MWd/ST) to EHFP18							
	Peaking Factors						
Fuel Design	**Local**	**Radial**	**Axial**	**R–Factor**	**Bundle Power (MWt)**	**Bundle Flow (1000 lb/hr)**	**Initial MCPR**
GE8x8NB	1.20	1.69	1.40	1.000	7.157	102.0	1.21

7. Selected Margin Improvement Options

Recirculation pump trip:	No
Rod withdrawal limiter:	No
Thermal power monitor:	No
Improved scram time:	Yes (ODYN Option B)
Measured scram time:	No
Exposure dependent limits:	Yes
Exposure points analyzed:	2 (EHFP–2205 MWd/MT, EHFP)

8. Operating Flexibility Options

Single–loop operation:	Yes
Load line limit:	Yes
Extended load line limit:	Yes
Increased core flow throughout cycle:	No
Increased core flow at EOC:	No
Feedwater temperature reduction throughout cycle:	No
Final feedwater temperature reduction:	No
ARTS Program:	Yes
Maximum extended operating domain:	No
Moisture separator reheater out of service:	No
Turbine bypass system out of service:	No
One turbine bypass valve out of service:	Yes
Safety/relief valves out of service:	No
Feedwater heaters out of service:	No
ADS out of service:	No

9. Core–wide AOO Analysis Results

Methods used: GEMINI; GEXL–PLUS

Exposure range: BOC18 to EHFP18–2205 MWd/MT (2000 MWd/ST)				
			Uncorrected ΔCPR	
Event	**Flux (%NBR)**	**Q/A (%NBR)**	**GE8x8NB**	**Fig.**
FW Controller Failure	203	114	0.11	2
Turbine Trip w/o Bypass	270	112	0.09	3
Load Reject w/o Bypass	276	112	0.09	4

Exposure range: EHFP18–2205 MWd/MT (2000 MWd/ST) to EHFP18				
			Uncorrected ΔCPR	
Event	**Flux (%NBR)**	**Q/A (%NBR)**	**GE8x8NB**	**Fig.**
FW Controller Failure	275	119	0.15	5
Load Reject w/o Bypass	341	116	0.14	6
Turbine Trip w/o Bypass	327	116	0.14	7

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

Rod withdrawal error (RWE) is analyzed in GE Licensing Report, *Extended Load Line Limit and ARTS Improvement Program Analyses for Cooper Nuclear Station Cycle 14*, NEDC–31892P, January 1991. A cycle–specific analysis was performed for this cycle to verify that the ARTS RWE generic limits in NEDC–31892P remain valid with the use of the new fuel design. The results obtained verified that the existing ARTS limits are still valid for this cycle.

11. Cycle MCPR Values[3]

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 Operating Limit MCPR shown below. This cycle specific SLMCPR was determined using the analysis basis documented in GESTAR with the following exceptions:

1. The actual core loading was analyzed.
2. The actual bundle parameters (e.g., local peaking) were used.
3. The full cycle exposure range was analyzed.

Safety limit: 1.06

Single loop operation safety limit: 1.07

Non–pressurization events:

Exposure Range: BOC18 to EHFP18	
	GE8x8NB
Loss of 100 °F feedwater heating	1.18
Fuel Loading Error (misoriented)	1.20
Fuel Loading Error (mislocated)	1.20
Rod withdrawal error (for RBM setpoint to 108%)	1.19

Pressurization events:

Exposure range: BOC18 to EHFP18–2205 MWd/MT (2000 MWd/ST) Exposure point: EHFP18–2205 MWd/MT (2000 MWd/ST)		
	Option A	**Option B**
	GE8x8NB	**GE8x8NB**
FW Controller Failure	1.22	1.20
Turbine Trip w/o Bypass	1.24	1.17
Load Reject w/o Bypass	1.24	1.17

3. For single–loop operation, the MCPR operating limit is 0.01 greater than the two–loop value

Exposure range: EHFP18–2265 MWd/MT (2000 MWd/ST) to EHFP18 Exposure point: EHFP18		
	Option A	**Option B**
	GE8x8NB	**GE8x8NB**
FW Controller Failure	1.25	1.22
Load Reject w/o Bypass	1.25	1.21
Turbine Trip w/o Bypass	1.25	1.21

12. Overpressurization Analysis Summary

Event	Psl (psig)	Pv (psig)	Plant Response
MSIV Closure (Flux Scram)	1219	1244	Figure 8

13. Loading Error Results

Variable water gap misoriented bundle analysis: Yes[4]

Event	ΔCPR
Fuel loading error (Misoriented)	0.14
Fuel loading error (Mislocated)	0.14

14. Control Rod Drop Analysis Results

Cooper Nuclear Station operates in the banked position withdrawal sequence (BPWS), so the control rod drop accident analysis is not required. NRC approval to use the generic analysis is documented in NEDE–24011–P–A–US, March 1991. CNS implemented the BPWS into the Rod Worth Minimizer (RWM) as documented in License Amendment No. 117. Removal of the Rod Sequence Control System (RSCS) at CNS has been approved by the NRC in License Amendment No. 156.

15. Stability Analysis Results

GE SIL–380 recommendations have been included in the Cooper Nuclear Station Technical Specifications; therefore, no stability analysis is required as documented in the letter, C. O. Thomas (NRC) to H. C. Pfefferlen (GE), *Acceptance for Referencing of Licensing Topical Report NEDE–24011, Rev. 6, Amendment 8, Thermal Hydraulic Stability Amendment to GESTAR II*, April 24, 1985.

Cooper Nuclear Station recognizes the issuance of NRC Bulletin No. 88–07, Supplement 1, *Power Oscillations in Boiling Water Reactors (BWRs)*, and has taken appropriate actions to address the identified concerns.

4. Includes a 0.00 penalty due to variable water gap R–factor uncertainty.

16. Loss–of–Coolant Accident Results

LOCA method used: SAFE/REFLOOD/CHASTE

Reference the *Loss–of–Coolant Accident Analysis Report for Cooper Nuclear Power Station*, NEDO–24045, August 1977, as amended.

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

Bundle Type: GE9B–P8DWB350–10GZ–80U–150–T

Average Planar Exposure		MAPLHGR(kW/ft)	
(GWd/ST)	(GWd/MT)	Most Limiting	Least Limiting
0.00	0.00	11.59	11.61
0.20	0.22	11.63	11.65
1.00	1.10	11.71	11.74
2.00	2.20	11.85	11.88
3.00	3.31	12.00	12.03
4.00	4.41	12.13	12.17
5.00	5.51	12.26	12.30
6.00	6.61	12.38	12.43
7.00	7.72	12.52	12.57
8.00	8.82	12.65	12.71
9.00	9.92	12.80	12.87
10.00	11.02	12.84	12.91
12.50	13.78	12.81	12.87
15.00	16.53	12.52	12.54
20.00	22.05	11.78	11.78
25.00	27.56	11.05	11.05
35.00	38.58	9.75	9.75
45.00	49.60	7.96	7.96
49.68	54.76	5.67	5.68
49.69	54.78	—	5.67

NOTE:

Peak clad temperatures (PCT) are ≤ 2181 °F at all exposures and local oxidation fractions are ≤ 0.077 at all exposures.

