Y1003J01A53
CLASS I
JANUARY 1983

SUPPLEMENTAL RELOAD LICENSING SUBMITTAL FOR BRUNSWICK STEAM ELECTRIC PLANT UNIT 1, RELOAD 3 (WITHOUT RECIRCULATION PUMP TRIP)

GENERAL ELECTRIC

Y1003J01A53
Class I
January 1983

SUPPLEMENTAL RELOAD LICENSING SUBMITTAL
FOR
BRUNSWICK STEAM ELECTRIC PLANT
UNIT 1, RELOAD 3
(WITHOUT RECIRCULATION PUMP TRIP)

Prepared: for
G. Zanardi

Verified:
R. T. Hill

Approved:
J. S. Charnley, Manager
Reload Fuel Licensing

NUCLEAR POWER SYSTEMS DIVISION • GENERAL ELECTRIC COMPANY
SAN JOSE, CALIFORNIA 95125

GENERAL ELECTRIC

IMPORTANT NOTICE REGARDING
CONTENTS OF THIS REPORT
PLEASE READ CAREFULLY

This report was prepared by General Electric solely for Carolina Power and Light Company (CP&L) for CP&L's use with the United States Nuclear Regulatory Commission (USNRC) for amending CP&L's operating license of the Brunswick Steam Electric Plant Unit 1. The information contained in this report is believed by General Electric to be an accurate and true representation of the facts known, obtained or provided to General Electric at the time this report was prepared.

The only undertakings of the General Electric Company respecting information in this document are contained in the Fuel Contract Supplemental Agreement between Carolina Power and Light Company and General Electric Company for Brunswick Steam Electric Plant Units 1 and 2, dated January 28, 1974, and nothing contained in this document shall be construed as changing said contract. The use of this information except as defined by said contract, or for any purpose other than that for which it is intended, is not authorized; and with respect to any such unauthorized use, neither General Electric nor any of the contributors to this document makes any representation or warranty (express or implied) as to the completeness, accuracy or usefulness of the information contained in this document or that such use of such information may not infringe privately owned rights; nor do they assume any responsibility for liability or damage of any kind which may result from such use of such information.

1. PLANT UNIQUE ITEMS (1.0)*

Single Loop Confirmatory Analysis	Appendix A
Additional LOCA Results	Appendix B

2. RELOAD FUEL BUNDLES (1.0, 2.7, 3.3.1 and 4.0)

Fuel Type	Cycle Loaded	Number	Number Drilled
Irradiated			
Initial Core	1	48	48
8DRB265L	2	52	52
8DRB283	2	124	124
P8DRB265H	3	16	16
P8DRB285	3	140	140
New			
P8DRB265H	4	72	72
P8DRB284H	4	72	72
P8DRB299	4	36	36
Total		560	560

3. REFERENCE CORE LOADING PATTERN (3.3.1)

Nominal previous cycle core average exposure at end of cycle:	15,786 MWd/ST
Minimum previous cycle core average exposure at end of cycle from cold shutdown considerations:	15,387 MWd/ST
Assumed reload cycle core average exposure at end of cycle:	16,350 MWd/ST
Core loading pattern:	Figure 1

*( ) refers to area of discussion in "Generic Reload Fuel Application," NEDE-24011-P-A-4, January 1982.

4. CALCULATED CORE EFFECTIVE MULTIPLICATION AND CONTROL SYSTEM WORTH - NO VOIDS, 20°C (3.3.2.1.1 and 3.3.2.1.2)

BOC k_{eff}	
Uncontrolled	1.114
Fully Controlled	0.958
Strongest Control Rod Out	0.989
R, Maximum Increase in Cold Core Reactivity with Exposure into Cycle, Δk	0.0

5. STANDBY LIQUID CONTROL SYSTEM SHUTDOWN CAPABILITY (3.3.2.1.3)

ppm	Shutdown Margin (Δk) 20°C, Xenon Free)
600	0.031

6. RELOAD UNIQUE TRANSIENT ANALYSIS INPUT (3.3.2.1.5 and 5.2) (REDY EVENTS ONLY)

	EOC 4-2000 MWd/T	EOC 4
Void Fraction (%)	41.3	41.3
Average Fuel Temperature (°F)	1302	1302
Void Coefficient N/A* (¢/% Rg)	-8.12/-10.15	-8.33/-10.42
Doppler Coefficient N/A (¢/°F)	-0.219/-0.208	-0.232/-0.220
Scram Worth N/A ($)	-46.31/-37.05	-46.31/-37.05

7. RELOAD-UNIQUE GETAB TRANSIENT ANALYSIS INITIAL CONDITION PARAMETERS (5.2)

Fuel Design	Peaking Factors (Local, Radial, Axial)			R-Factor	Bundle Power (MWt)	Bundle Flow (10^3 lb/hr)	Initial MCPR
BOC 4 to EOC 4-2000 MWd/T							
P8x8R	1.20	1.53	1.40	1.051	6.516	111.0	1.23
8x8R	1.20	1.55	1.40	1.051	6.614	110.3	1.21
8x8	1.22	1.42	1.40	1.098	6.045	109.6	1.21

*N = Nuclear Input Data
A = Used in Transient Analysis

Fuel Design	Peaking Factors (Local, Radial, Axial)			R-Factor	Bundle Power (MWt)	Bundle Flow (10^3 lb/hr)	Initial MCPR
EOC 4-2000 MWd/T to EOC 4							
P8x8R	1.20	1.41	1.40	1.051	6.004	114.8	1.35
8x8R	1.20	1.44	1.40	1.051	6.139	113.8	1.32
8x8	1.22	1.32	1.40	1.098	5.616	113.0	1.31

8. SELECTED MARGIN IMPROVEMENT OPTIONS (5.2.2)

Transient Recategorization: No

Recirculation Pump Trip: No

Rod Withdrawal Limiter: No

Thermal Power Monitor: Yes

Measured Scram Time: No

Number of Exposure Points: 2

9. CORE-WIDE TRANSIENT ANALYSIS RESULTS (5.2.1)

Transient	Flux (% NBR)	Q/A (% NBR)	ΔCPR P8x8R	ΔCPR 8x8R	ΔCPR 8x8	Figure
Exposure: BOC 4 to EOC 4-2000 MWd/T Load Rejection Without Bypass	478	119	0.16	0.15	0.14	2A
Exposure: EOC 4-2000 MWd/T to EOC 4 Load Rejection without Bypass	746	127	0.28	0.25	0.24	2B
Exposure: BOC to EOC Loss of Feedwater Heater	123	122	0.14	0.14	0.14	3
Exposure: BOC 4 to EOC 4-2000 MWd/T Feedwater Controller Failure	286	116	0.11	0.10	0.09	4A
Exposure: EOC 4-2000 MWd/T to EOC 4 Feedwater Controller Failure	454	125	0.23	0.21	0.20	4B

10. LOCAL ROD WITHDRAWAL ERROR (WITH LIMITING INSTRUMENT FAILURE) TRANSIENT SUMMARY (5.2.1)

Limiting Rod Pattern: Figure 5

Includes 2.2% Power Spiking Penalty: Yes

Rod Block Reading	Rod Position (feet withdrawn)	ΔCPR			MLHGR (kW/ft)	
		P8x8R	8x8R	8x8*	8x8*	8x8R/ P8x8R
104	3.0	0.12	0.12			17.0
105	3.5	0.15	0.15			17.6
106	4.0	0.18	0.18			18.0
107	4.0	0.18	0.18			18.0
108	4.5	0.20	0.20			18.0
109	5.0	0.22	0.22			18.0
110	5.5	0.23	0.23			18.0

Set Point Selected Is: 107

11. CYCLE MCPR VALUES (5.2)

Nonpressurization Events:

Exposure Range: BOC to EOC

	P8x8R	8x8R	8x8
Loss of Feedwater Heater	1.21	1.21	1.21
Fuel Loading Error	1.22		
Rod Withdrawal Error	1.25	1.25	

Minimum for LOCA: 1.20

Pressurization Events:

Exposure Range: BOC 4 to EOC 4-2000 MWd/T

	Option A			Option B		
	P8x8R	8x8R	8x8	P8x8R	8x8R	8x8
Load Rejection Without Bypass	1.28	1.27	1.26	1.09	1.08	1.08
Feedwater Controller Failure	1.23	1.22	1.21	1.17	1.16	1.15

