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SUPPLEMENTAL RELOAD LICENSING SUBMITTAL FOR VERMONT YANKEE NUCLEAR POWER STATION RELOAD 6

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SUPPLEMENTAL RELOAD LICENSING SUBMITTAL
FOR
VERMONT YANKEE NUCLEAR POWER STATION
RELOAD 6

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Exposure-dependent limits (EOC-2 GWd/t and EOC-1 GWd/t).

2. RELOAD FUEL BUNDLES (1.0, 2.0, 3.3.1, and 4.0)[1]

	Fuel Type	Number	Number Drilled
Irradiated	8DB274L	68	68
Irradiated	8DB274H	124	124
Irradiated	8DB219L	20	20
Irradiated	8DPB289	60	60
New	P8DPB289	96	96
Total		368	368

3. REFERENCE CORE LOADING PATTERN (3.3.1)

Nominal previous cycle core exposure: 14.16 GWd/t. Nominal core average exposure at end of cycle 15.21 GWd/t including coastdown. Core loading pattern: Figure 1.

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	1.115
Fully Controlled	0.956
Strongest Control Rod Out	0.989
R, Maximum Increase in Cold Core Reactivity with Exposure Into Cycle, Δk	0.0

*( ) refers to areas of discussion in Reference 1.

**Reference 1: "General Electric Boiling Water Reactor Generic Reload Fuel Application," NEDE-24011-P-A, May 1979.

5. STANDBY LIQUID CONTROL SYSTEM SHUTDOWN CAPABILITY (3.3.2.1.3)

ppm	Shutdown Margin (Δk) (20°C, Xenon Free)
800	0.053

6. RELOAD UNIQUE TRANSIENT ANALYSIS INPUTS (3.3.2.1.5 AND 5.2)

	EOC7	EOC7-1	EOC7-2
Void Coefficient N/A* (-¢/% Rg)	8.54/10.68	9.07/11.33	9.05/11.31
V id Fraction (%)	40.13	40.13	40.13
Doppler Coefficient N/A (-¢/°F)	0.226/0.215	0.222/0.211	0.215/0.204
Average Fuel Temperature (°F)	1312	1312	1312
Scram Worth N/A (-$)	35.32/28.25	34.81/27.85	33.47/26.78
Scram Reactivity versus Time	Figure 2a	Figure 2b	Figure 2c

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

	EOC7			EOC7-1 GWd/t			EOC7-2 GWd/t		
Exposure	8x8	8x8R	P8x8R	8x8	8x8R	P8x8R	8x8	8x8R	P8x8R
Peaking factors (local, radial)	1.22 1.41	1.20 1.52	1.20 1.50	1.22 1.46	1.20 1.58	1.20 1.56	1.22 1.48	1.20 1.58	1.20 1.58
R-Factor	1.084	1.051	1.051	1.084	1.051	1.051	1.084	1.051	1.051
Bundle Power (MWt)	5.974	6.422	6.350	6.200	6.667	6.604	6.256	6.683	6.686
Bundle Flow (10^3 lb/hr)	109.1	110.7	111.5	107.6	109.2	109.9	107.2	109.1	109.3
Initial MCPR	1.28	1.28	1.30	1.23	1.23	1.24	1.22	1.22	1.22

*N = Nuclear Input Data

A = Used in Transient Analysis

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8. SELECTED MARGIN IMPROVEMENT OPTIONS (5.2.2)

Exposure-dependent limits: EOC7-1 GWd/t to EOC7

EOC7-2 GWd/t to EOC7-1 GWd/t

BOC7 to EOC7-2 GWd/t

9. CORE-WIDE TRANSIENT ANALYSIS RESULTS (5.2.1)

Transient	Exposure	Power (%)	Core Flow (%)	$\hat{\phi}$ (% NBR)	Q/A (% NBR)	P_{SL} (PSIG)	P_V (PSIG)	ΔCPR 8x8/8x8R/P8x8R	Plant Response
Load Rejection without Bypass	EOC7	104.5	100	290.1	117.5	1202	1238	0.21/0.21/0.23	Figure 3a
	EOC7-1 GWd/t	104.5	100	239.3	113.9	1193	1228	0.16/0.16/0.17	Figure 3b
	EOC7-2 GWd/t	104.5	100	182.5	107.2	1175	1211	0.06/0.06/0.06	Figure 3c
Turbine Trip without Bypass	EOC7	104.5	100	288.9	117.4	1205	1240	0.21/0.21/0.23	Figure 3d
	EOC7-1 GWd/t	104.5	100	236.8	113.7	1196	1231	0.16/0.16/0.17	Figure 3e
	EOC7-2 GWd/t	104.5	100	172.2	107.3	1178	1213	0.06/0.06/0.06	Figure 3f
Loss of 100°F FW Heater	BOC7 to EOC7	104.5	100	123.9	123.5	1020	1066	0.15/0.15/0.15	Figure 4
Feedwater Controller Failure	BOC7 to EOC7	104.5	100	116.4	110.2	1021	1065	0.05/0.05/0.06	Figure 5

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

TRANSIENT SUMMARY (5.2.1)

Rod Block Reading**	Rod Position (Feet Withdrawn)	ΔCPR* 8x8/8x8R/P8x8R	LHGR*** 8x8/8x8R/P8x8R	Limiting Rod Pattern
104	3.5	0.12/0.09/0.11	14.88/12.81/12.74	Figure 6
105**	4.0	0.14/0.10/0.13	15.55/12.81/13.14	↓
106	4.5	0.16/0.11/0.15	15.82/12.84/13.[illegible]3	↓
107	5.0	0.17/0.12/0.17	15.86/12.95/13.41	↓
108	6.0	0.20/0.14/0.20	15.86/13.11/13.44	↓
109	8.0	0.24/0.16/0.25	15.86/13.11/13.44	↓
110	9.5	0.27/0.17/0.27	16.45/13.53/13.67	↓

*Based on initial MCPR of 1.28 (8x8), 1.28 (8x8R), 1.37 (P8x8R).

**Indicates setpoint selected.

***Includes 2.2% fuel densification penalty.

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11. OPERATING MCPR LIMIT (5.2)

See Appendix A.

12. OVERPRESSURIZATION ANALYSIS SUMMARY (5.3)

Transient	Power (%)	Core Flow (%)	P_{sl} (psig)	P_v (psig)	Plant Response
MSIV Closure (Flux Scram)	104.5	100	1250	1287	Figure 7

13. STABILITY ANALYSIS RESULTS (5.4)

Decay Ratio: Figure 8

Reactor Core Stability:

Decay Ratio, x_2/x_o (Natural Circulation- 105% Rod Line)	0.71

Channel Hydrodynamic Performance

	Decay Ratio (Natural Circulation - 105% Rod Line)
8x8 channel	0.26
8x8 channel*	0.33
8x8R channel	0.3

*With lower tieplate holes

14. LOSS-OF-COOLANT ACCIDENT RESULTS (5.5.2)

Fuel type 8DPB289 was introduced in Reload 5. The Reload-5 MAPLHGR, PCT and Local Oxidation Fraction are applicable to P8DPB289 for Reload 6 (i.e., PCT 10°F to 50°F less for Reload 6, compared to Reload 5.

15. LOADING ERROR RESULTS (5.5.4)

See Appendix A.

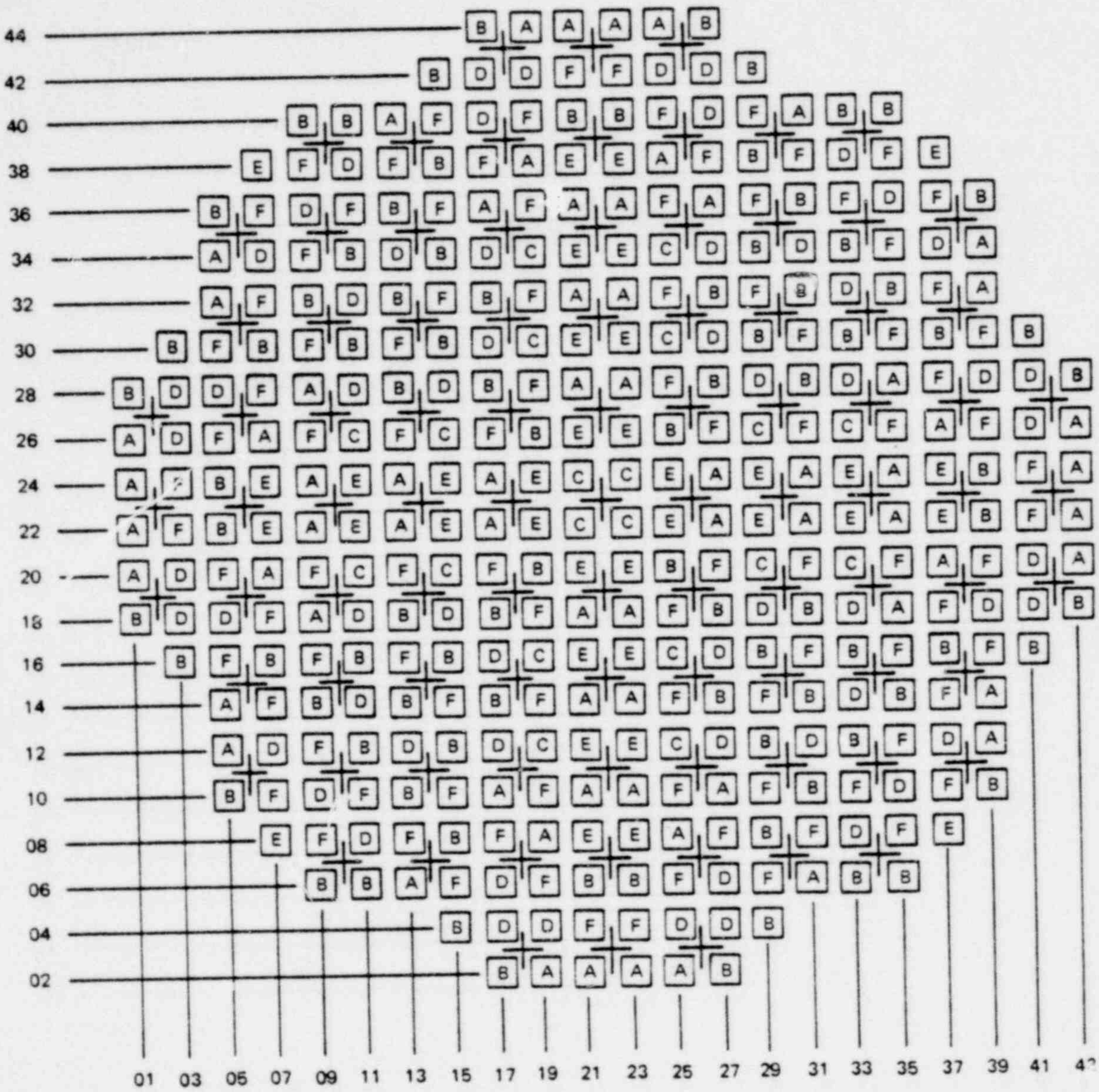
16. CONTROL ROD DROP ANALYSIS RESULTS (5.5.1)

Doppler Reactivity Coefficient: Figure 9

Accident Reactivity Shape Functions: Figures 10 and 11

Scram Reactivity Functions: Figures 12 and 13

In the cold condition (20°C), the peak fuel enthalpy, including the 5% power spiking effect due to fuel densification, is 135 cal/gm. Therefore, the peak fuel enthalpy design limit will not be exceeded.