When in single loop operation, a MAPLHGR factor of 0.75 is substituted for the LOCA analysis factors of 1.0 and 0.86 contained in the flow dependent MAPLHGR curves (K_f) that are applied to the full power nodal exposure–dependent limits.

NRC approval for single loop operation is documented in Amendment No. 94, dated September 24, 1985, to Cooper Nuclear Station Facility Operating License.

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

Bundle Type: GE9B–P8DWB348–11GZ–80M–150–T (GE8x8NB)

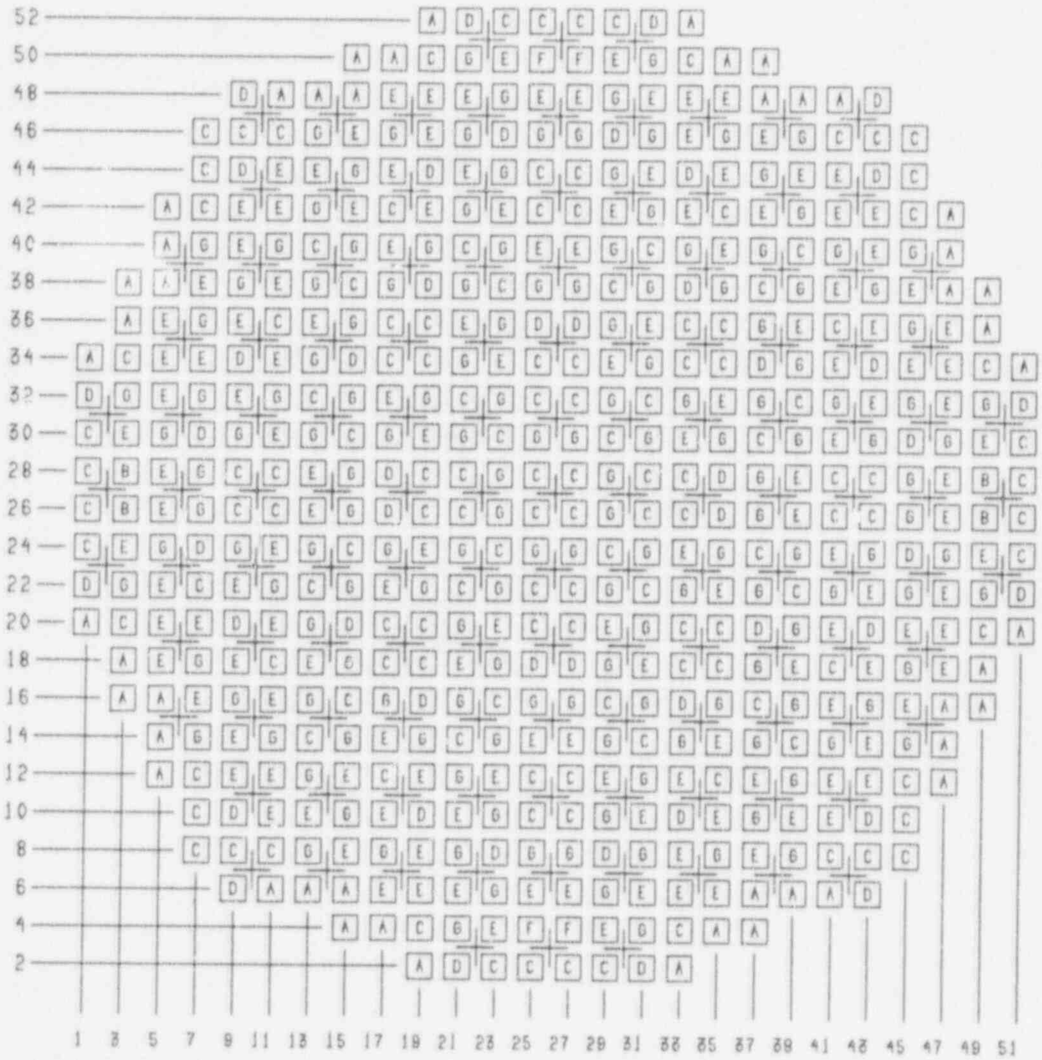
Average Planar Exposure		MAPLHGR(kW/ft)	
(GWd/ST)	**(GWd/MT)**	**Most Limiting**	**Least Limiting**
0.00	0.00	10.85	11.82
0.20	0.22	10.90	11.87
1.00	1.10	11.01	11.96
2.00	2.20	11.17	12.08
3.00	3.31	11.36	12.19
4.00	4.41	11.56	12.32
5.00	5.51	11.76	12.44
6.00	6.61	11.91	12.55
7.00	7.72	12.07	12.65
8.00	8.82	12.23	12.68
9.00	9.92	12.38	12.67
10.00	11.02	12.48	12.80
12.50	13.78	12.61	12.93
15.00	16.53	12.47	12.60
20.00	22.05	11.79	11.91
25.00	27.56	11.05	11.17
35.00	38.58	9.69	9.74
45.00	49.60	7.86	8.09
49.56	54.63	5.62	5.91
49.59	54.66	—	5.90
49.68	54.76	—	5.85
49.73	54.81	—	5.83

NOTE:

Peak clad temperatures (PCT) are ≤ 2127 °F at all exposures and local oxidation fractions are ≤ 0.065 at all exposures.

When in single loop operation, a MAPLHGR factor of 0.75 is substituted for the LOCA analysis factors of 1.0 and 0.86 contained in the flow dependent MAPLHGR curves (K_f) that are applied to the full power nodal exposure–dependent limits.

NRC approval for single loop operation is documented in Amendment No. 94, dated September 24, 1985, to Cooper Nuclear Station Facility Operating License.