*On periphery of core (low power region) and not limiting

Pressurization Events:

Exposure Range: EOC 4-2000 MWd/T to EOC 4

	Option A			Option B		
	P8x8R	8x8R	8x8	P8x8R	8x8R	8x8
Load Rejection Without Bypass	1.41	1.38	1.37	1.29	1.26	1.25
Feedwater Controller Failure	1.36	1.34	1.33	1.29	1.27	1.26

12. OVERPRESSURIZATION ANALYSIS SUMMARY (5.3)

Transient	P_{sl} (psig)	P_v (psig)	Plant Response
MSIV Closure	1212	1241	Figure 6

13. STABILITY ANALYSIS RESULTS (5.4)

Rod Line Analyzed: 105%

Decay Ratio: Figure 7

Reactor Core Stability Decay Ratio, x_2/x_0 0.72

Channel Type

8x8R/P8x8R 0.48

8x8 0.58

14. LOADING ERROR RESULTS (5.5.4)

Variable Water Gap Misoriented Bundle Analysis: Yes

Includes 2.2% Power Spiking Penalty: Yes

Event	Initial MCPR	Resulting MCPR
Misoriented	1.20	1.07

15. CONTROL ROD DROP ANALYSIS RESULTS (5.5.1)

Bounding Analysis Results:

Doppler Reactivity Coefficient: Figure 8

Accident Reactivity Shape Functions: Figures 9 and 10

Scram Reactivity Functions: Figures 11 and 12

Plant Specific Analysis Results:

Parameter(s) Not Bounded, Cold:	Accident Reactivity Scram Reactivity
Resultant Peak Enthalpy, Cold:	220.4
Parameter(s) Not Bounded, HSB:	None
Resultant Peak Enthalpy, HSB:	

16. LOSS-OF-COOLANT ACCIDENT RESULT (5.5.2)

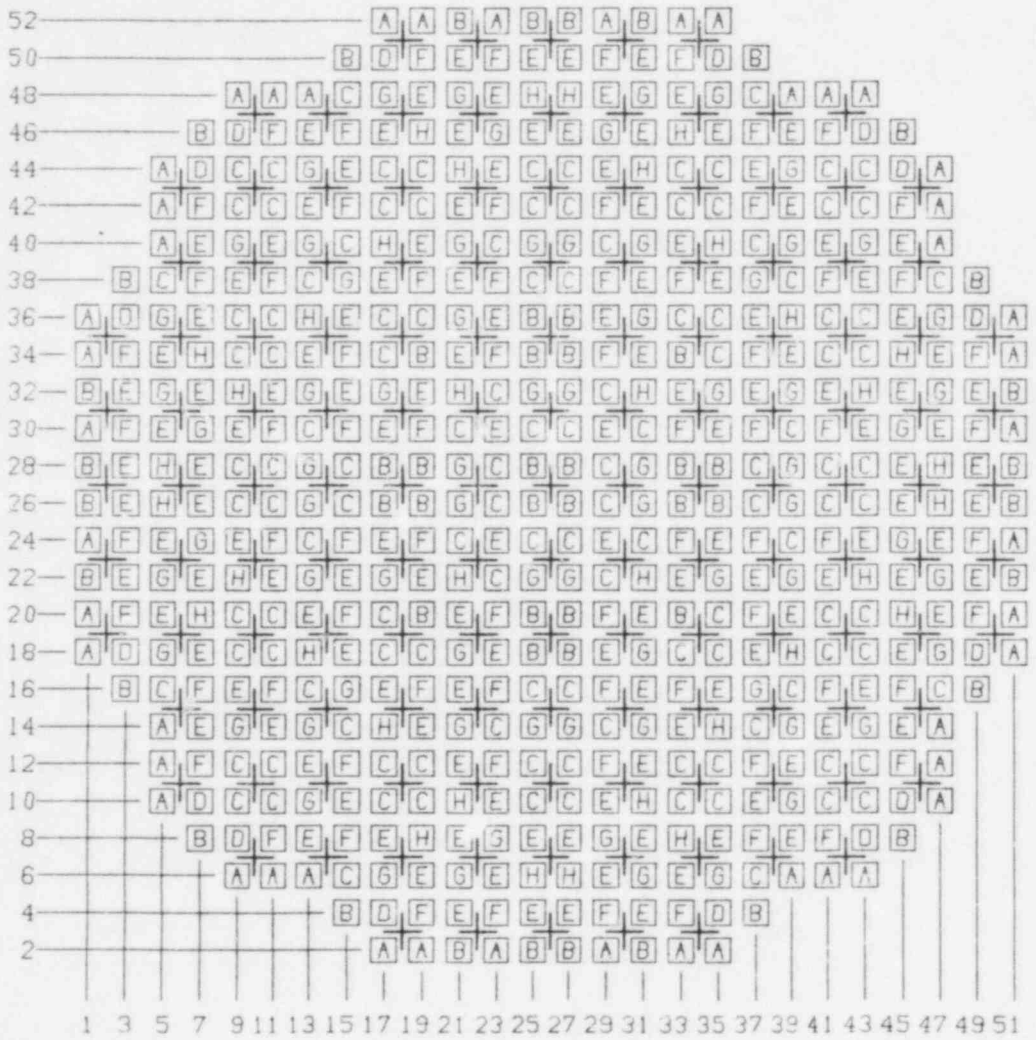
"Loss-of-Coolant Accident Analysis Report for Brunswick Steam Electric Plant Unit 1," General Electric Company, November 1978 (NEDO-24165, as amended).

Fuel Type: P8DRB284H

Exposure (MWd/ST)	MAPLHGR (kW/ft)	PCT (°F)	Local Oxidation (Fraction)
200	11.2	2067	0.021
1,000	11.2	2062	0.021
5,000	11.7	2105	0.023
10,000	12.0	2140	0.026
15,000	12.0	2146	0.026
20,000	11.8	2133	0.025
25,000	11.1	2040	0.019
30,000	10.4	1937	0.013
35,000	9.8	1839	0.009
40,000	9.1	1756	0.006

Fuel Type: P8DRB299

Exposure (MWd/st)	MAPLHGR (kW/ft)	PCT (°F)	Local Oxidation (Fraction)
200	10.9	2029	0.019
1,000	11.0	2029	0.018
5,000	11.5	2071	0.021
10,000	12.2	2155	0.027
15,000	12.3	2178	0.029
20,000	12.1	2170	0.028
25,000	11.5	2104	0.023
30,000	11.0	2005	0.016
35,000	10.2	1900	0.011
40,000	9.7	1820	0.008