FUEL TYPE	
A = 8 DB 274 L	D = 8 DB 289
B = 8 DB 274 H	E = 8 DB 274 H, R-5
C = 8 DB 219	F = P8DPB 289, R-b

Figure 1. Vermont Yankee, Reload-6 Design Reference Core Loading

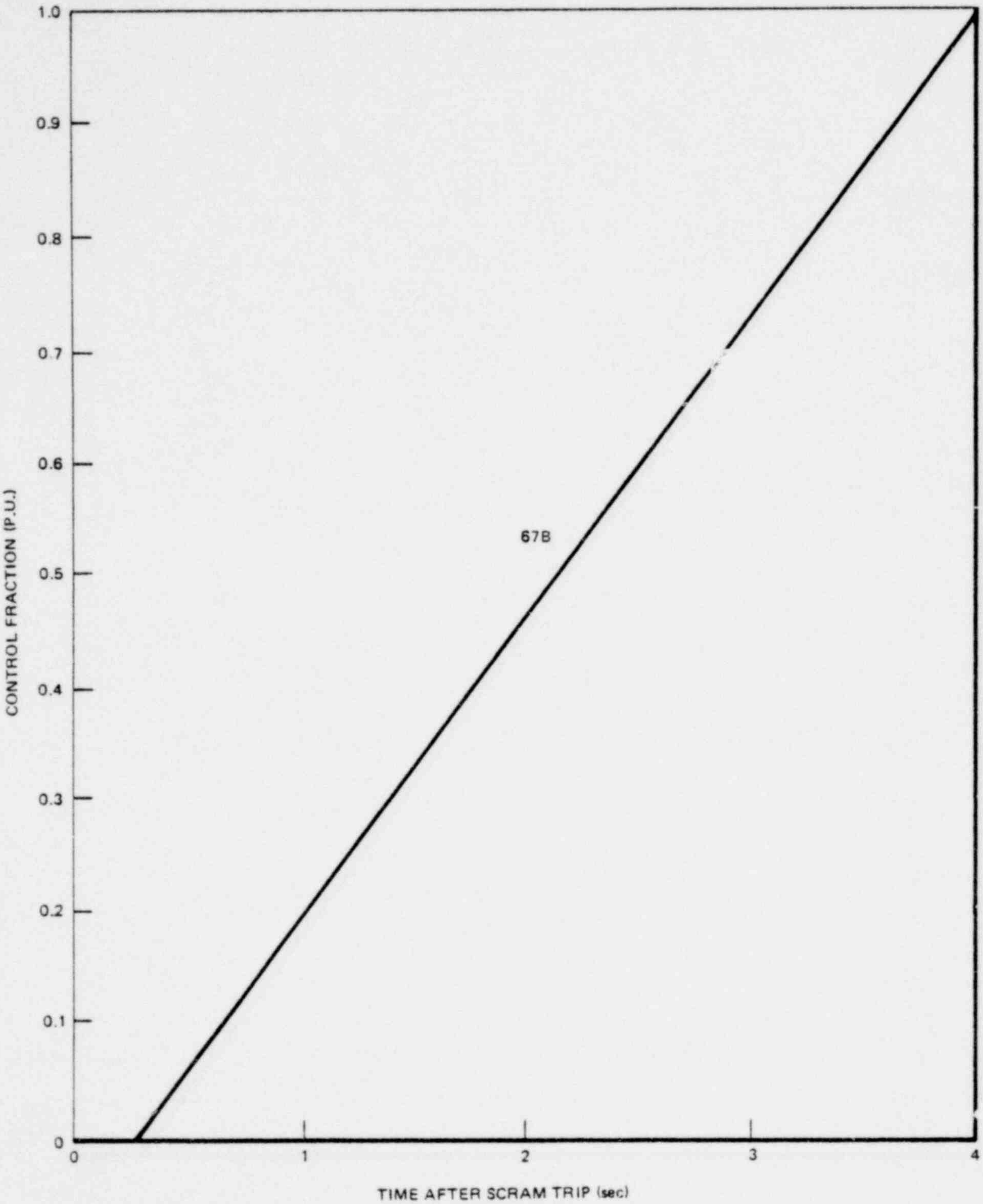


Figure 2a. CRD Function for Vermont Yankee

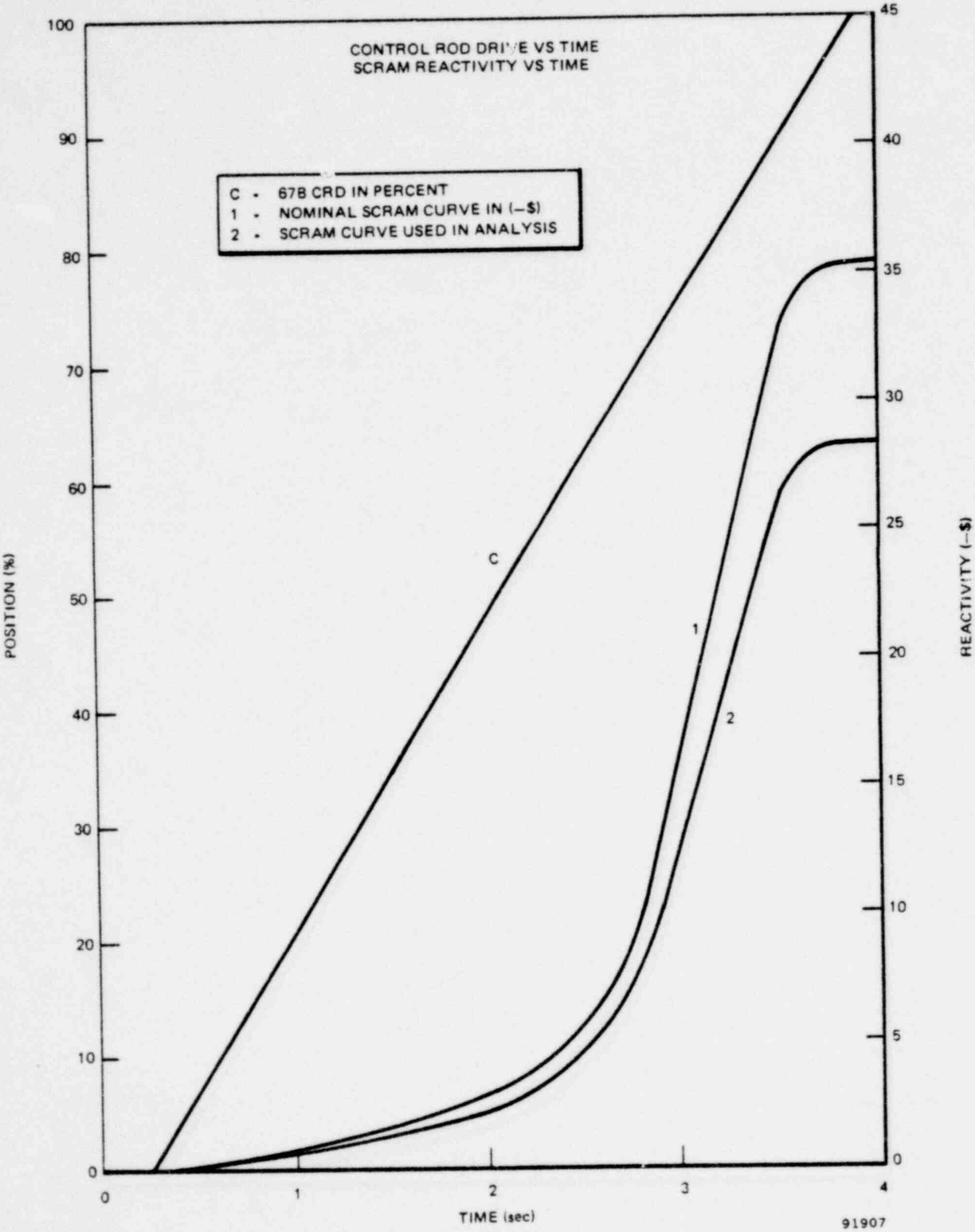


Figure 2bi. Scram Reactivity Function, EOC7

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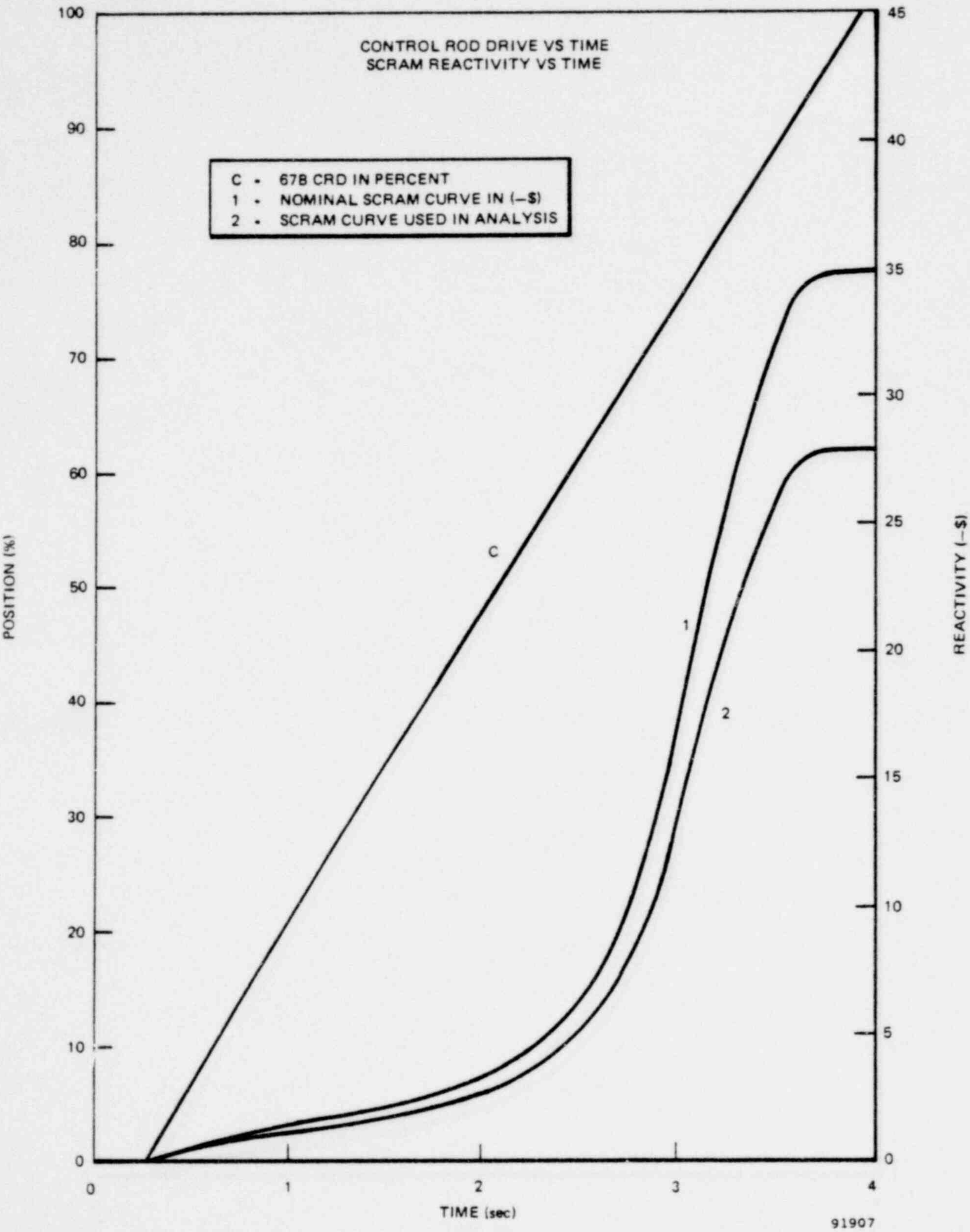