Fuel Type			
A=GE9B-P8DWB320-10GZ1-80M-150-T	(Cycle 15)	E=GE9B-P8DWB348-11GZ-80M-150-T	(Cycle 17)
B=GE9B-P8DWB348-11GZ-80M-150-T	(Cycle 17)	F=GE9B-P8DWB348-11GZ-80M-150-T	(Cycle 18)
C=GE9B-P8DWB348-11GZ-80M-150-T	(Cycle 16)	G=GE9B-P8DWB350-10GZ-80U-150-T	(Cycle 18)
D=GE9B-P8DWB348-12GZ-80M-150-T	(Cycle 16)		

Figure 1 Reference Core Loading Pattern

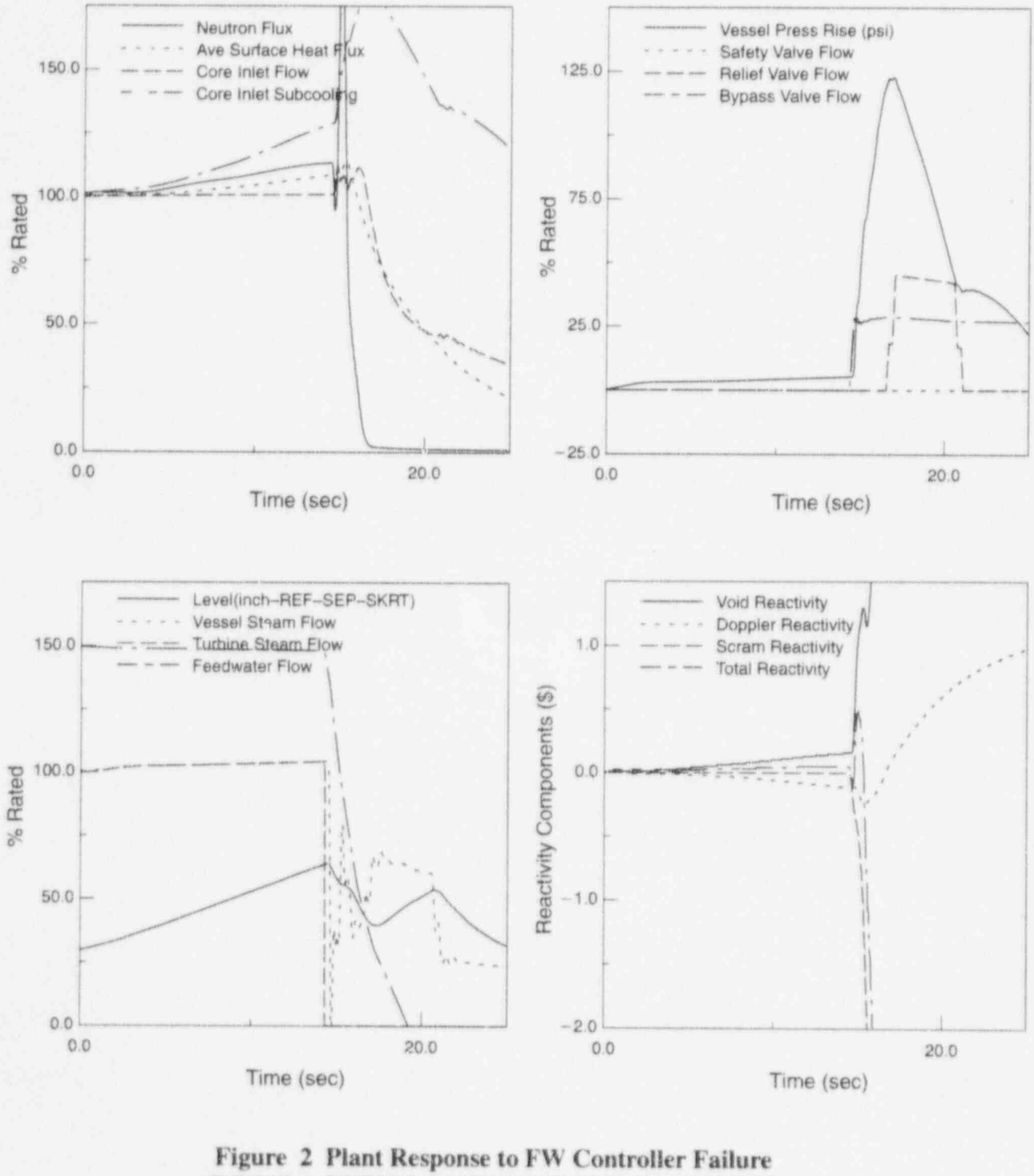


Figure 2 Plant Response to FW Controller Failure (BOC18 to EHFP18–2205 MWd/MT (2000 MWd/ST))