FUEL TYPE	
A = INITIAL CORE	E = P8DRB285
B = 8DRB265L	F = P8DRB265H
C = 8DRB283	G = P8DRB284H
D = P8DRB265H	H = P8DRB299

Figure 1. Reference Core Loading Pattern

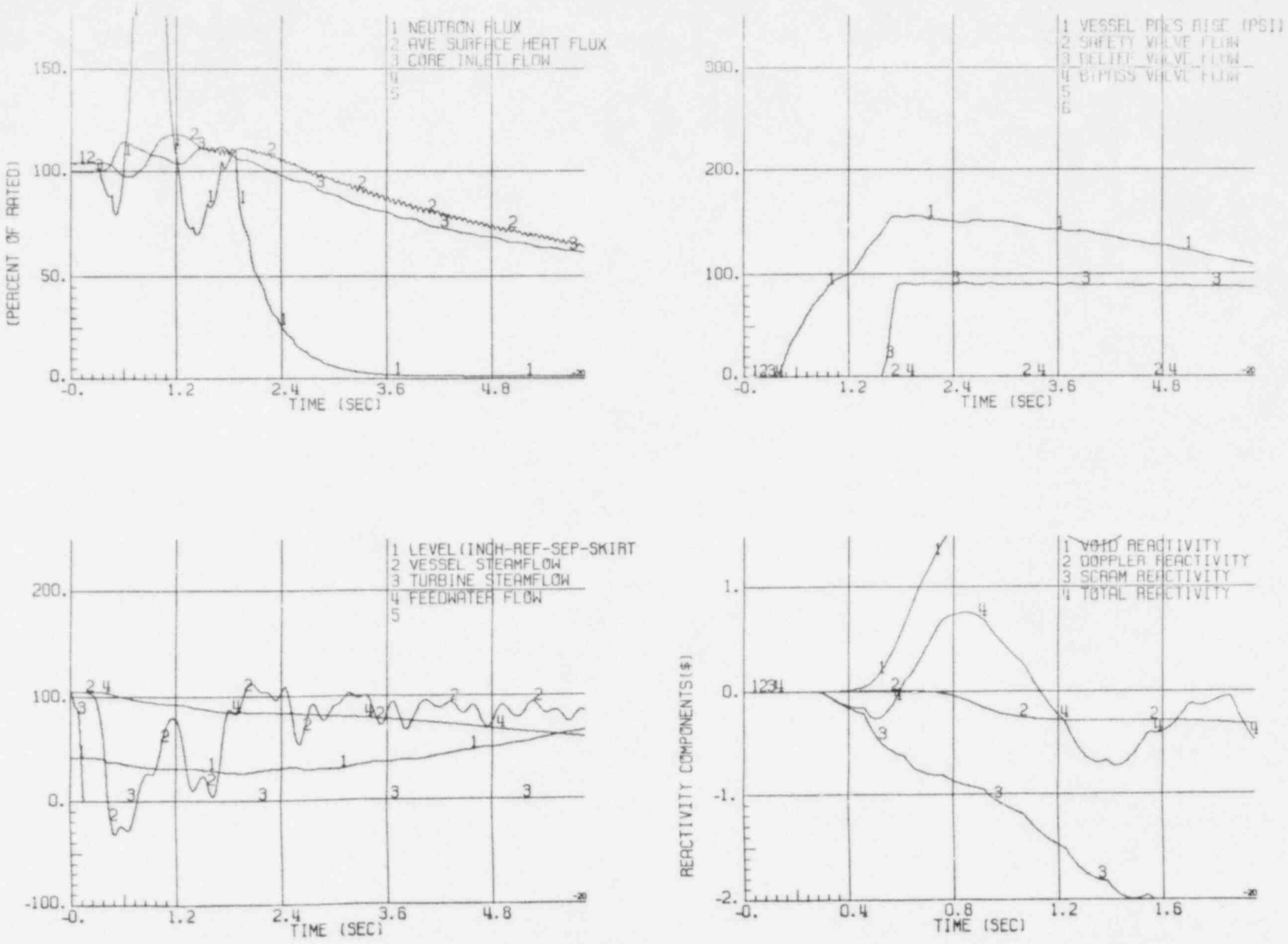


Figure 2A. Plant Response to Generator Load Rejection Without Bypass (EOC-2000)

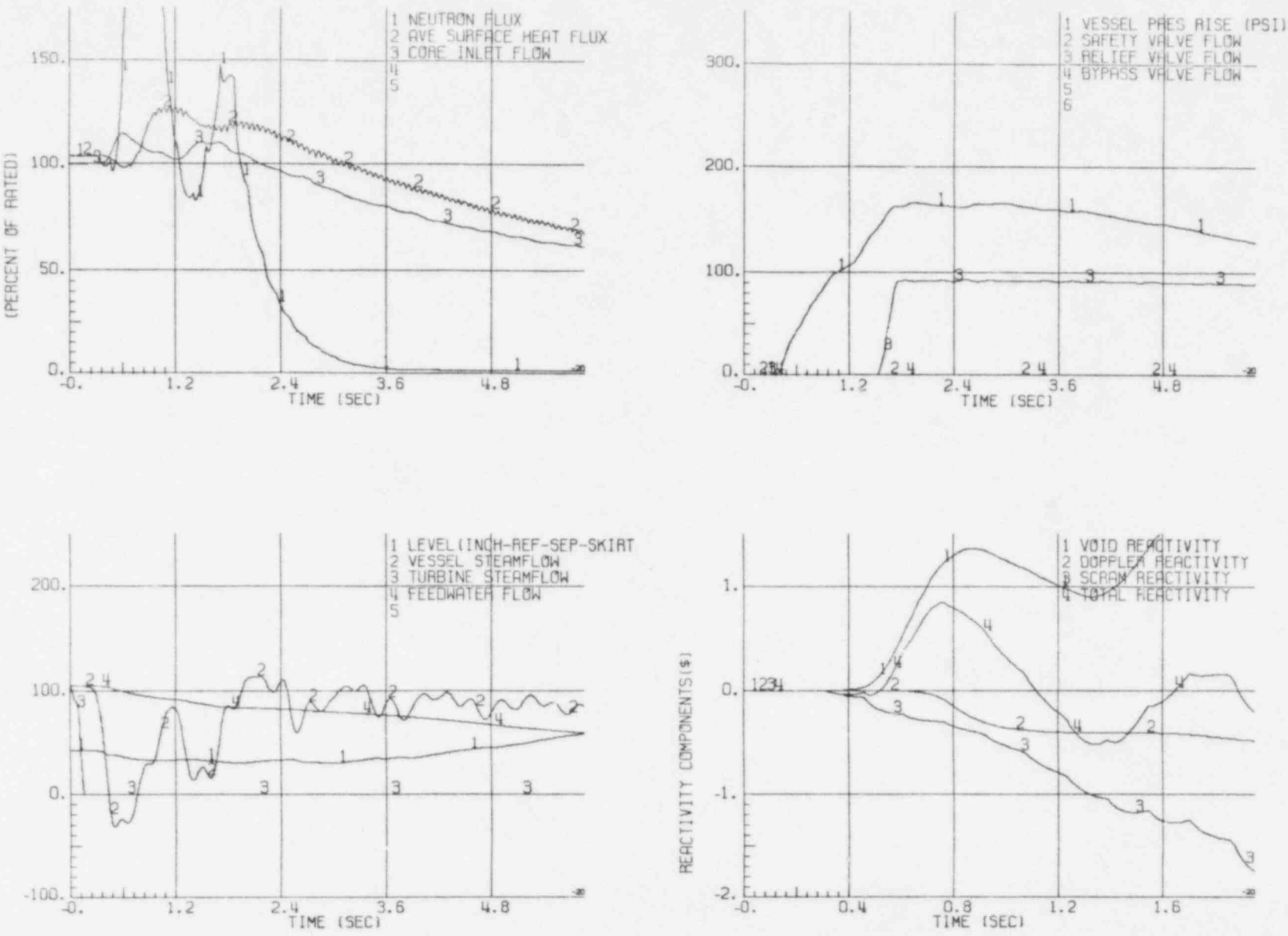


Figure 2B. Plant Response to Generator Load Rejection Without Bypass (EOC 4)