Figure 2bii. Scram Reactivity Function, EOC7-1 GWd/t

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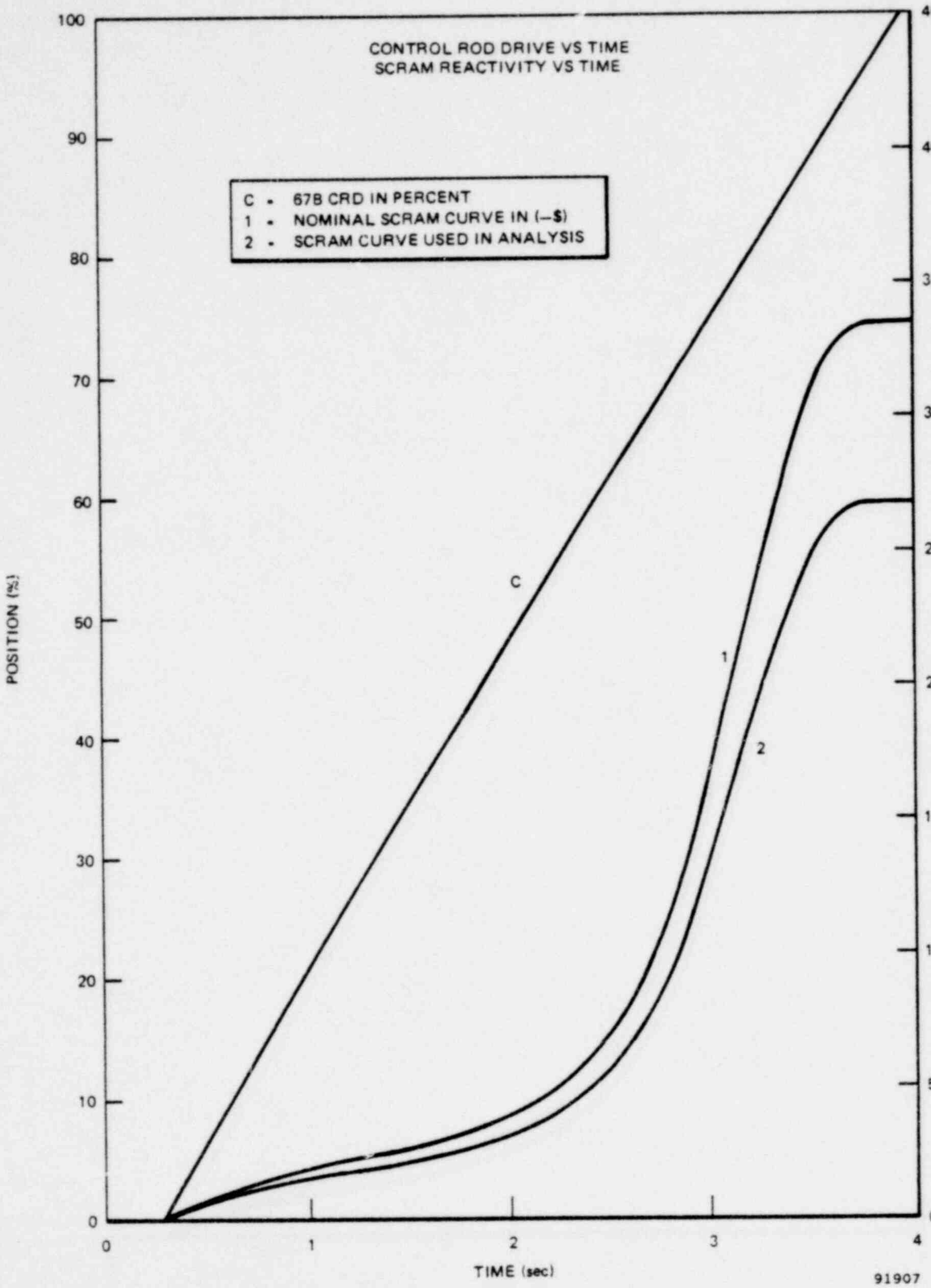

Figure 2biii. Scram Reactivity Function EOC7-2 GWd/t

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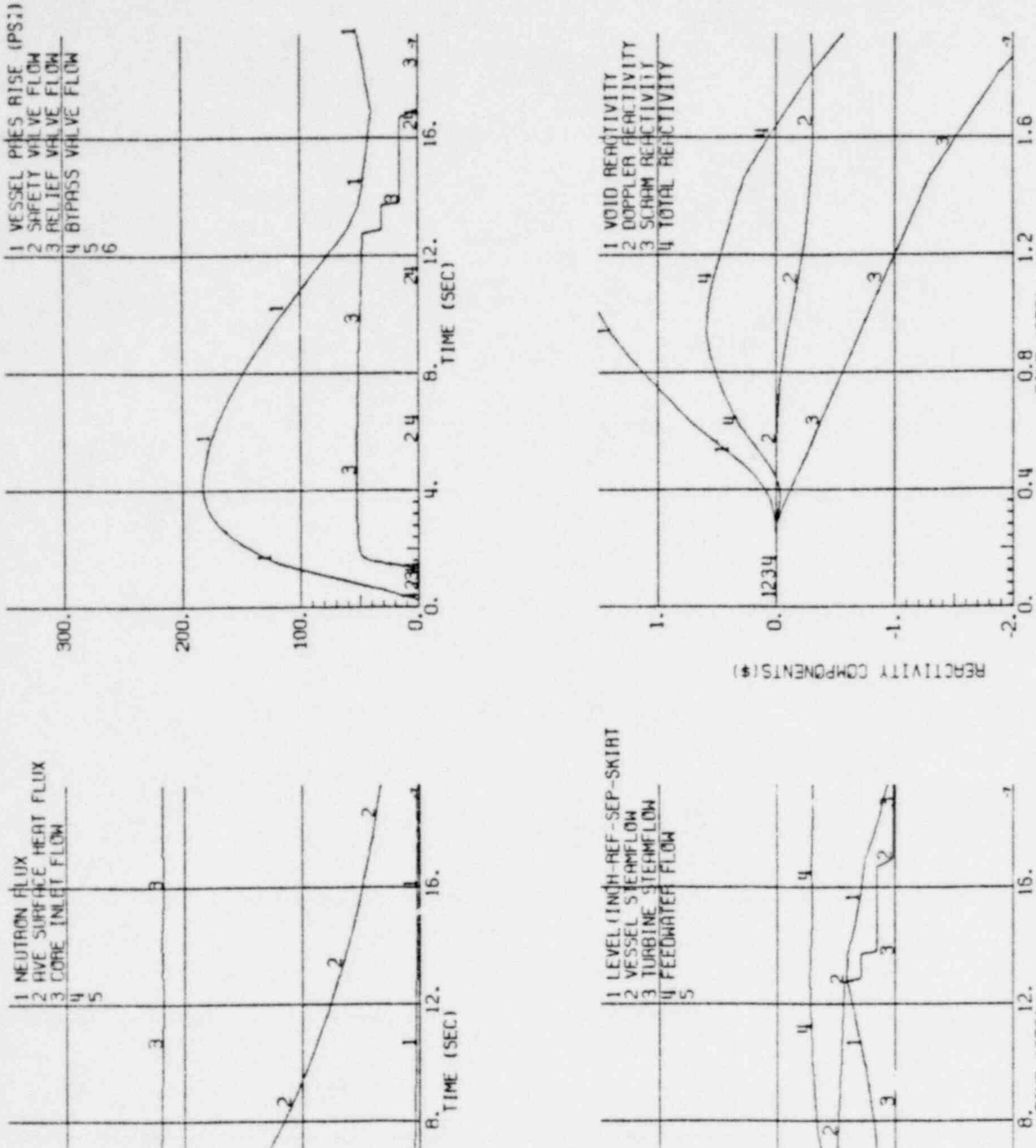

Figure 3a. Vermont Yankee EOC7 Generator Load Rejection, Without Bypass

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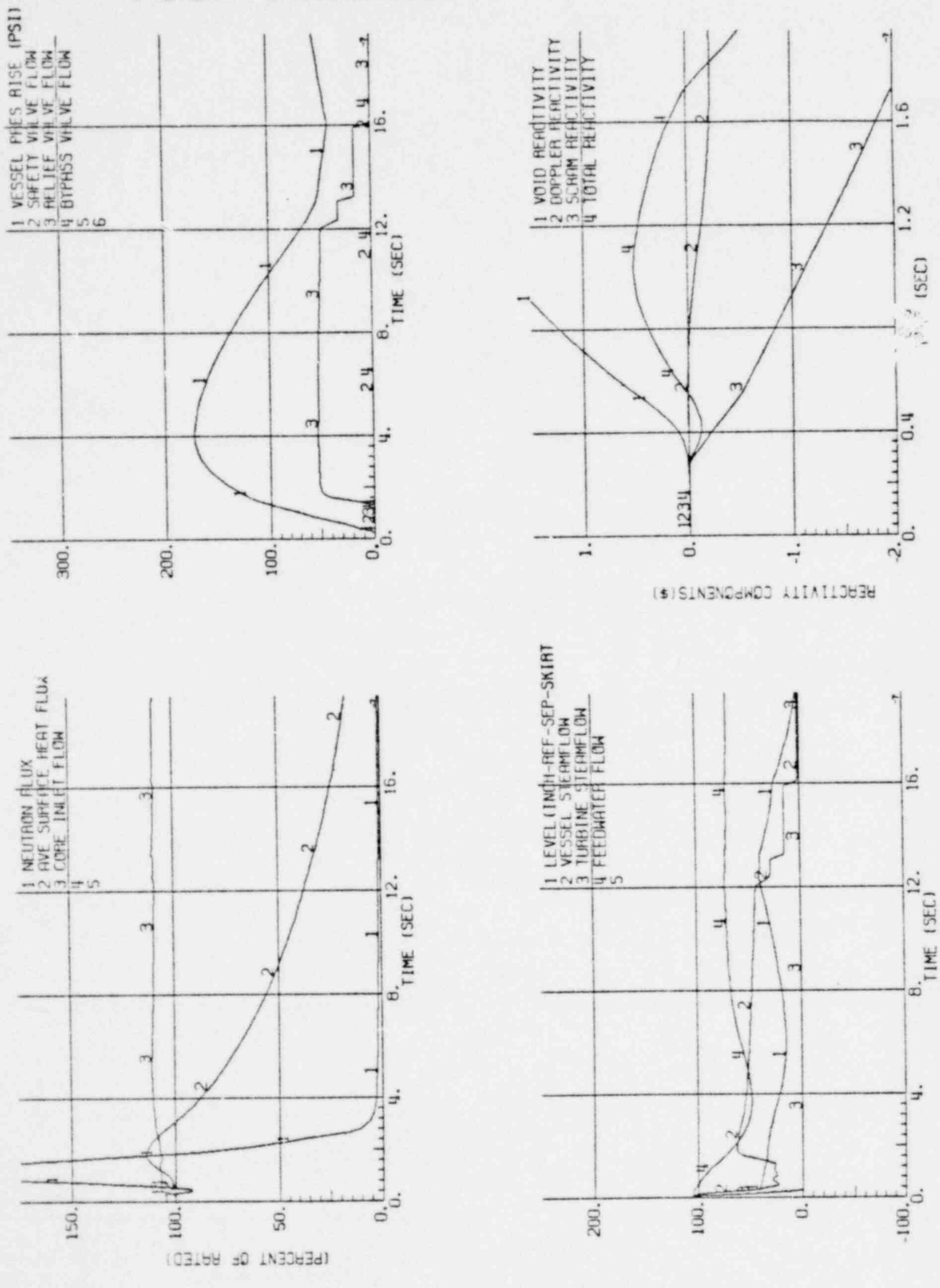