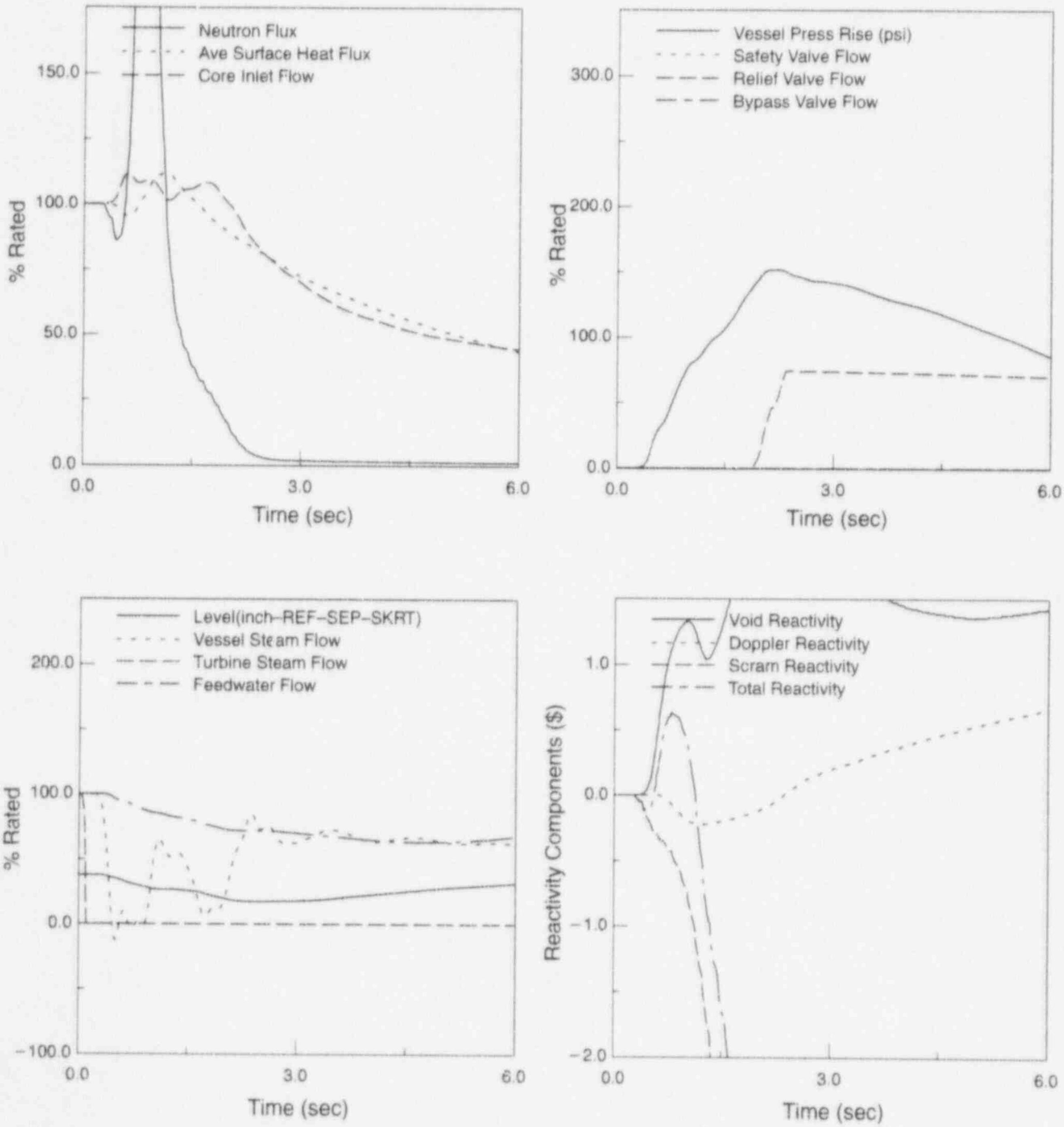


Figure 3 Plant Response to Turbine Trip w/o Bypass (BOC18 to EHFP18–2205 MWd/MT (2000 MWd/ST))

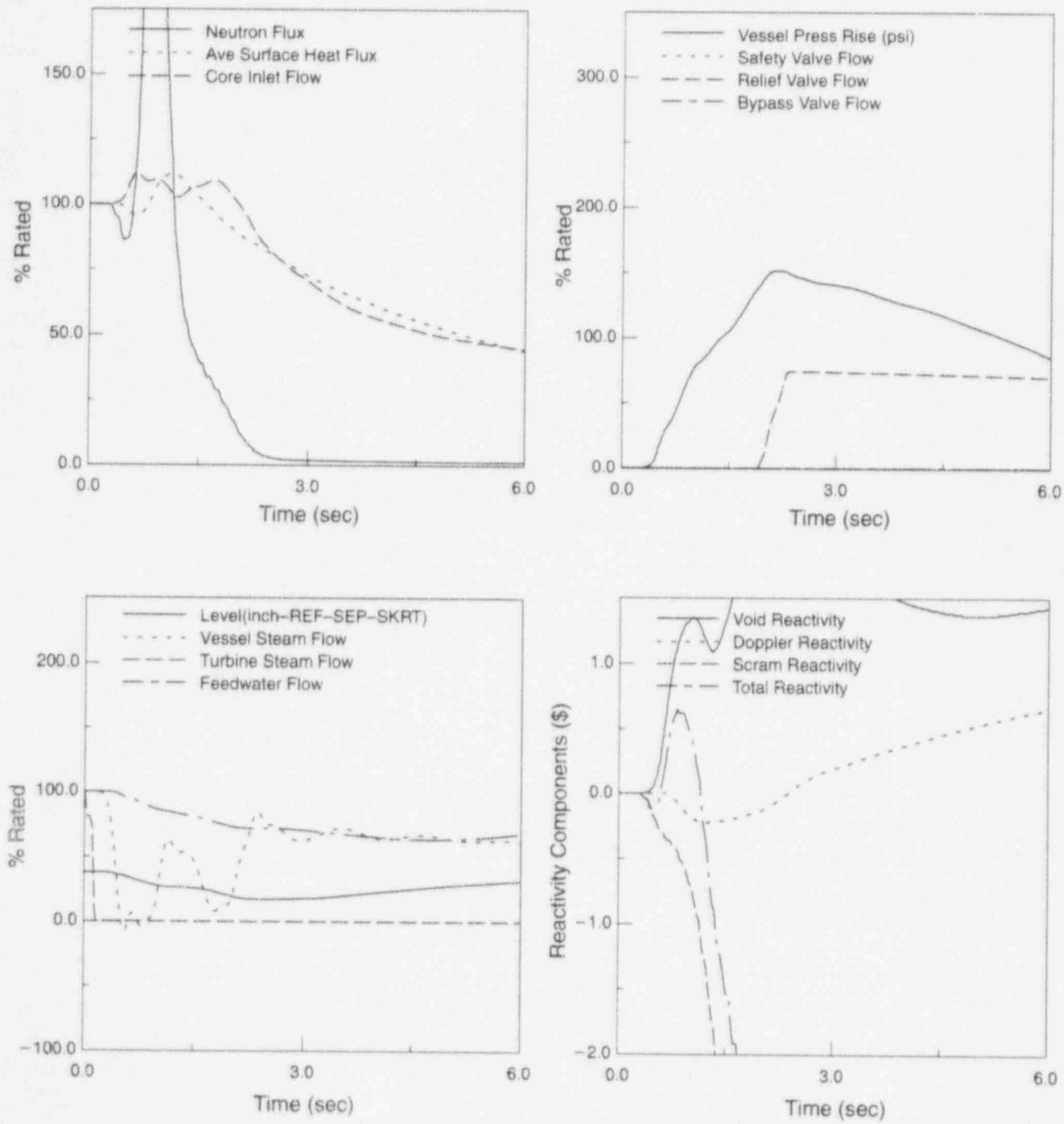


Figure 4 Plant Response to Load Reject w/o Bypass (BOC18 to EHFP18-2205 MWd/MT (2000 MWd/ST))