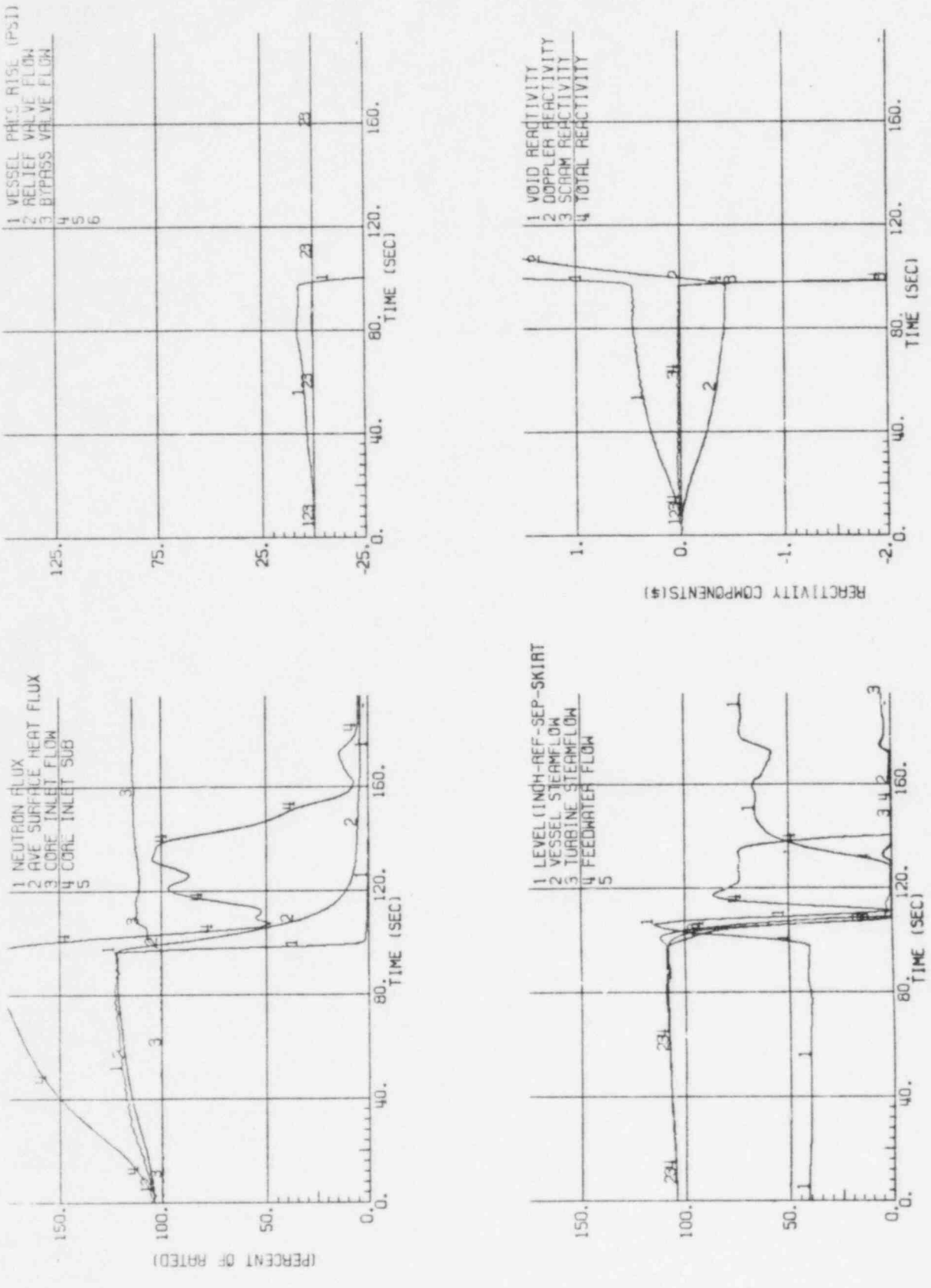


Figure 3. Plant Response to Loss of 100° Feedwater Heating

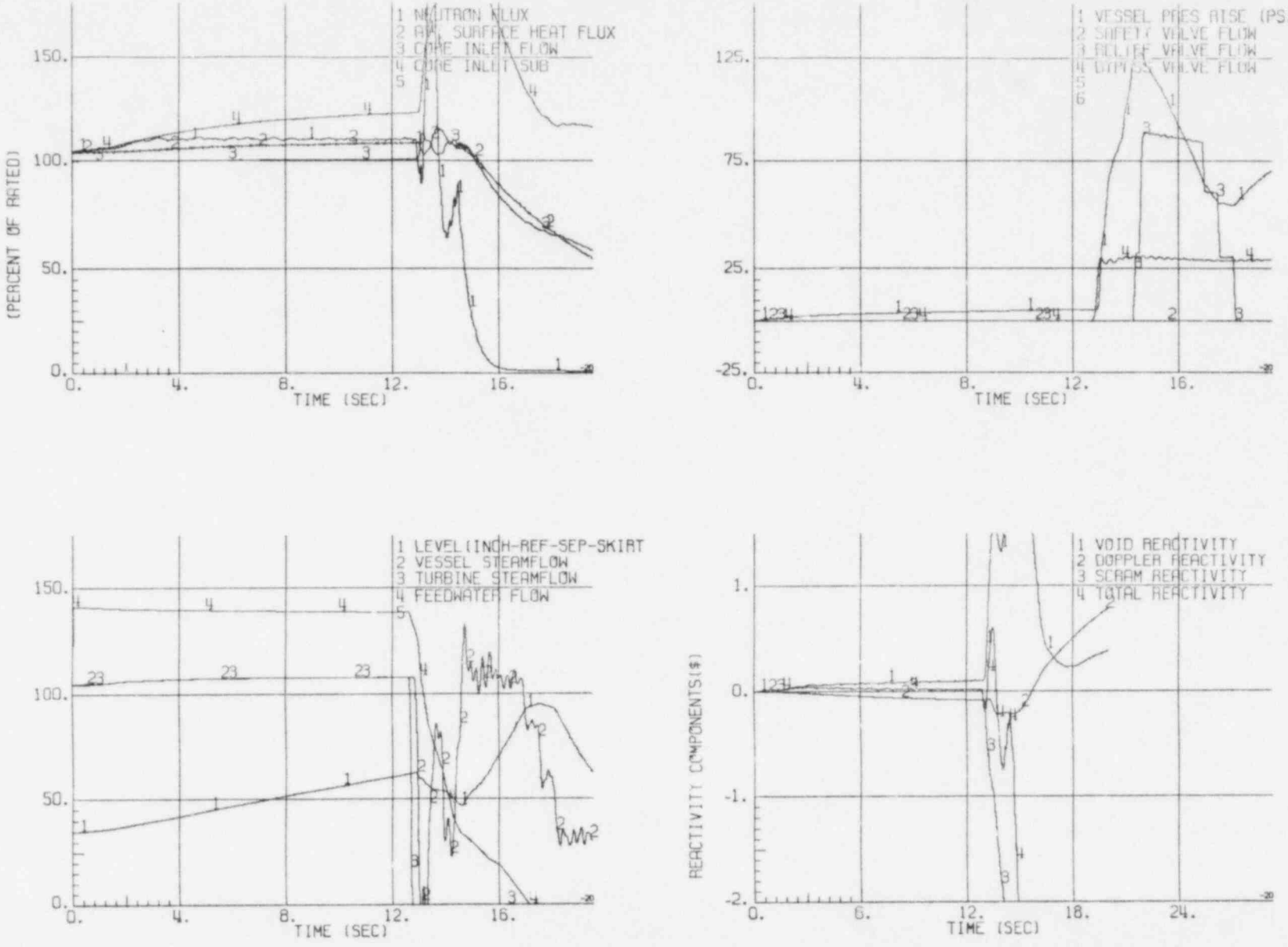


Figure 4A. Plant Response to Feedwater Controller Failure, Maximum Demand (EOC-2000)