Figure 3b. Vermont Yankee EOC7-1 GWd/t Generator Load Rejection, Without Bypass

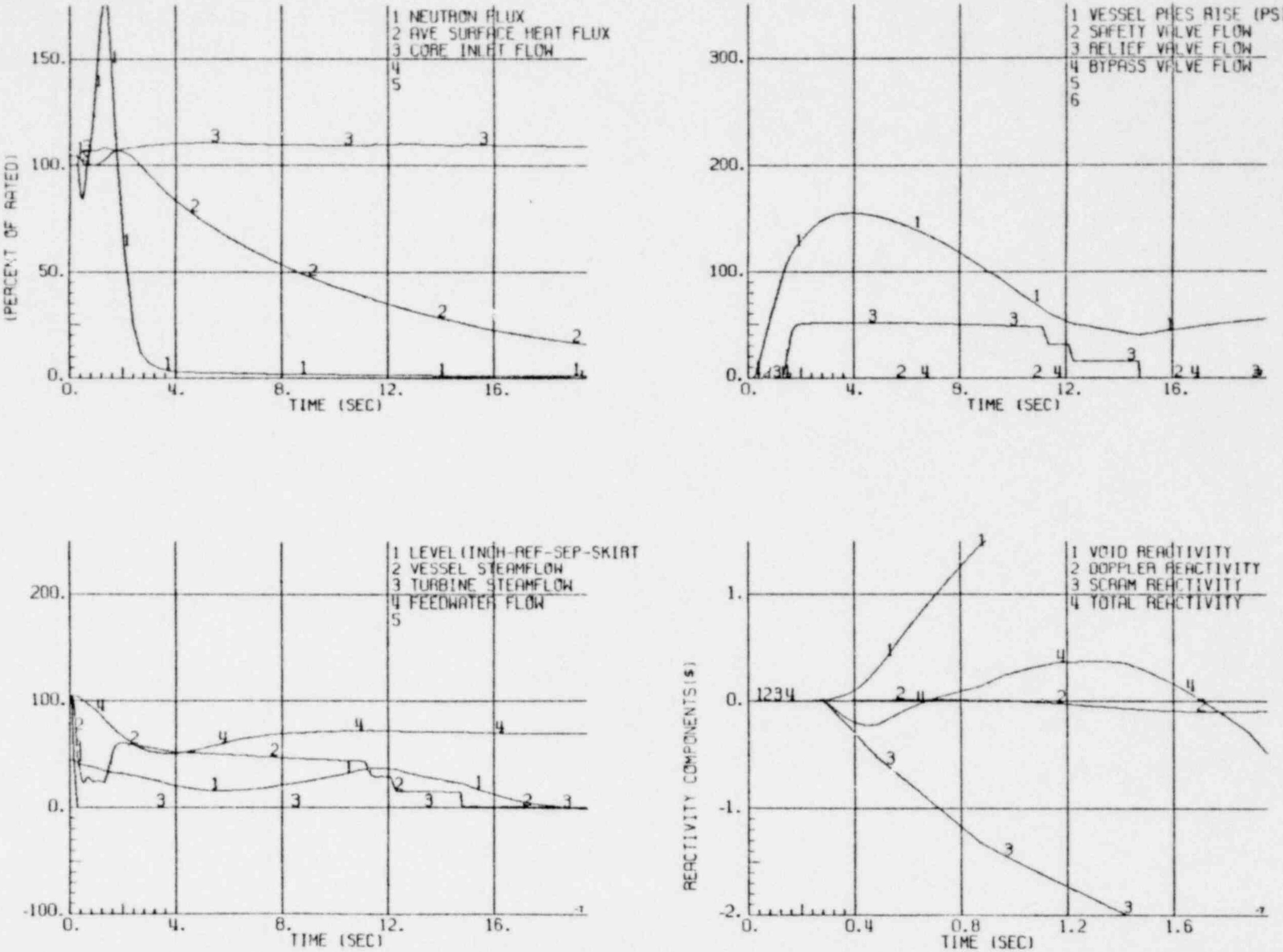

Figure 3c. Vermont Yankee EOC7-2 GWd/t Generator Load Rejection, Without Bypass

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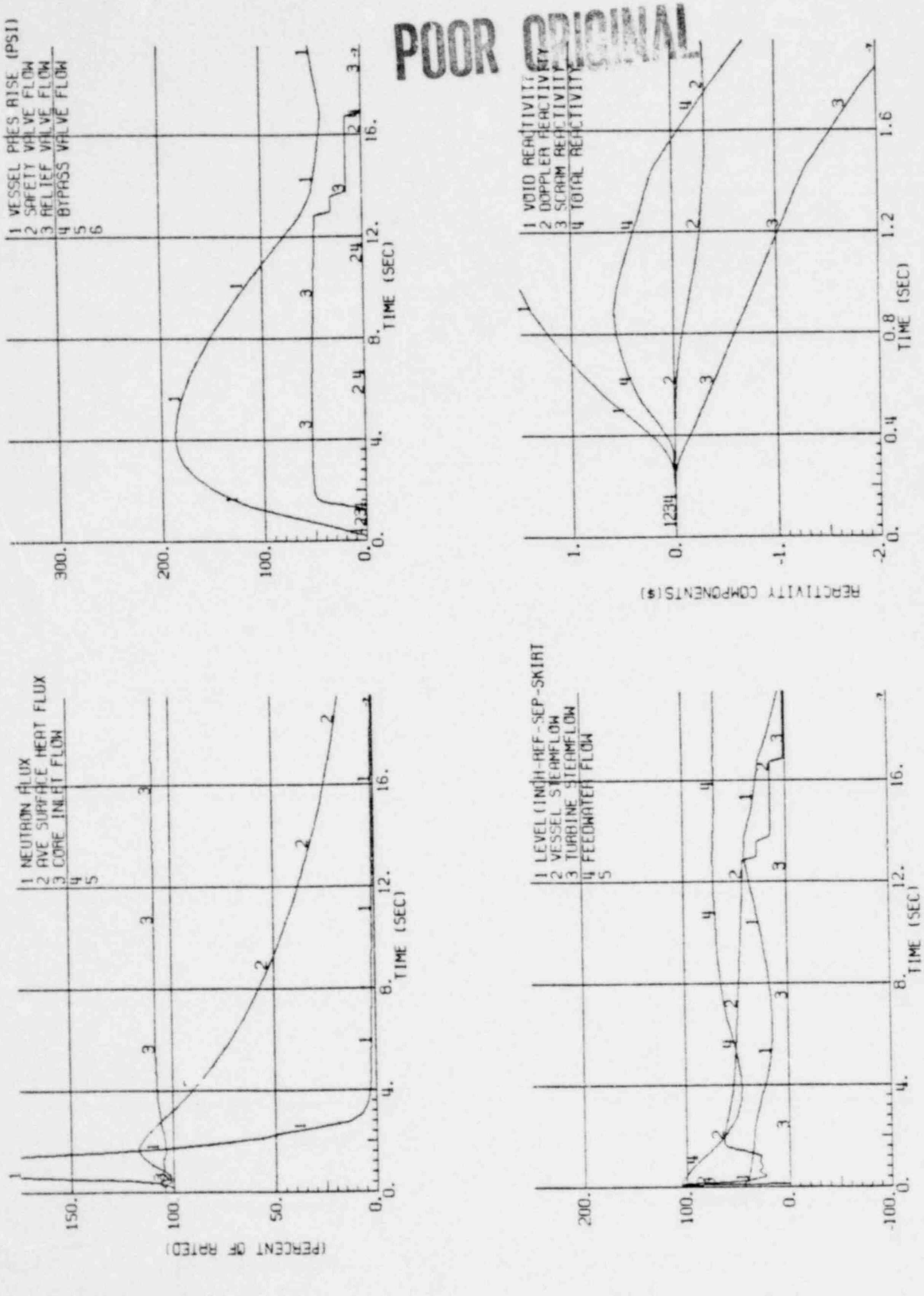

Figure 3d. Vermont Yankee EOC7 Turbine Trip Without Bypass, Trip Scram

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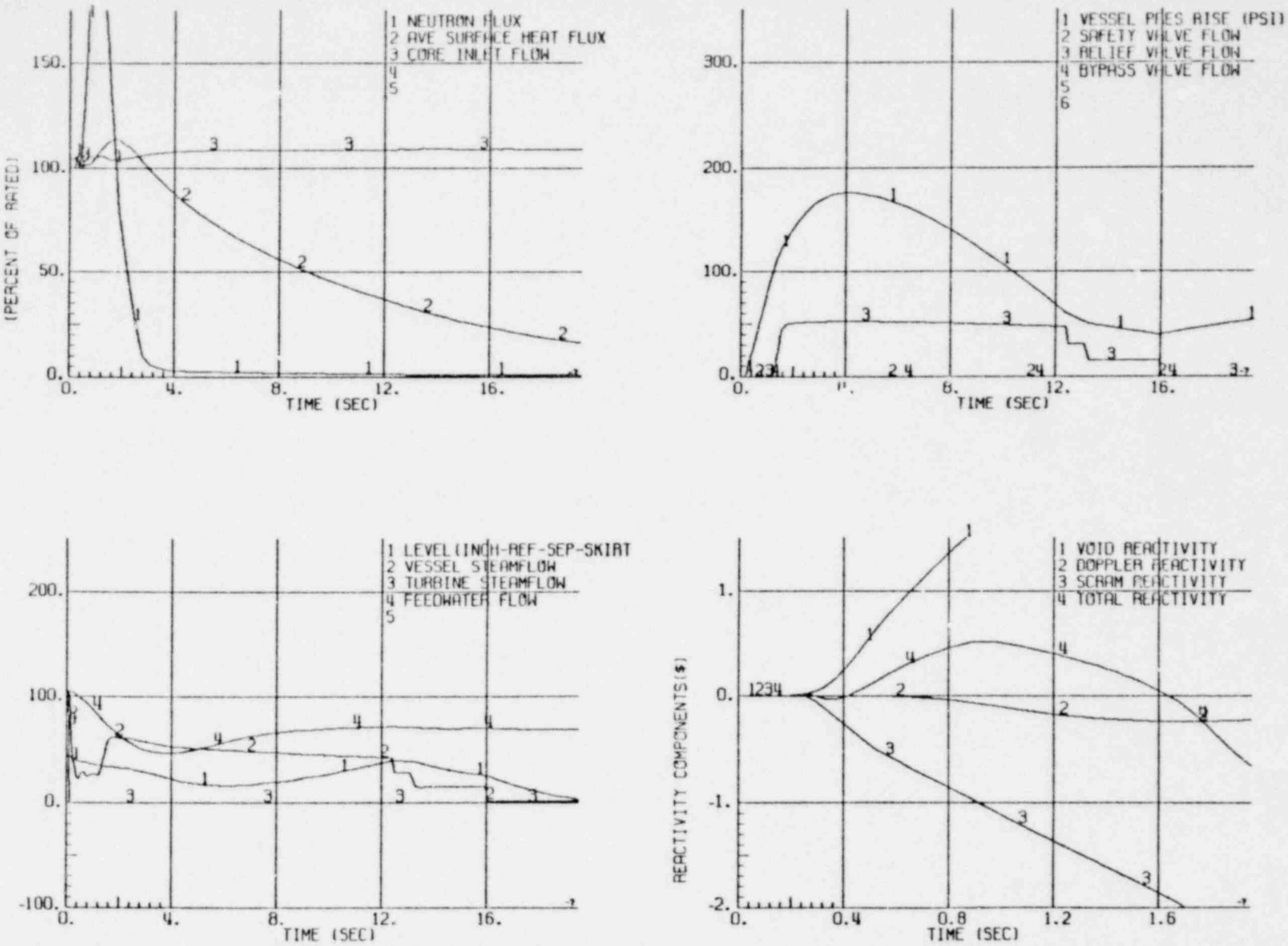