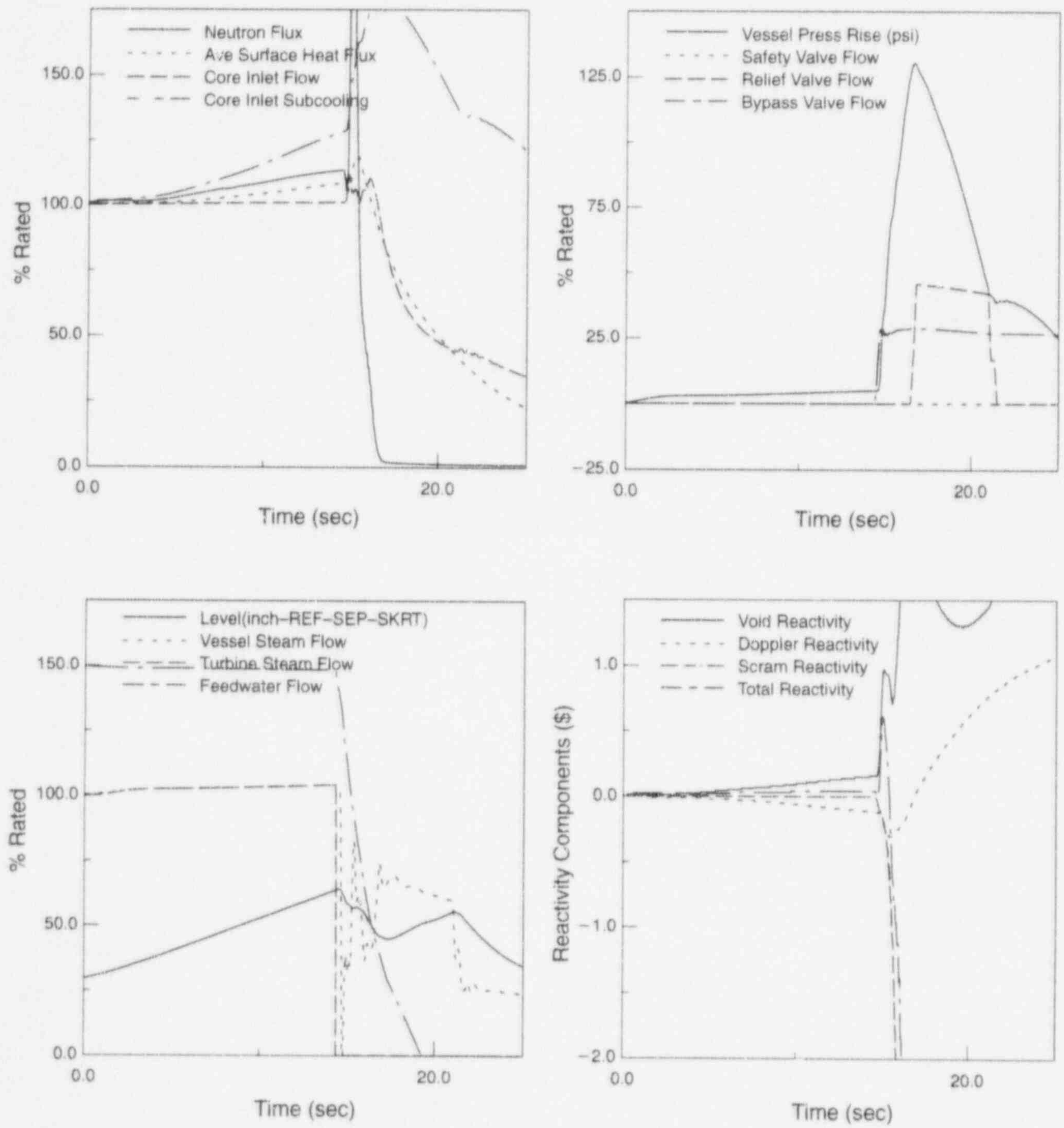


Figure 5 Plant Response to FW Controller Failure (EHFP18–2205 MWd/MT (2000 MWd/ST) to EHFP18)

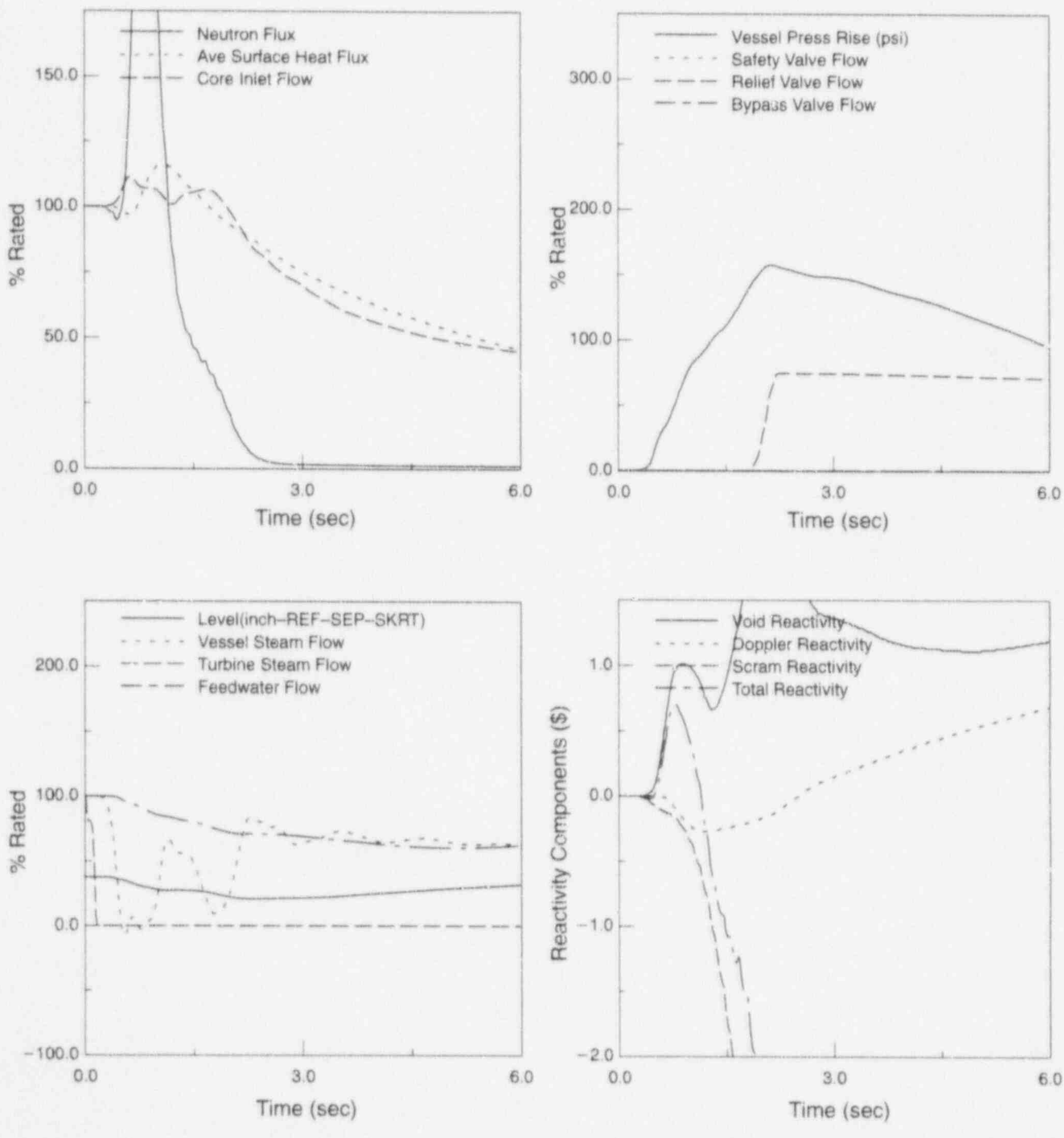


Figure 6 Plant Response to Load Reject w/o Bypass (EHFP18–2205 MWd/MT (2000 MWd/ST) to EHFP18)