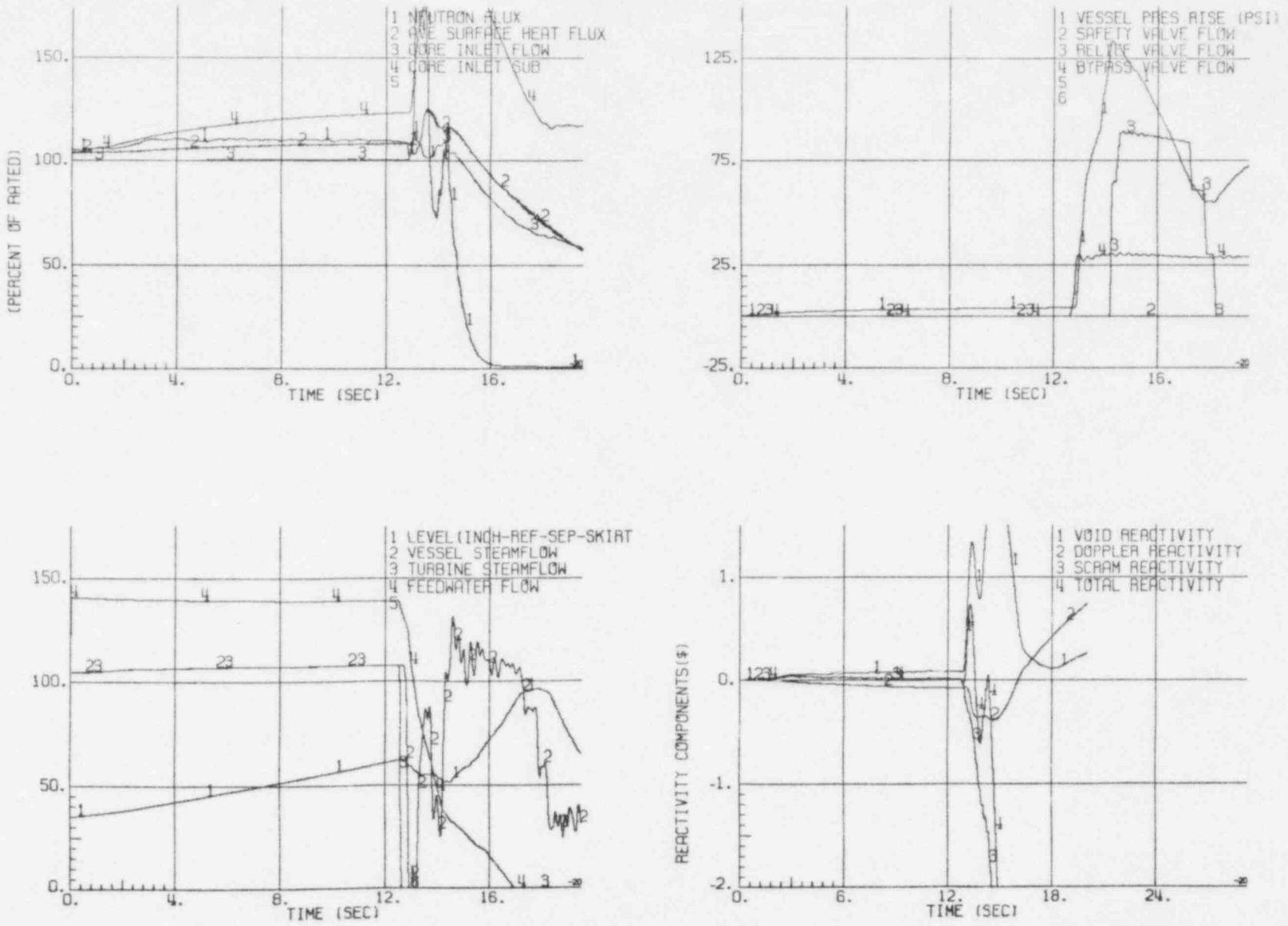


Figure 4B. Plant Response to Feedwater Controller Failure, Maximum Demand (EOC 4)

NOTES: 1. ROD PATTERN IS 1/4 CORE MIRROR SYMMETRIC.
2. NO. INDICATES NUMBER OF NOTCHES WITHDRAWN OUT OF 48. BLANK IS A WITHDRAWN ROD.
3. ERROR ROD IS (22, 39).

	2	6	10	14	18	22	26
51					40		40
47				6		10	
43			40		46		44
39		10		10		0	
35	40		40		44		46
31		10		6		10	
27	36		40		40		40

Figure 5. Limiting Rod Withdrawal Error Rod Pattern

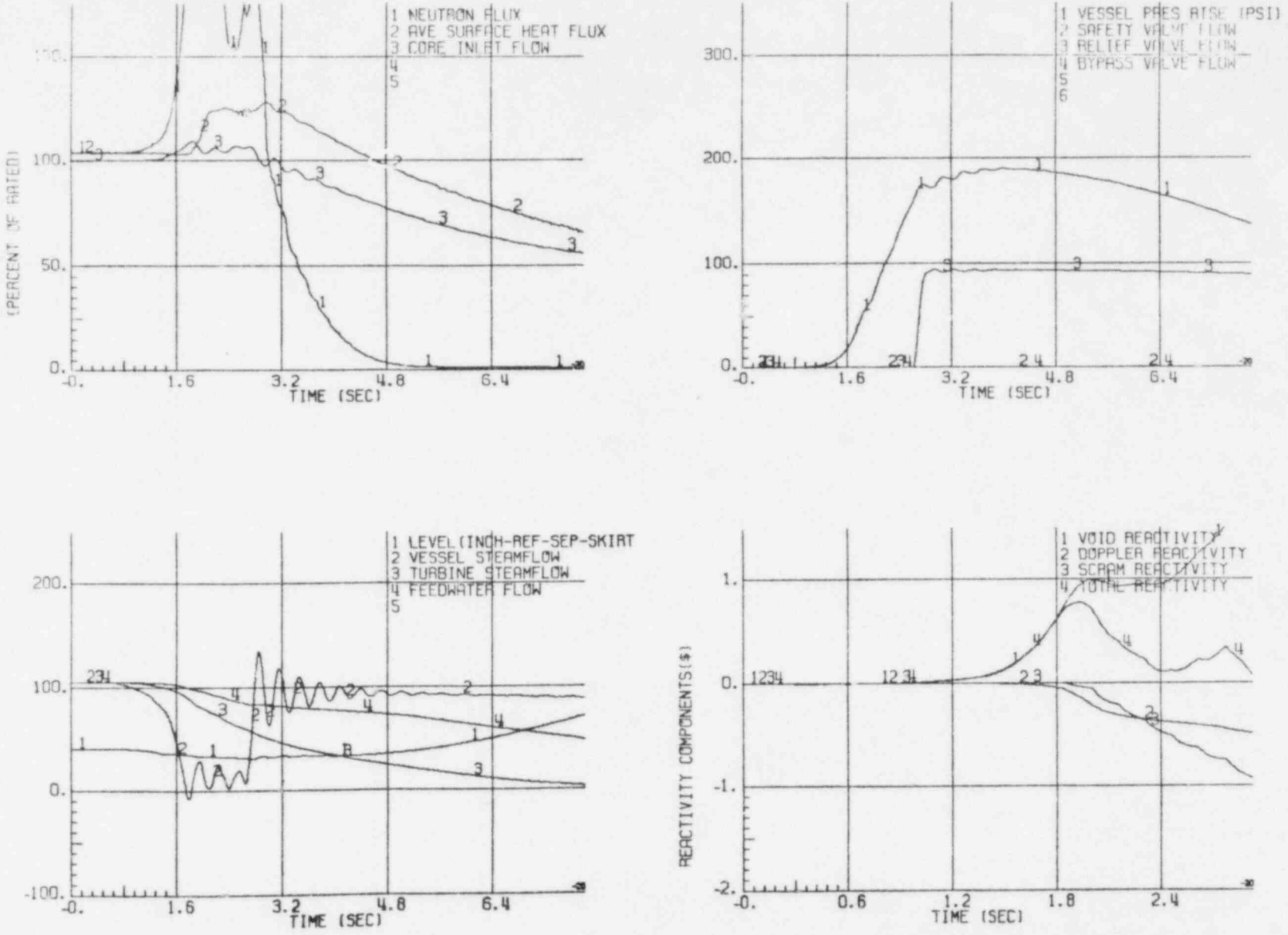


Figure 6. Plant Response to MSIV Closure (Flux Scram)