Figure 3e. Vermont Yankee EOC7-1 GWd/t Turbine Trip Without Bypass, Trip Scram

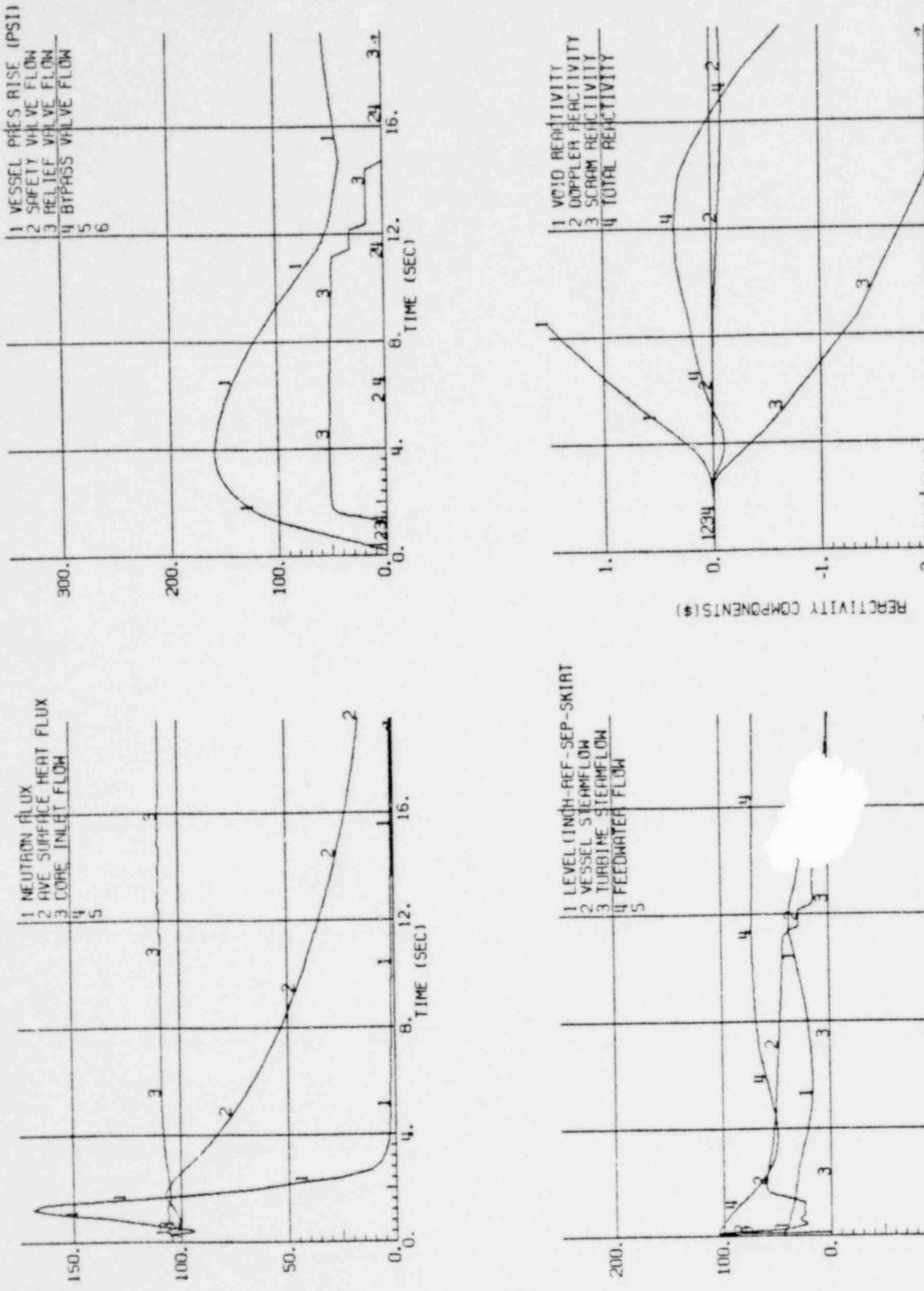

Figure 3f. Vermont Yankee EOC7-2 GWd/t Turbine Trip Without Bypass, Trip Scram

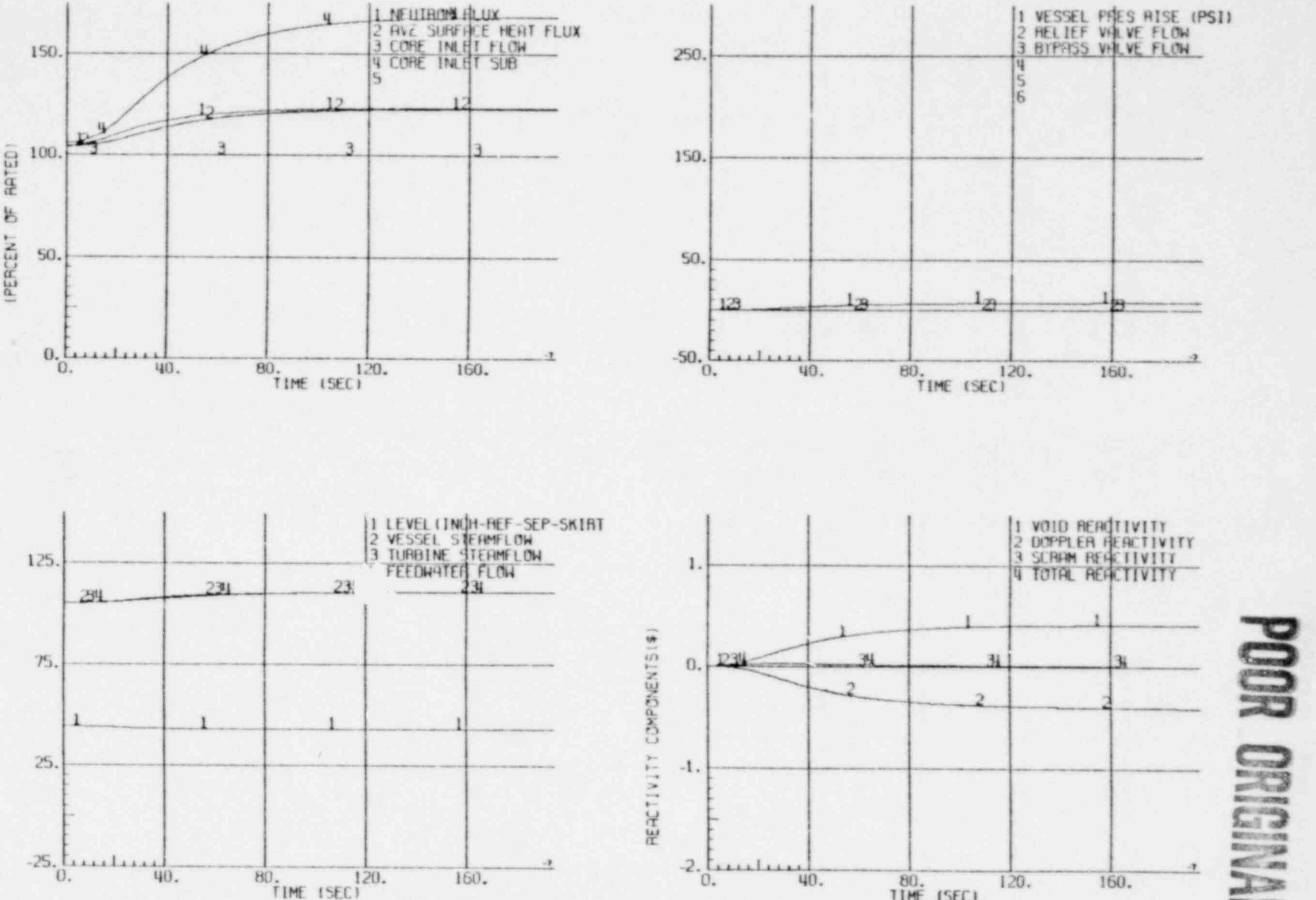

Figure 4. Vermont Yankee BOC7 to EOC7 Loss of 100°F Feedwater Heating, MFC

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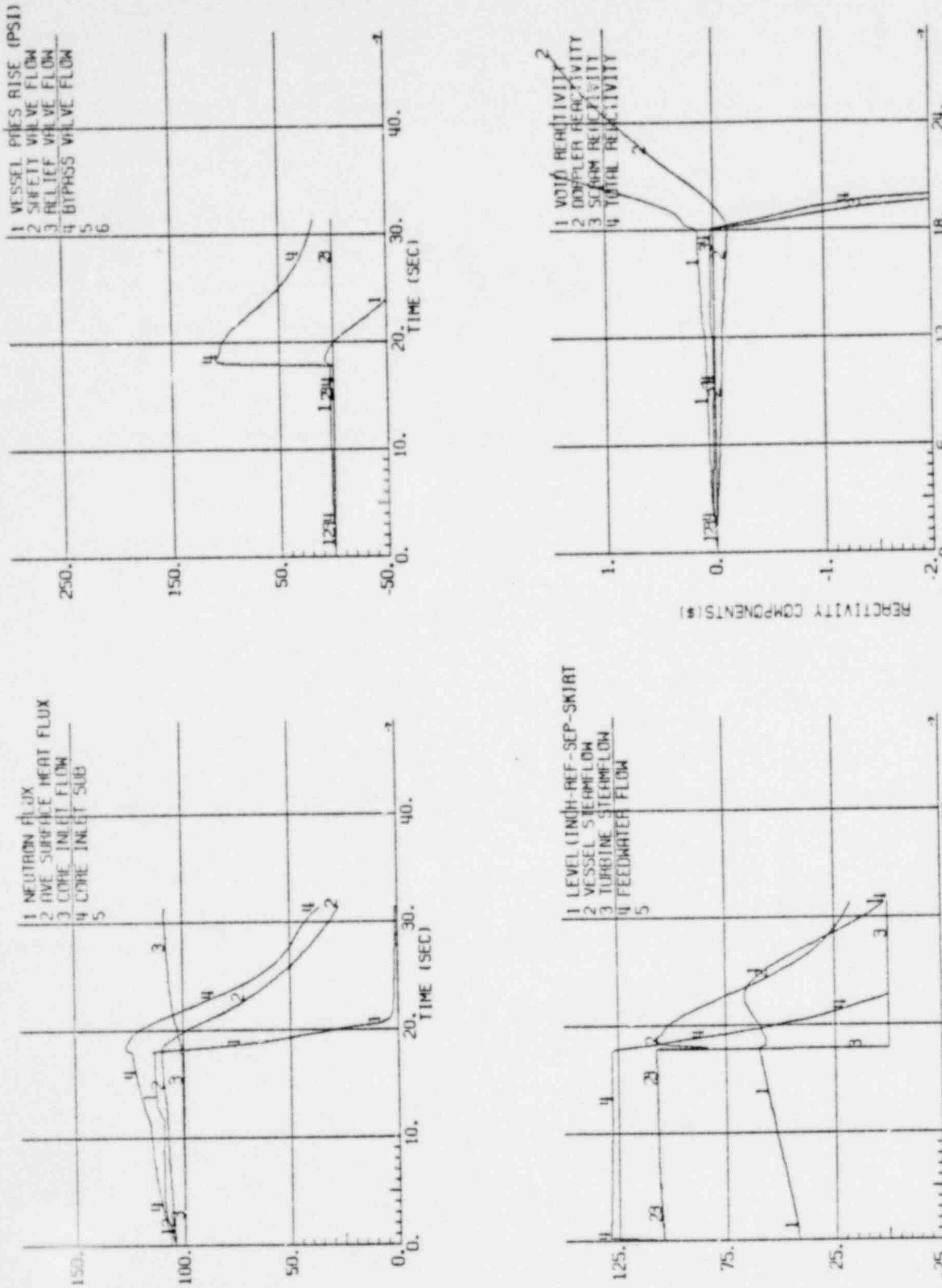

Figure 5. Vermont Yankee BOC7 to EOC7 Feedwater Controller Failure, Maximum Demand With High Level Turbine

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	01	03	05	07	09	11	13	15	17	19	21
01						20					