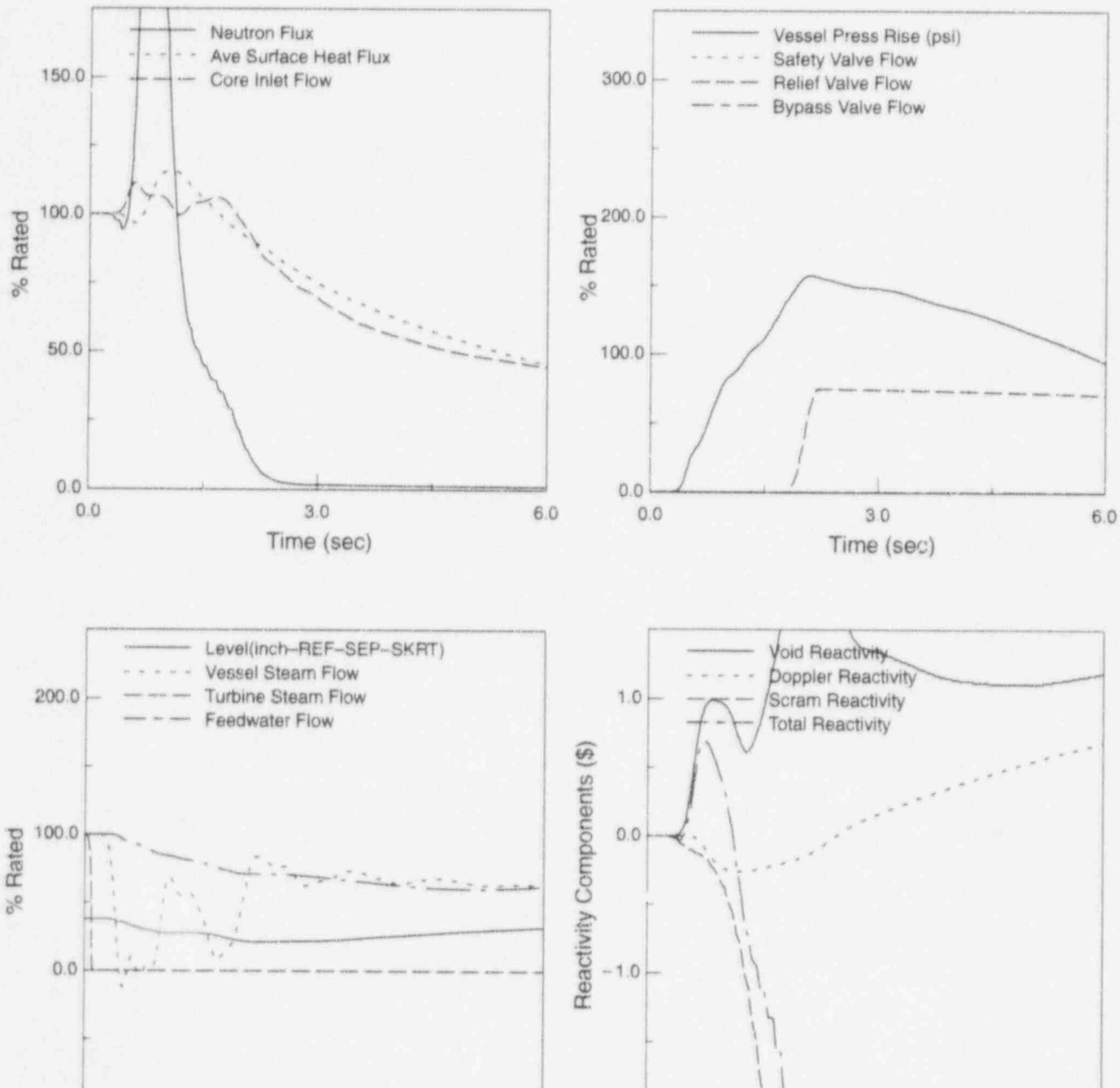


Figure 7 Plant Response to Turbine Trip w/o Bypass (EHFP18–2205 MWd/MT (2000 MWd/ST) to EHFP8)