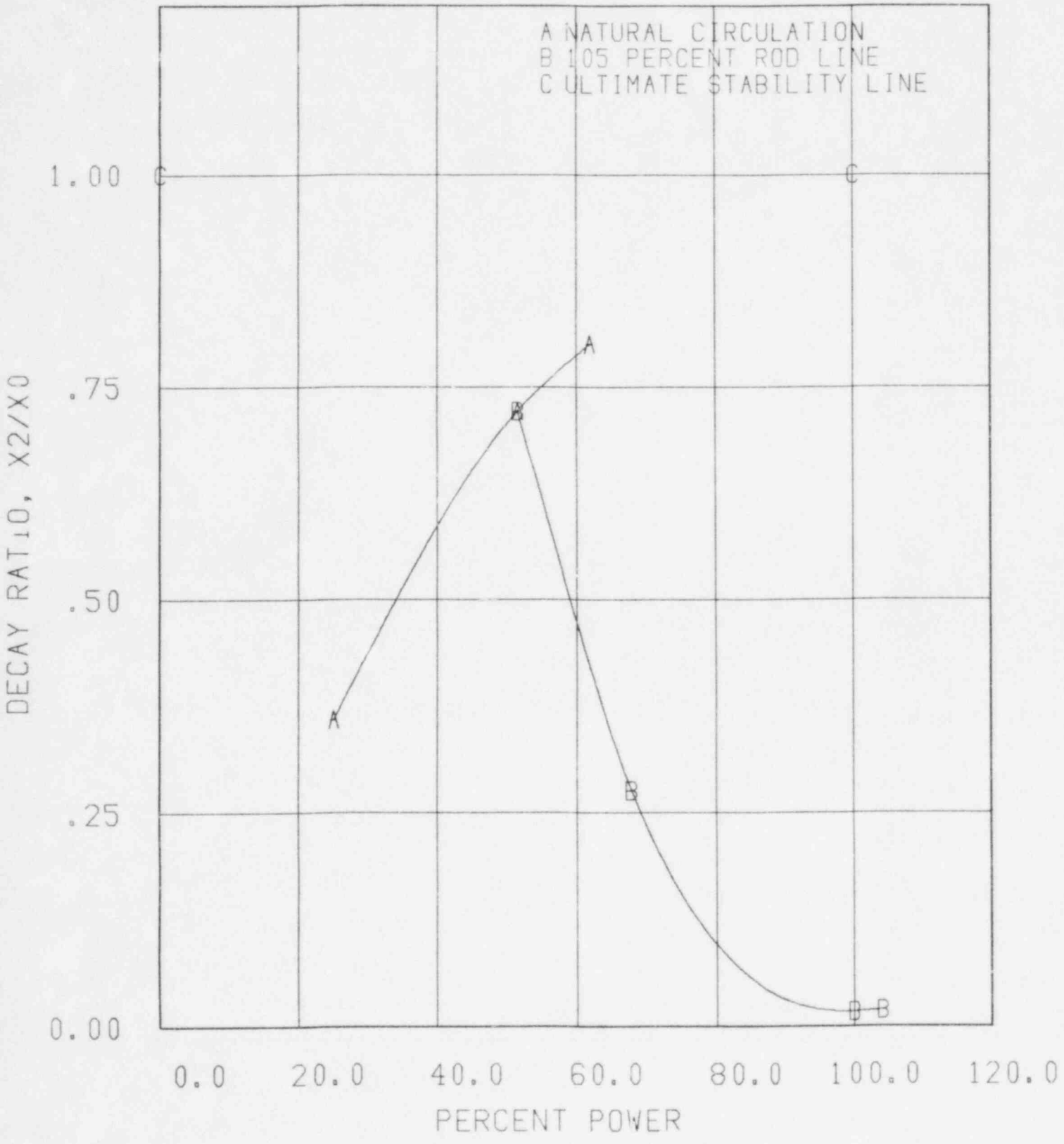


Figure 7. Reactor Core Decay Ratio

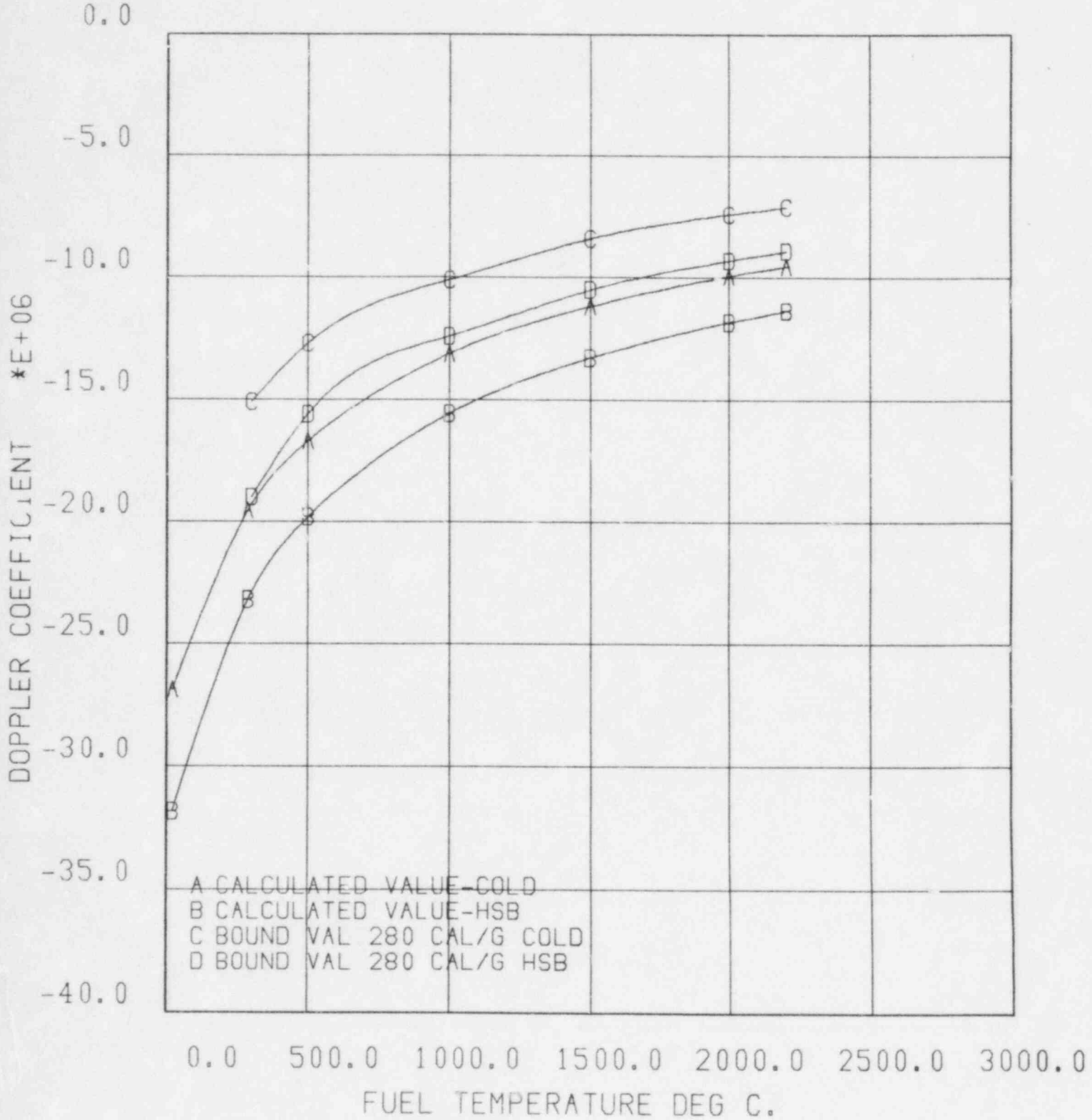


Figure 8. Fuel Doppler Coefficient in $1/\Delta°C$

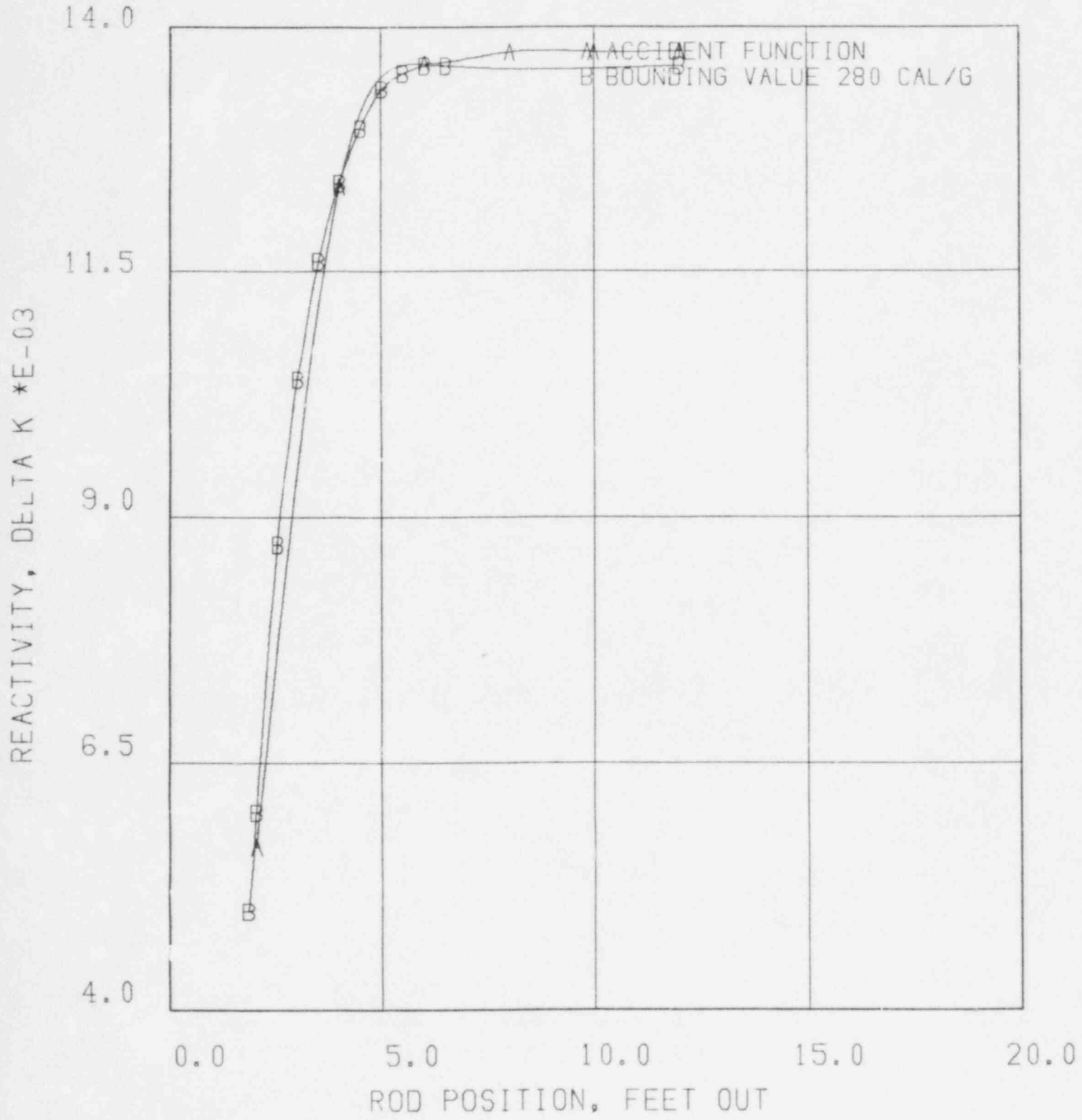


Figure 9. Accident Reactivity Shape Function Cold Startup

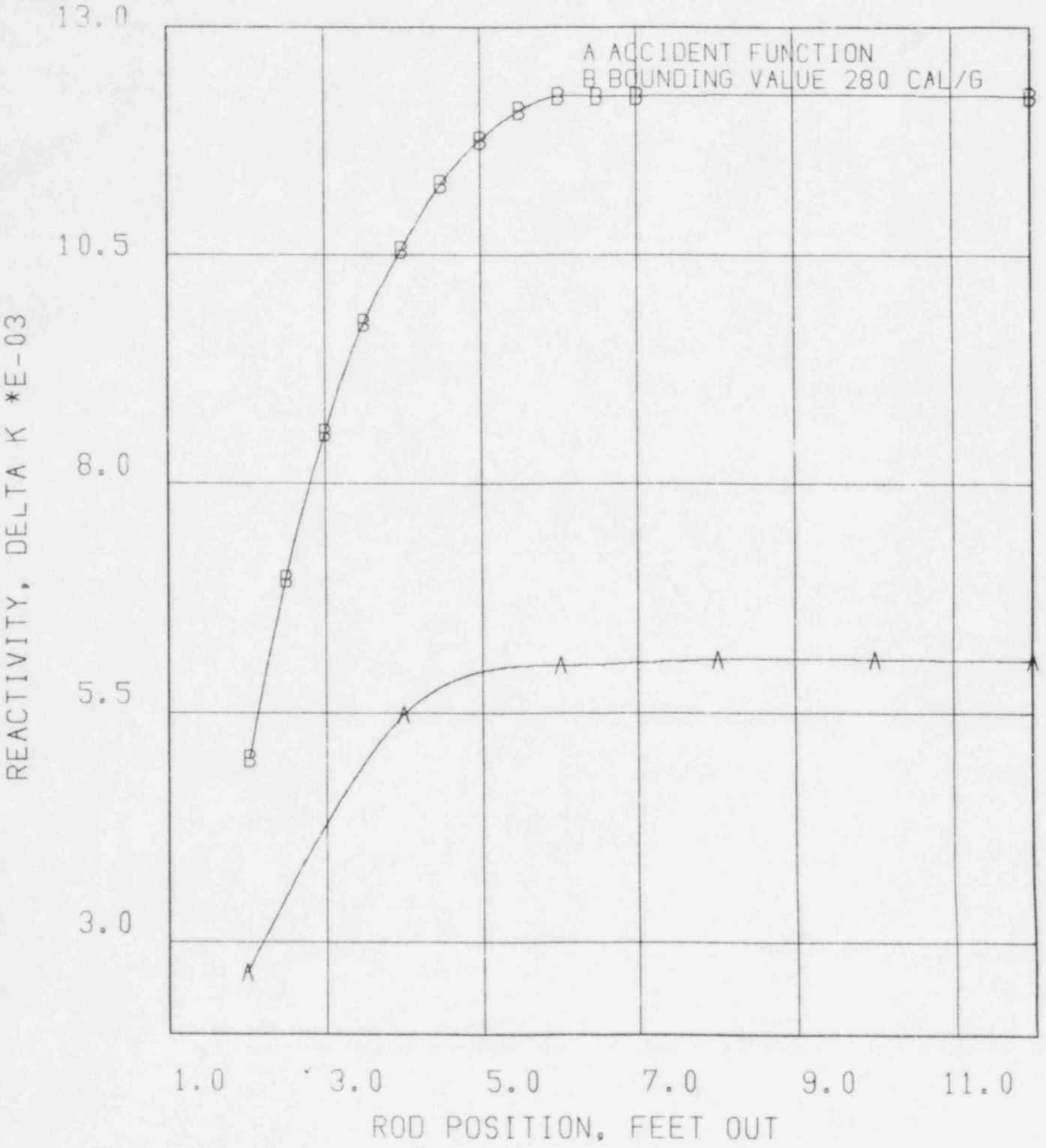


Figure 10. Accident Reactivity Shape Function Hot Startup

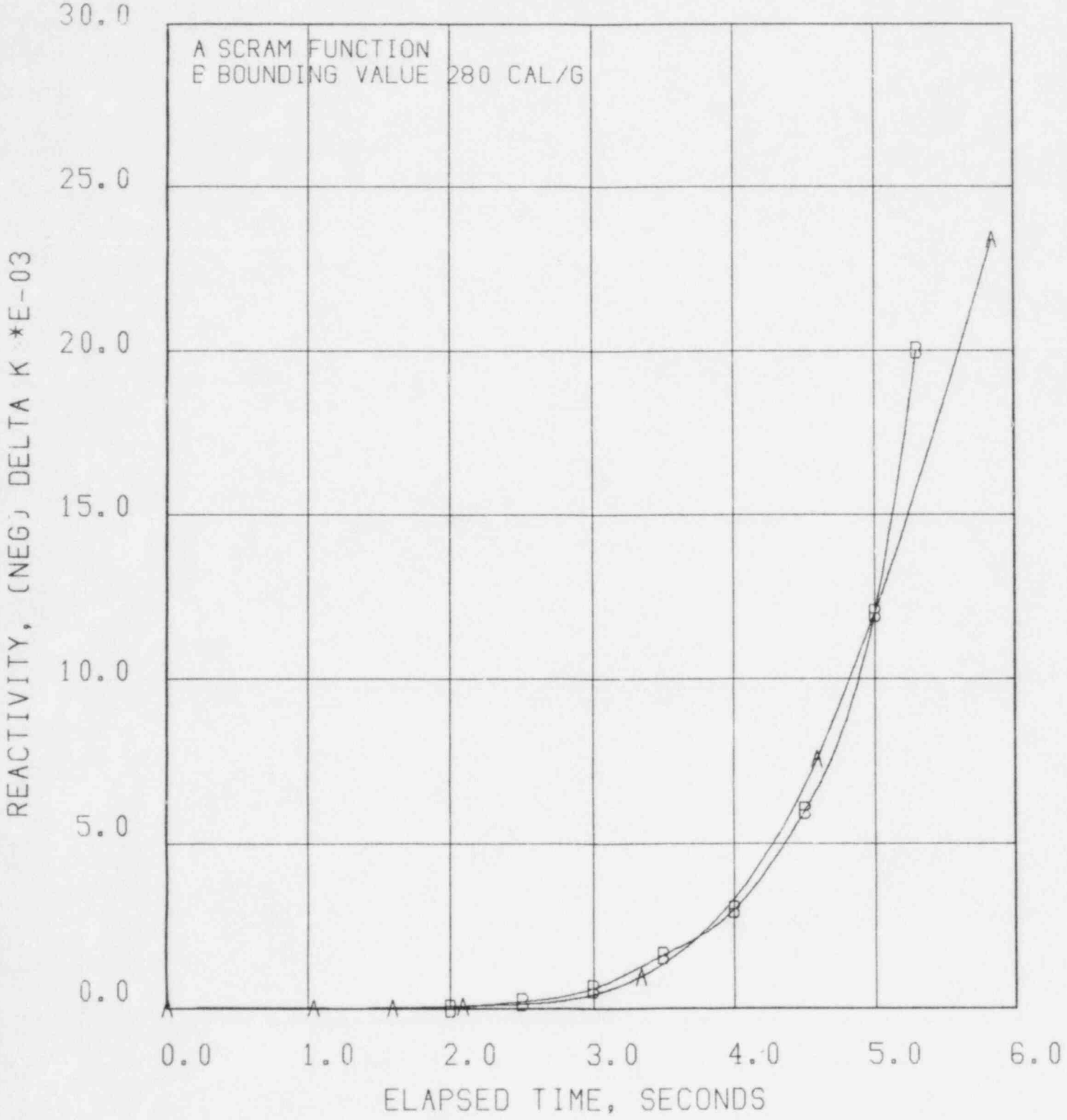


Figure 11. Scram Reactivity Function Cold Startup

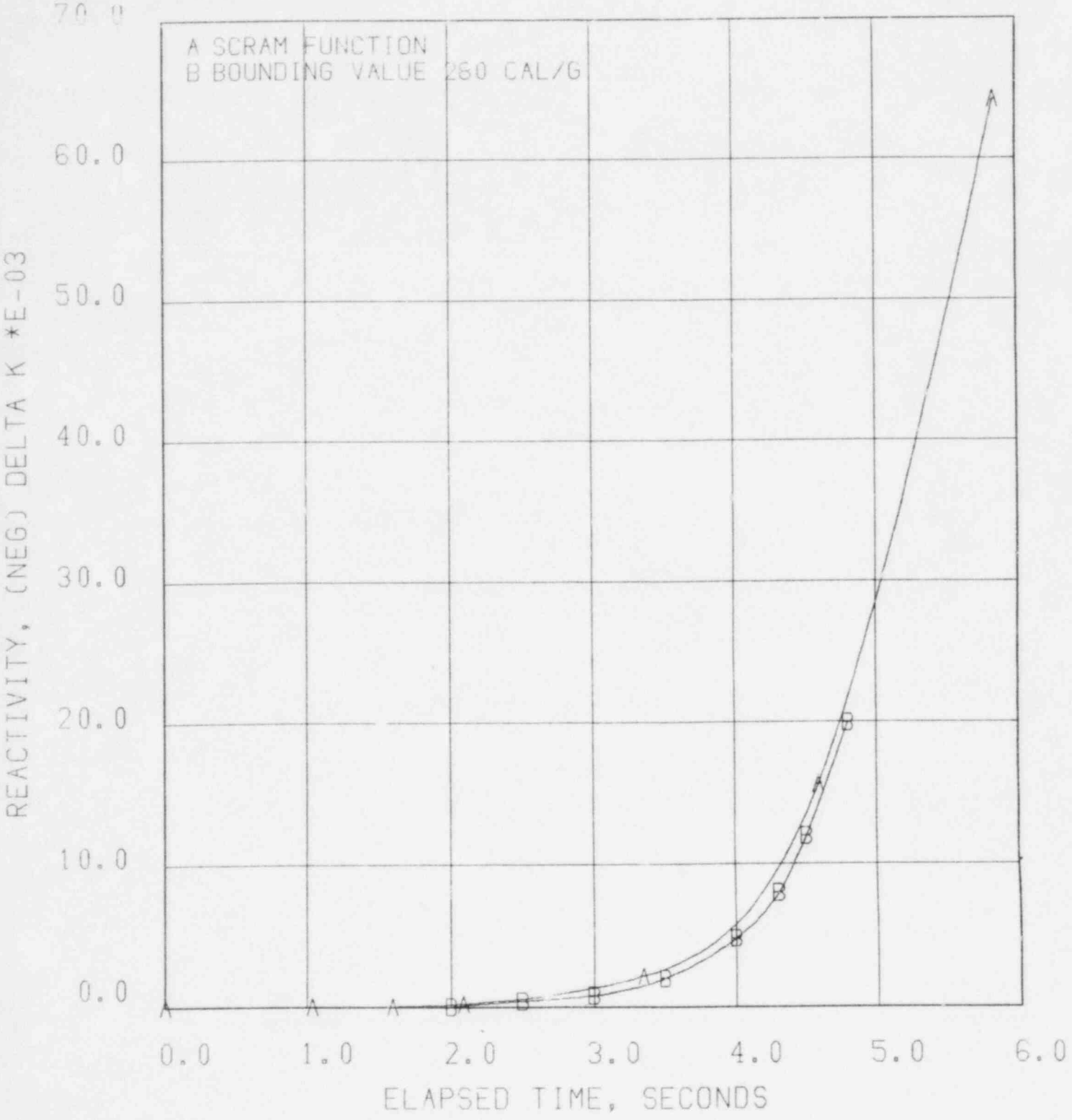


Figure 12. Scram Reactivity Function Hot Startup

APPENDIX A

CONFIRMATION OF SINGLE LOOP OPERATION

The previous Single Loop Operation analysis performed for Brunswick 1 (Reference A-1) has been verified to be applicable for Cycle 4.

REFERENCES