03			36		8		8		36		
05		4		34		34		34		4	
07			22		10		10		22		
09		30				42				30	
11	4		10		0		0		10		4
13											
15											
17											
19											
21											

Notes:

1. Rod Pattern Is 1/2 Core Symmetric, Upper Half Shown on Map.
2. Numbers Indicate Number of Notches Withdrawn out of 48. Blank Is a Withdrawn Rod.
3. Error Rod Is at 09,11.

Figure 6. Limiting Rod Pattern for RWE

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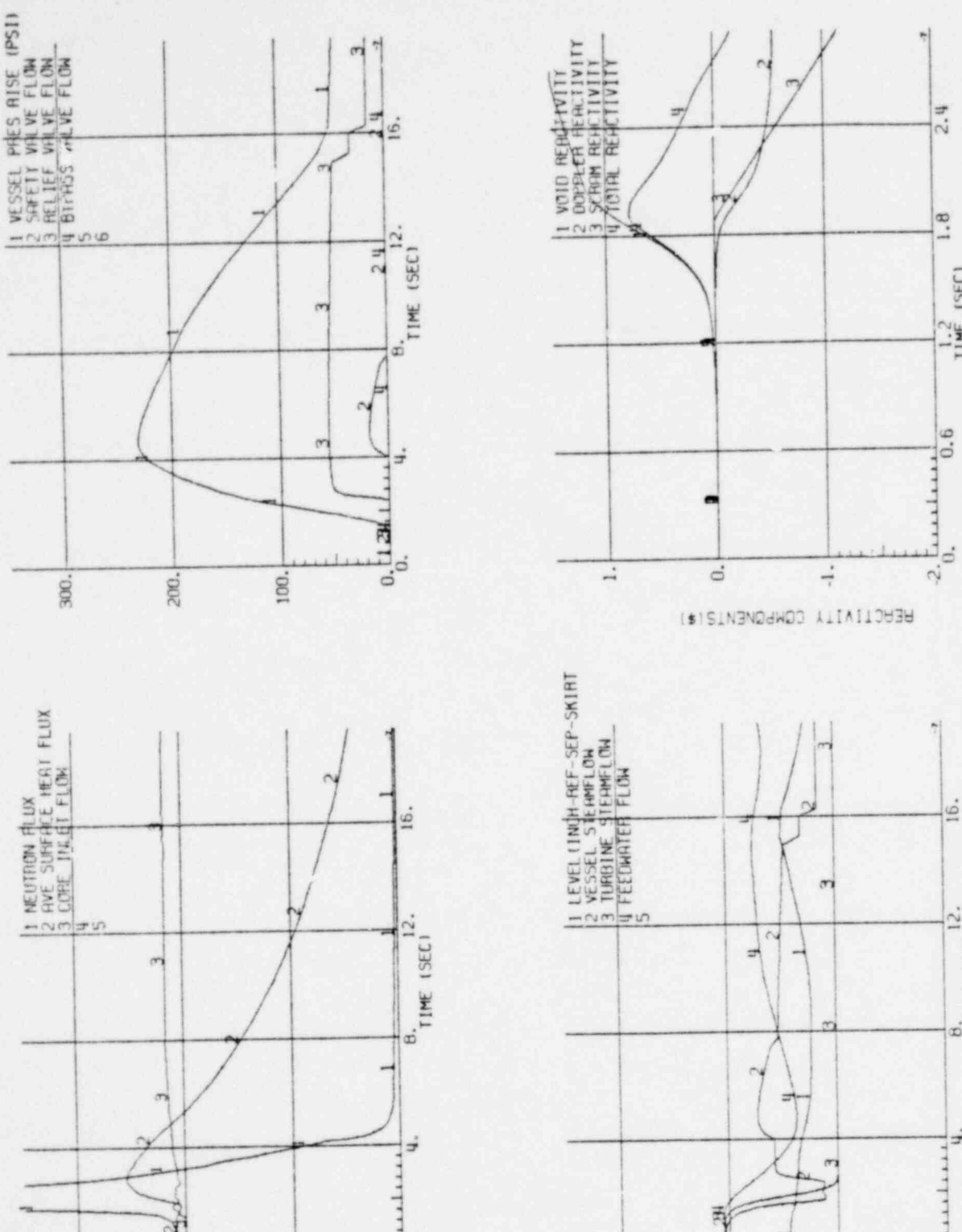

Figure 7. Vermont Yankee EOC7 MSIV Closure, Flux Scram

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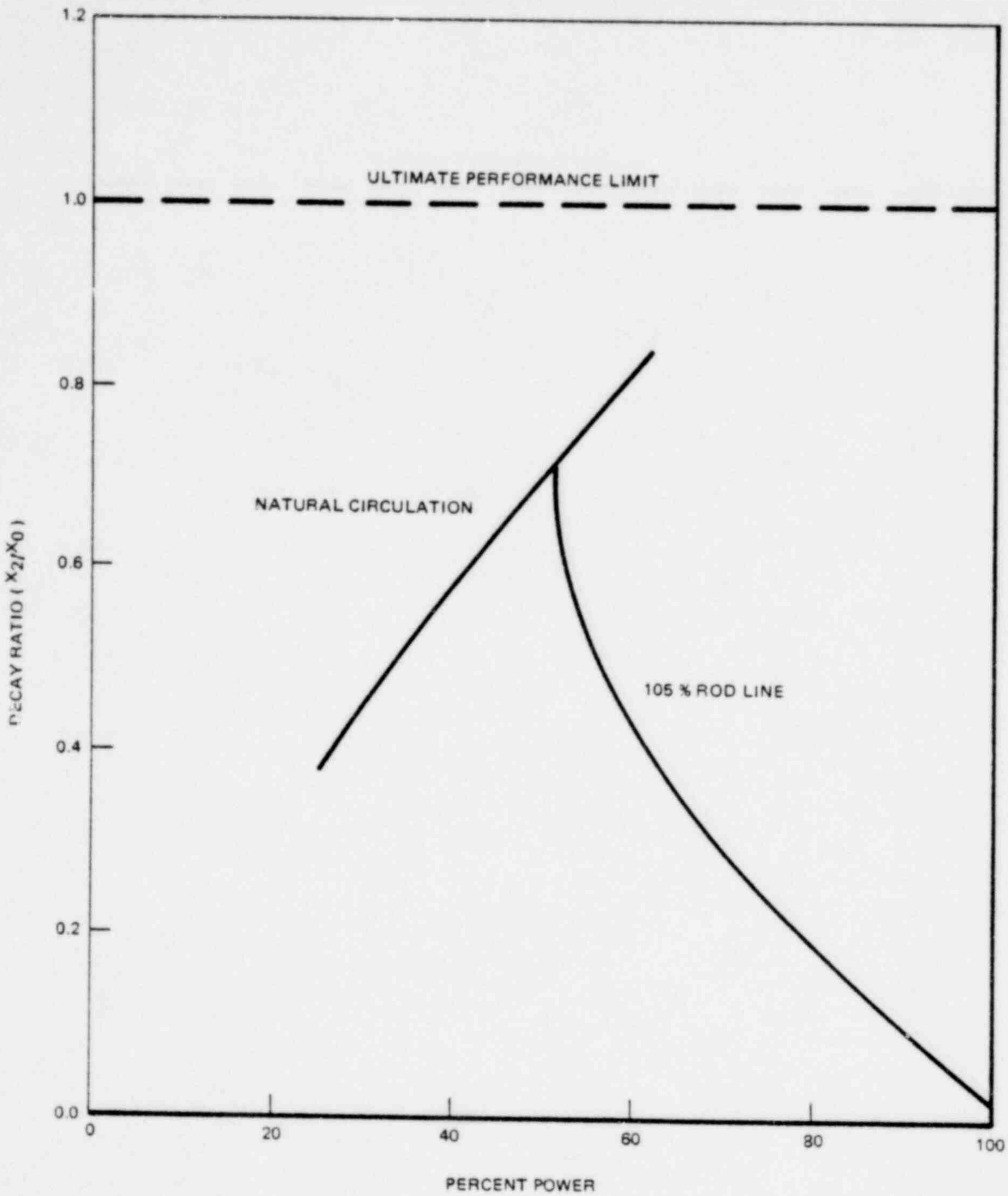