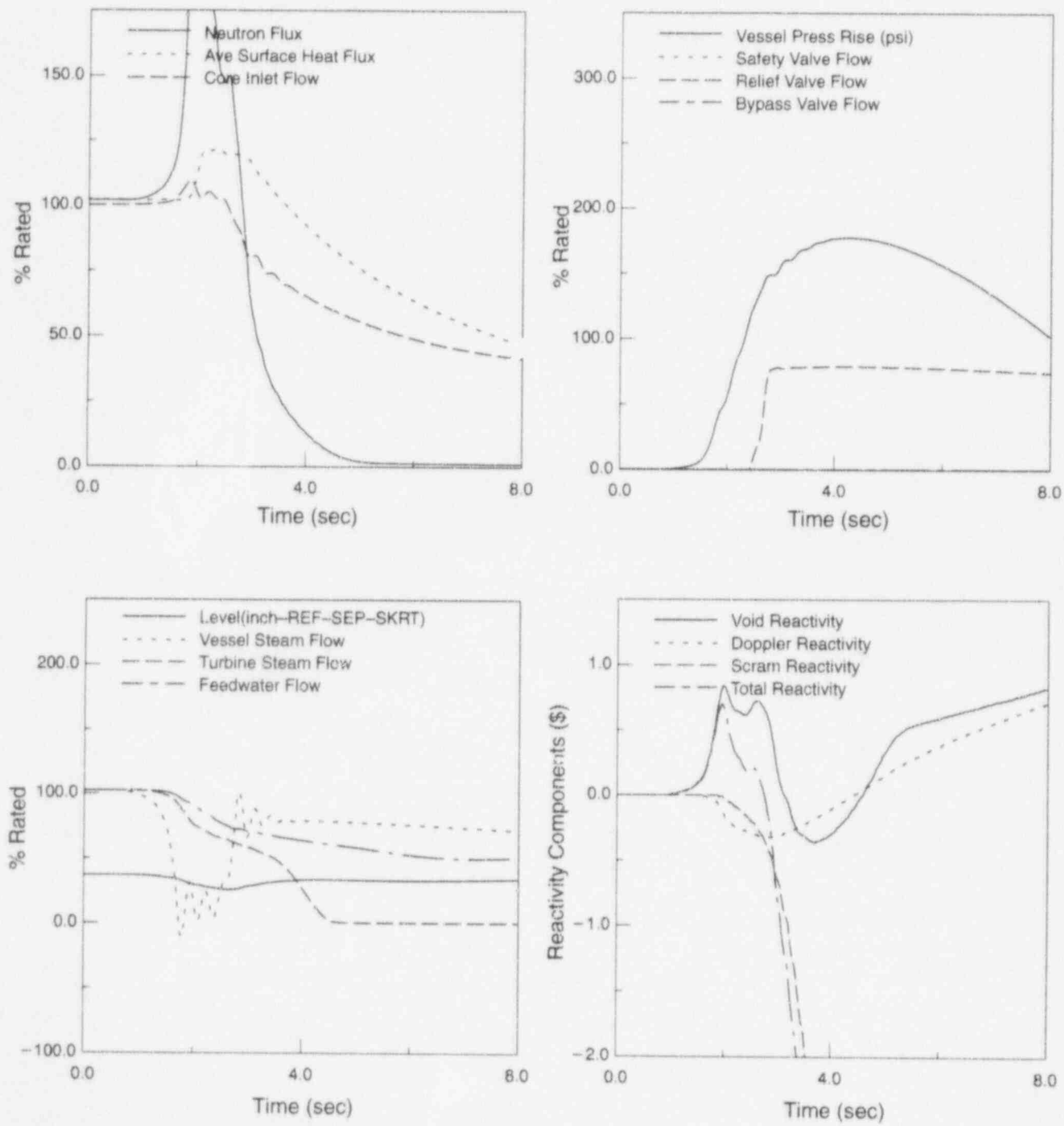


Figure 8 Plant Response to MSIV Closure (Flux Scram)

Appendix A
Analysis Conditions

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

Table A–1

STANDARD	
Parameter	**Analysis Value**
Thermal power, MWt	2381.0
Core flow, Mlb/hr	73.5
Reactor pressure, psia	1035.0
Inlet enthalpy, BTU/lb	520.4
Non–fuel power fraction	0.038
Steam flow, Mlb/hr	9.56
Dome pressure, psig	1005.0
Turbine pressure, psig	955.1
No. of Safety/Relief Valves	8
No. of Single Spring Safety Valves	3
Relief mode lowest setpoint, psig	1113.0
Safety mode lowest setpoint, psig	1277.0

Appendix B

Decrease in Core Coolant Temperature Events

The loss–of–feedwater heating (LFWH) and the HPCI inadvertent startup anticipated operational occurrences (AOO) are the only cold water injection events checked on a cycle–by–cycle basis.

The LFWH 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, flux, and Q/A normally reported in Section 9 are not outputs of the BWR Simulator Code; therefore, these items are not included in this document for the LFWH event.

For Cycle 18, the Inadvertent HPCI analysis was shown to be bounded by the LFWH event. This was done by showing the core inlet subcooling due to feedwater temperature reduction from HPCI plus the core inlet subcooling due to excess feedwater from HPCI is less than the core inlet subcooling for the LFWH event.

References

B–1. *Steady State Nuclear Methods*, NEDE–30130–P–A and NEDO–03130–A, April 1985.

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

Appendix C

SRV Tolerance Analysis

The limiting overpressure event for Cooper is the main steam isolation valve closure with flux scram (MSIVF). The Cycle 18 reload evaluation was performed with the SRV and SV opening pressures at 3% above their nominal values. The peak vessel pressure reported for the Cycle 18 reload is 1244 psig.

An SRV tolerance analysis was previously completed and reported in Reference C–1. To demonstrate the applicability of Reference C–1 results to Cycle 18, an additional MSIVF event was analyzed with SRV opening pressure of 1210 psig (SRV upper limit). Except for the SRV opening pressure, this evaluation used the same analysis conditions as in the standard MSIVF analysis. Figure C–1 shows the reactor response for the MSIVF event with the upper limit SRV opening pressure set to 1210 psig. The peak vessel pressure for this case is 1304 psig at the vessel bottom, which is significantly below the vessel overpressure limit of 1375 psig. Thus, the Cycle 18 Upper limit case meets the ASME code requirement for the overpressure protection.

This evaluation demonstrates compliance to vessel overpressure limits for Cycle 18 with the upper limit SRV pressure. Thus, the applicability of Reference C–1 can be extended to Cycle 18.

Reference

C–1. *SRV Setpoint Tolerance Analysis for Cooper Nuclear Station*, General Electric Company, NEDC–31628P, October 1988.