A-1. "Brunswick Steam Electric Plant Units 1 and 2 Single-Loop Operation," General Electric Company, September 1981 (NEDO-24344).

APPENDIX B

ADDITIONAL LOCA RESULTS

Fuel Type: IC Type 2

Exposure (MWd/ST)	MAPLHGR (kW/ft)	PCT (°F)	Local Oxidation (Fraction)
200	11.0	2017	0.018
1,000	11.1	2016	0.018
5,000	11.7	2078	0.020
10,000	12.2	2146	0.024
15,000	12.2	2163	0.026
20,000	12.0	2149	0.025
25,000	11.1	2026	0.017
30,000	10.1	1886	0.010

Fuel Type: 8DRB265L

Exposure (MWd/ST)	MAPLHGR (kW/ft)	PCT (°F)	Local Oxidation (Fraction)
200	11.6	2128	0.026
1,000	11.6	2129	0.025
5,000	12.1	2178	0.029
10,000	12.1	2169	0.028
15,000	12.1	2183	0.029
20,000	11.9	2170	0.029
25,000	11.3	2101	0.023
30,000	10.7	2020	0.017
35,000	10.2	1946	0.013
40,000	9.6	1857	0.010

Fuel Type: P8DRB265H

Exposure (MWd/ST)	MAPLHGR (kW/ft)	PCT (°F)	Local Oxidation (Fraction)
200	11.5	2103	0.024
1,000	11.6	2111	0.024
5,000	11.9	2135	0.025
10,000	12.1	2147	0.026
15,000	12.1	2157	0.027
20,000	11.9	2138	0.025
25,000	11.3	2063	0.020
30,000	10.7	1977	0.015

Fuel Type: 8DRB283

Exposure (MWd/ST)	MAPLHGR (kW/ft)	PCT (°F)	Local Oxidation (Fraction)
200	11.2	2090	0.023
1,000	11.2	2083	0.022
5,000	11.8	2149	0.027
10,000	12.0	2161	0.028
15,000	12.1	2180	0.029
20,000	11.8	2164	0.028
25,000	11.3	2096	0.023
30,000	11.1	2072	0.021
35,000	10.4	1986	0.016
40,000	9.8	1903	0.012

Fuel Type: P8DRB285

Exposure (MWd/ST)	MAPLHGR (kW/ft)	PCT (°F)	Local Oxidation (Fraction)
200	10.9	2038	0.019
1,000	11.0	2048	0.020
5,000	11.8	2141	0.026
10,000	12.3	2177	0.029
15,000	12.2	2174	0.028
20,000	11.8	2131	0.025
25,000	11.0	2031	0.018
30,000	10.4	1928	0.012