Figure 8. Decay Ratio

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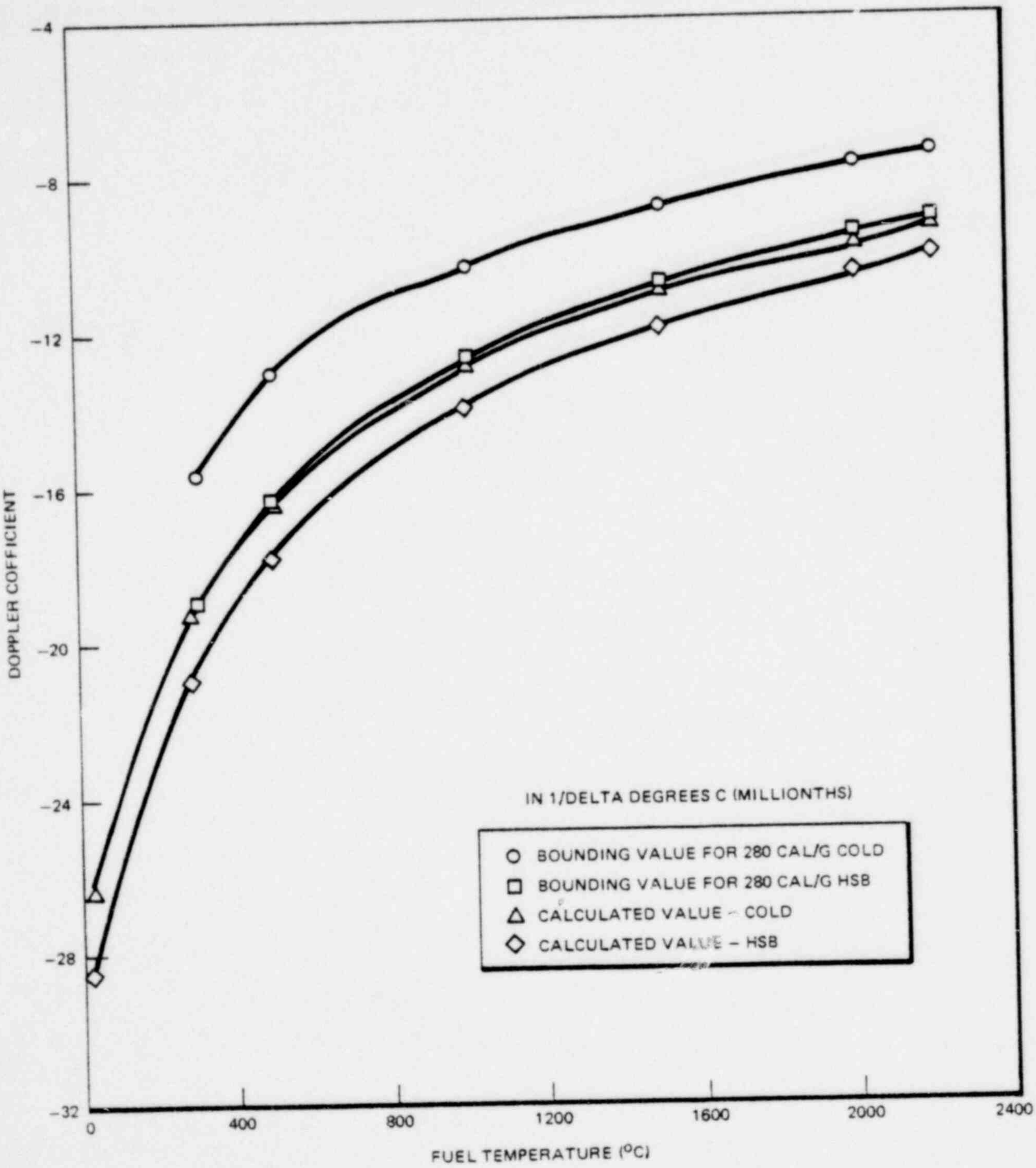

Figure 9. Fuel Doppler Coefficient

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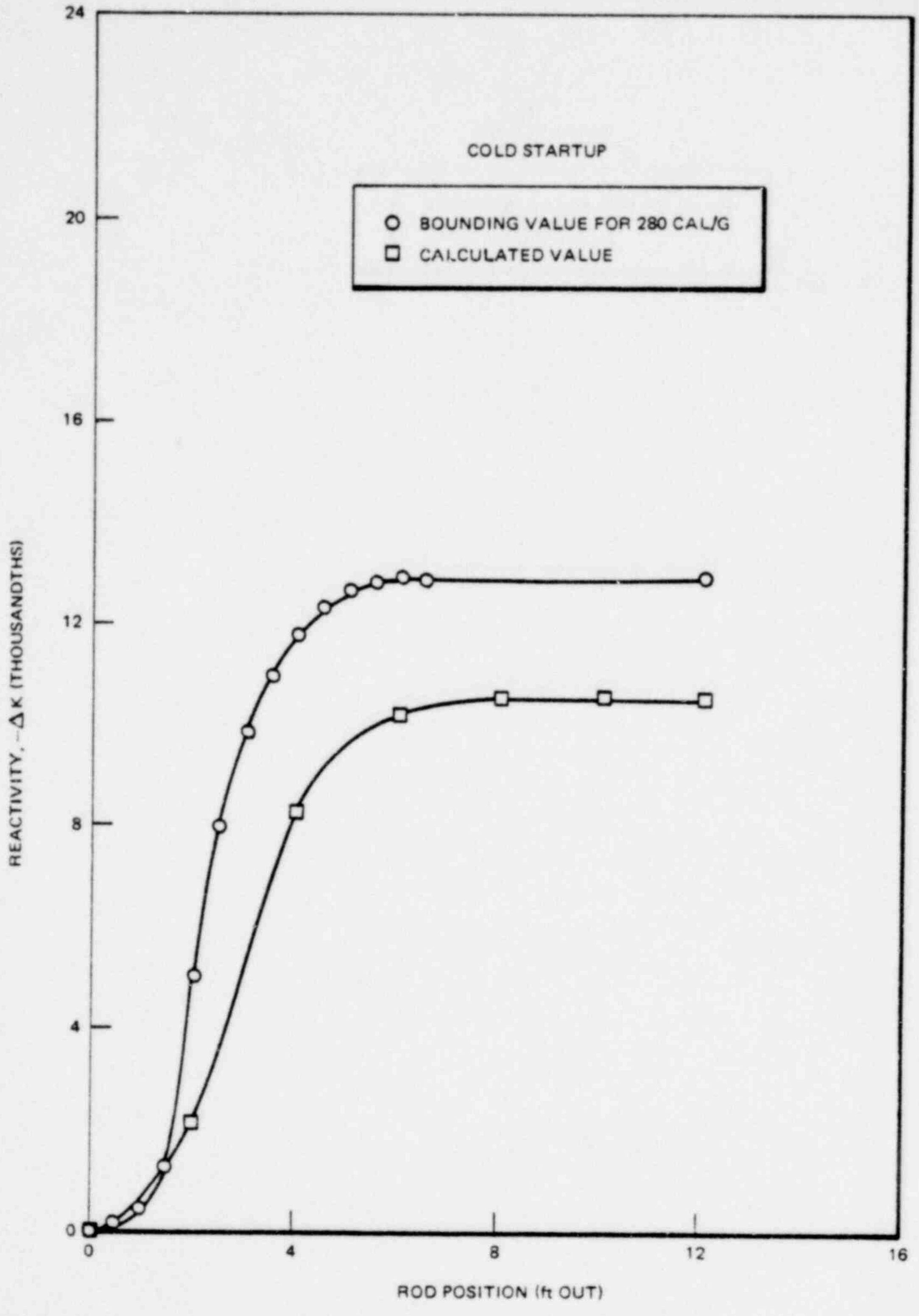

Figure 10. Accident Reactivity Shape Function at 20°C

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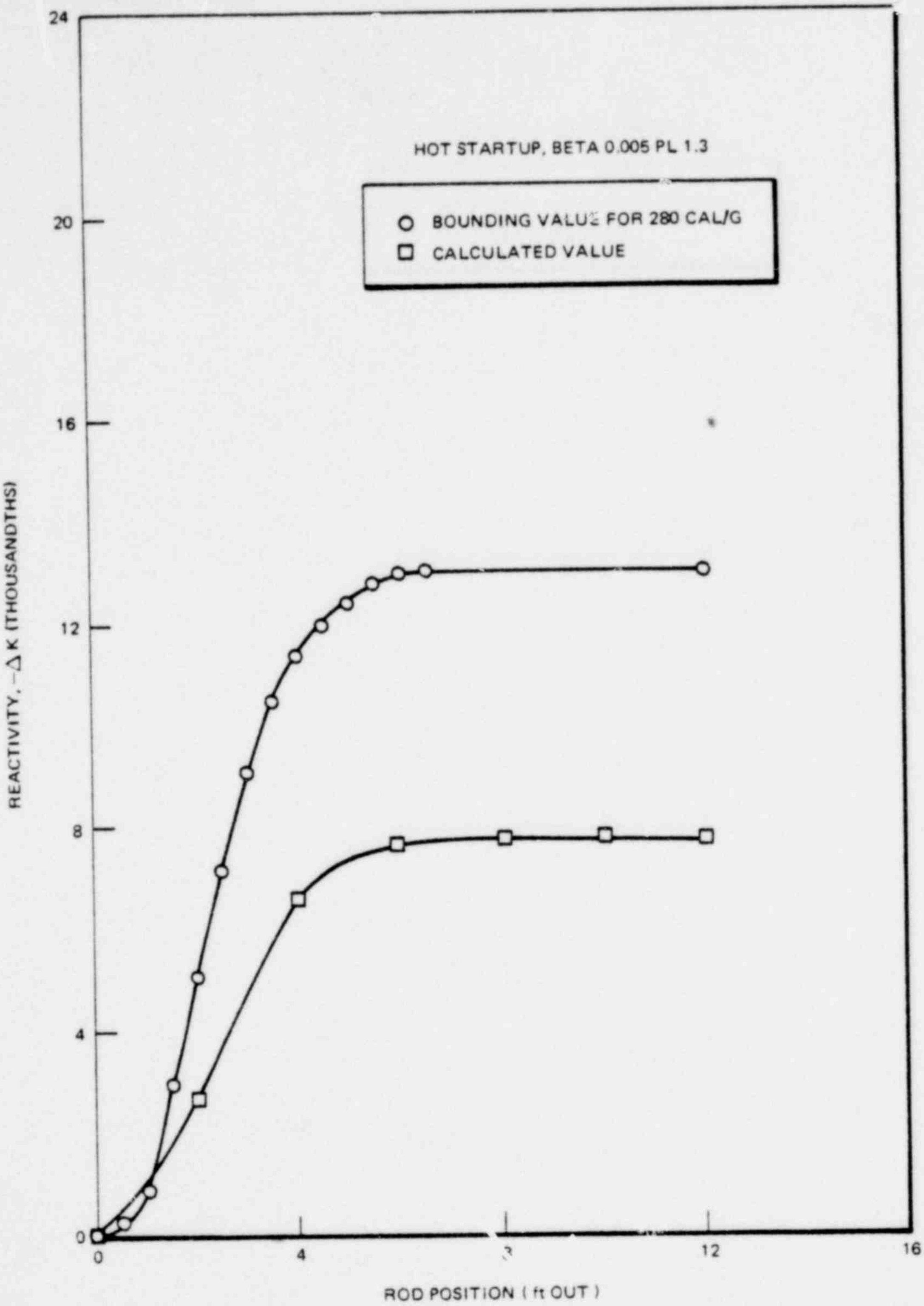