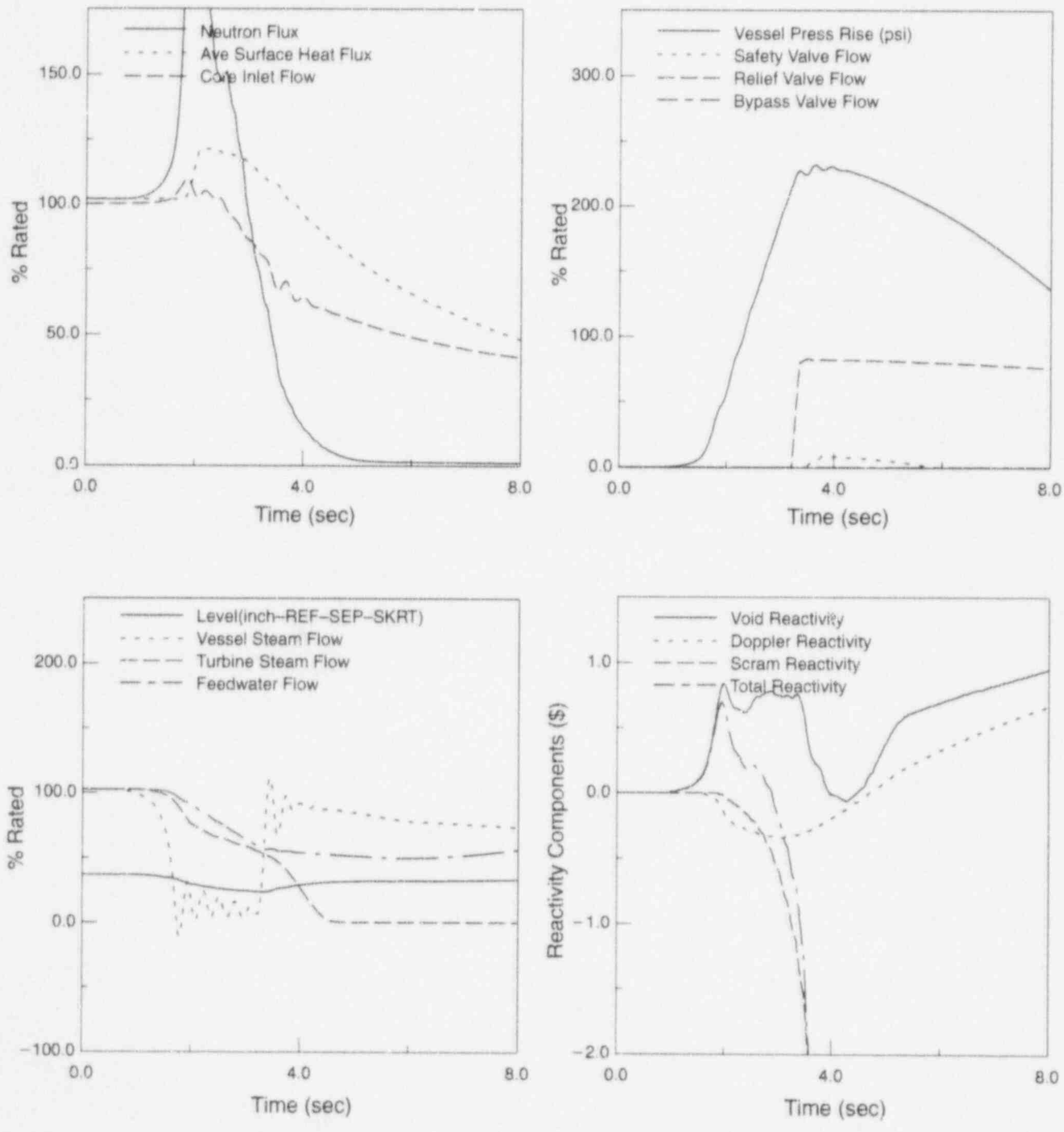


Figure C-1 Plant Response to MSIV Closure (Flux Scram)
(SRV Tolerance Analysis)

Appendix D

One Turbine Bypass Valve Out of Service

In order to support continued operation of Cooper Nuclear Station with the possibility that one bypass valve may be unavailable, the turbine bypass valve (BPV) out of service operation was evaluated. The objective of this evaluation was to calculate the MCPR for the limiting event with one BPV unavailable and determine whether the calculated MCPR specified for the most limiting event for Cycle 18 is affected.

The effect of one BPV unavailable is to reduce the pressure relief capability in the early part of a pressurization event (i.e., before the relief and safety valves can open) and thus result in an increase in the ΔCPR. The limiting pressurization events that are analyzed on a cycle-specific basis for Cooper are the turbine trip without bypass, the load reject without bypass, and the feedwater controller failure events. The turbine trip without bypass and the load reject without bypass events are not affected by one BPV being unavailable because the analyses do not take credit for any BPV's being available. Therefore, only the feedwater controller failure event (FWCF) was analyzed.

The same conditions that were used for the Cycle 18 reload analysis for the FWCF were used, except that one BPV was assumed to be unavailable. End of Cycle 18 conditions were used as these are the most stringent. A conservative representation for the BPV opening characteristic was assumed. Both Option A and Option B scram conditions were analyzed and the results are provided below. Figure D–1 shows the reactor response for the FWCF event with one BPV unavailable.

With one BPV unavailable, the MCPRs are as follows:

Exposure range: BOC18 to EHFP18

	Option A	Option B
GE8x8NB	1.27	1.24

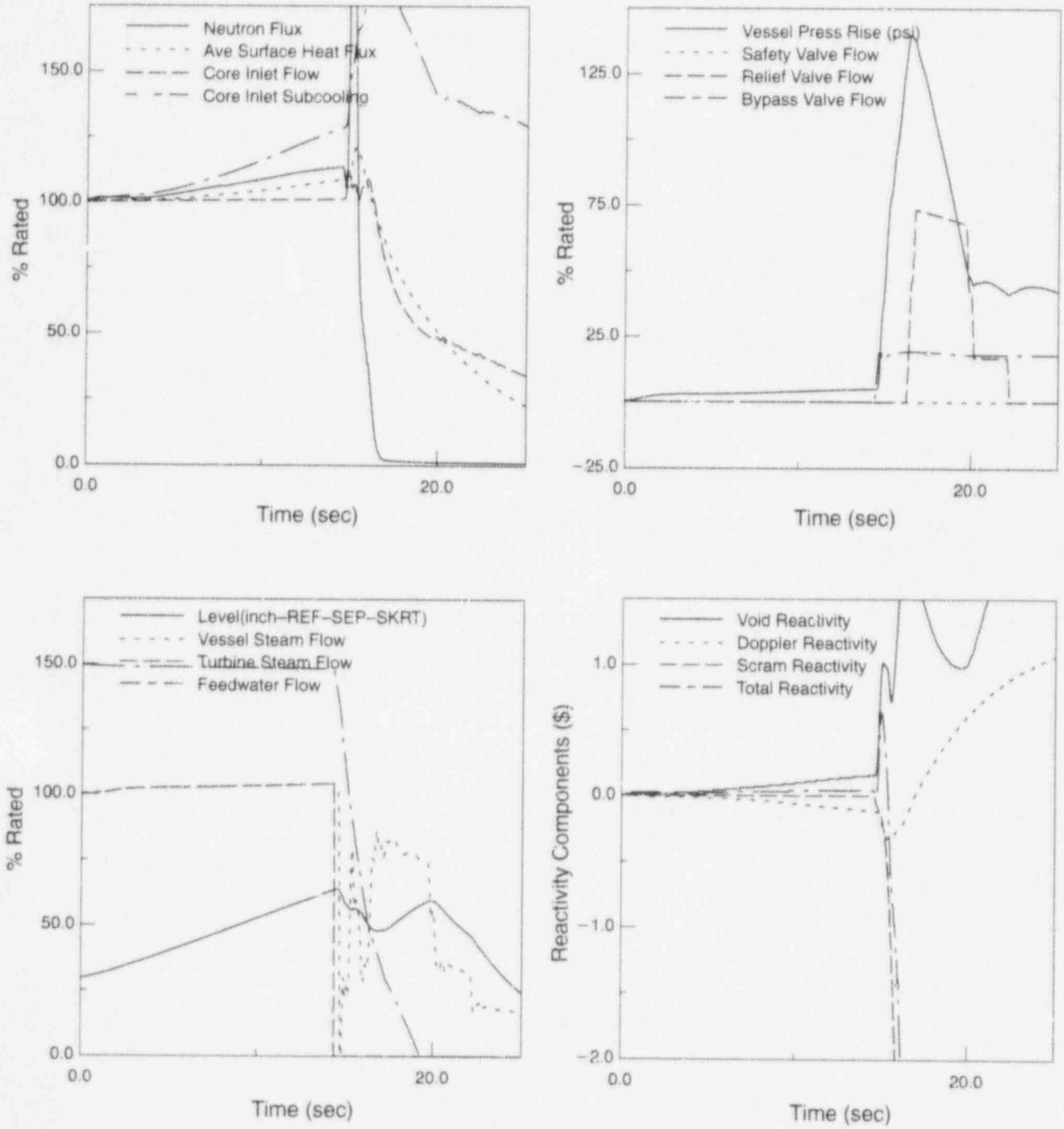


Figure D–1 Plant Response to FW Controller Failure (One Turbine Bypass Valve Out of Service)