Figure 11. Accident Reactivity Shape Function at 286°C

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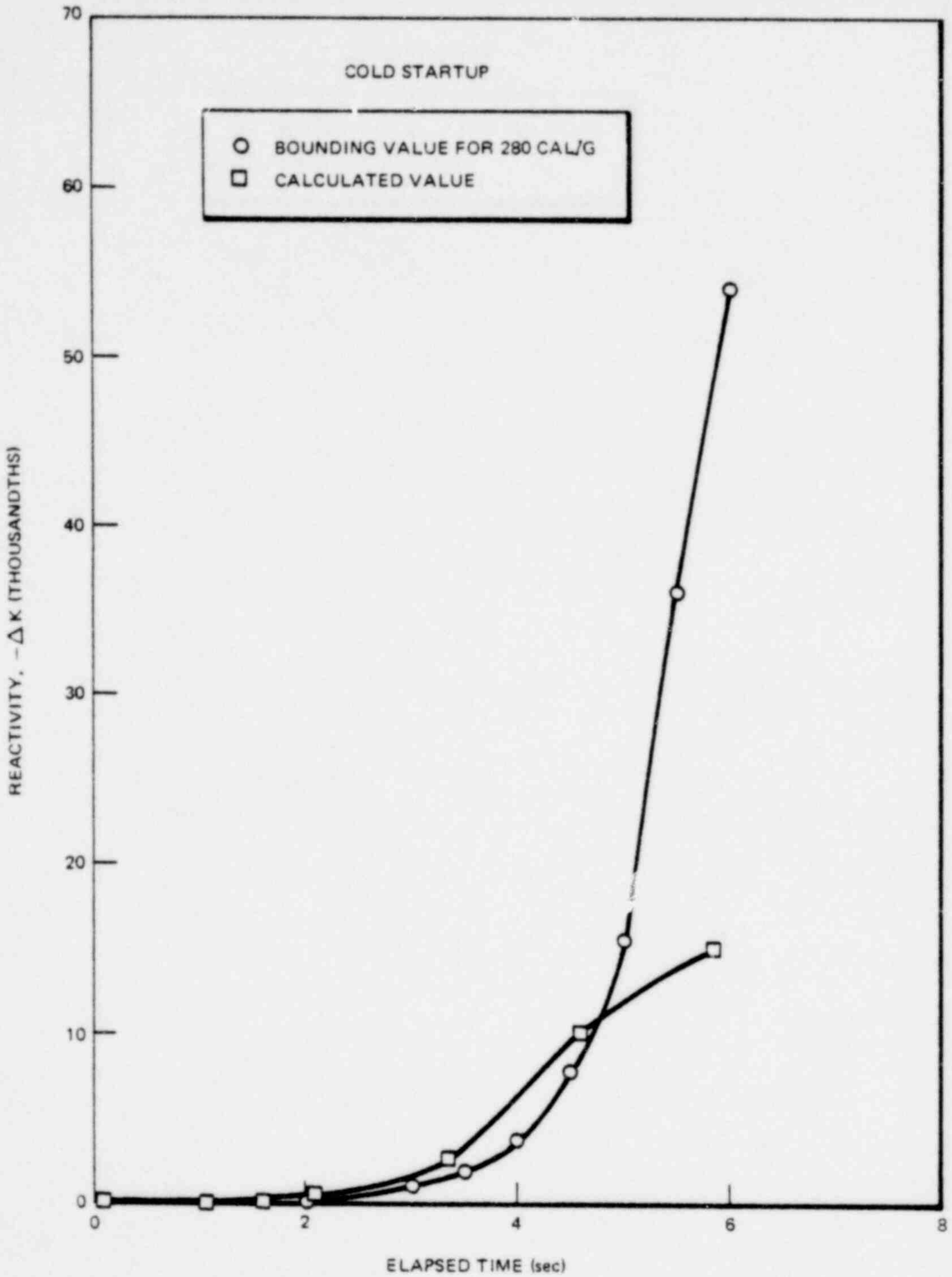

Figure 12. Scram Reactivity Function at 20°C

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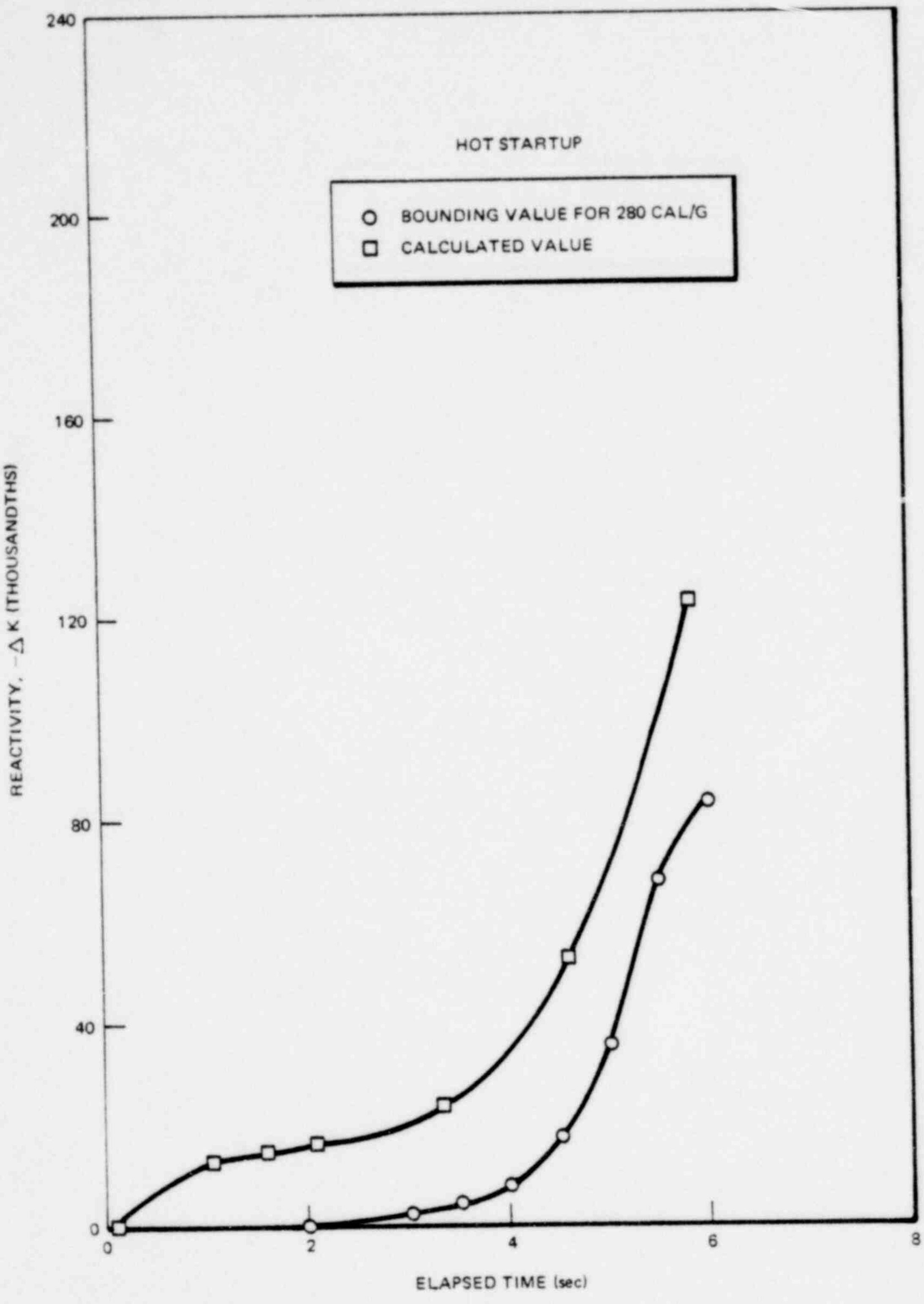

Figure 13. Scram Reactivity Function at 286°C

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APPENDIX A to NEDO-24208

11. OPERATING MCPR LIMIT (5.2)

If, during steady-state operation, the off-gas activity as measured at the SJAE's exceeds 236,000 μCi/sec for fifteen (15) minutes or 1.18 Ci/sec for one (1) minute, the operating MCPR limit shall be as follows:

	MCPR Operating Limit		
Exposure Range	8x8	8x8R	P8x8R
EO7-1 GWd/t to EOC7	1.28	1.28	1.30
EOC7-2 GWd/t to EOC7-1 GWd/t	1.26	1.26	1.26
BOC7 to EOC7-2 GWd/t	1.26	1.26	1.26

If, during steady-state operation, the off-gas activity as measured at the SJAE's is less than specified above, the operating MCPR limit shall be as follows:

	MCPR Operating Limit		
Exposure Range	8x8	8x8R	P8x8R
EOC7-1 GWd/t to EOC7	1.28	1.28	1.30
EOC7-2 GWd/t to EOC7-1 GWd/t	1.23	1.23	1.24
BOC7 to EOC7-2 GWd/t	1.22	1.22	1.22

15. LOADING ERROR RESULTS (5.5.4)

NEW BUNDLE LOADING ERROR EVENT ANALYSES PROCEDURES

The bundle loading error analyses results presented in Section 15 in this supplement are based on new analyses procedures for both the rotated bundle and the mislocated bundle loading error events. The use of these new analyses procedures is discussed below.

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NEW ANALYSIS PROCEDURE FOR THE ROTATED BUNDLE LOADING ERROR EVENT

The rotated bundle loading error event analysis results presented in this supplement are based on the new analysis procedure decribed and approved in Reference A-1. This new method of performing the analysis is based on a more accurate detailed analytical model.

The principle difference between the previous analysis procedure and the new analysis procedure is the modeling of the water gap along the axial length of the bundle. The previous analysis used a uniform water gap, whereas the new analysis utilizes a variable water gap which is more representative of the actual condition, since the interfacing between the top guide and the fuel spacer buttons, caused by misorientation, causes the bundle to lean. The effect of the variable water gap is to reduce the power peaking and the R-factor in the upper regions of the limiting fuel rod. This results in the calculation of a reduced CPR for the rotated bundle. The calculation was performed using the same analytical models as were previously used. The only change is in the simulation of the water gap, which more accurately represents the actual geometry.

The results of the analysis indicate for the 8DPB289 bundle a 17.5 kW/ft LHGR (includes densification spiking penalty of 2.2%) and 0.19 ΔCPR (includes a 0.02 penalty due to variable wa r gap R-factor uncertainty) with a minimum CPR of 1.07.

NEW ANALYSIS PROCEDURE FOR THE MISLOCATED BUNDLE LOADING ERROR EVENT

The mislocated bundle loading error event analyses results presented in this supplement are based on the new analysis procedure described in Reference A-1. This new method of performing the analysis employs a statistically corrected Haling procedure and analyzes every bundle in the core.

The use of the statistically corrected Haling analyses procedure indicates that the minimum CPR for mislocated bundles (e.g., 8DPB289 into 8D274) is greater than the safety limit (1.07) for all exposures throughout Cycle 7.

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REFERENCES

A-1 Safety Evaluation Report (letter), D. G. Eisenhut (NRC) to R. E. Engel (GE), MFN-200-78, dated May 8, 1978.

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